PTO/AIA/15 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	14970-94702
First Named Inventor	WEI-YU CHEN
Title	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [✔] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✔] **Specification** [*Total Pages* 56] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✔] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 23]
6. **Inventor's Oath or Declaration** [*Total Pages* 1] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [✔] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✔] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s)) Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [✔] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:** _____

***Note**: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✔] The address associated with Customer Number: 24728 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Tim Tingkang Xia/	Date	December 13, 2013
Name (Print/Type)	Tim Tingkang Xia	Registration No. (Attorney/Agent)	45,242

PTO/SB/17 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

FEE TRANSMITTAL

Complete if known	
Application Number	
Filing Date	December 13, 2013
First Named Inventor	WEI-YU CHEN
Examiner Name	
Art Unit	
Practitioner Docket No.	14970-94702

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($) 2080

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 50-3537 Deposit Account Name: Morris, Manning & Martin, LLP

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**Fees Paid ($)**
Utility	280	140*	70	600	300	150	720	360	180	1600
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The $140 small entity status filing fee for a utility application is further reduced to $70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	**Undiscounted Fee ($)**	**Small Entity Fee ($)**	**Micro Entity Fee ($)**
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
26	-20 or HP =	6 x	80	=	480

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
3	-3 or HP =	_____ x	_____	=	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**
_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $400 ($200 for small entity) ($100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**		**Fee Paid ($)**
79	- 100 =	_____	/ 50 =	_____ (round **up** to a whole number)	x _____	=	_____

4. OTHER FEE(S) **Fees Paid ($)**

Non-English specification, $130 fee (no small or micro entity discount) _____

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity) _____

Other (e.g., late filing surcharge): _____ _____

SUBMITTED BY

Signature	/Tim Tingkang Xia/	Registration No. (Attorney/Agent) 45,242	Telephone (404) 495-3678
Name (Print/Type)	Tim Tingkang Xia		Date December 13, 2013

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	WEI-YU		CHEN	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Taichung	Country of Residence i	TW

Mailing Address of Inventor:

Address 1	No.11, Jingke Rd., Nantun District		
Address 2			
City	Taichung	**State/Province**	
Postal Code	408	**Country** i	TW

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	24728		
Email Address	mmmipdocket@system.foundationip.com	Add Email	Remove Email

Application Information:

Title of the Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		
Attorney Docket Number	14970-94702	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	23	**Suggested Figure for Publication (if any)**	1A

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	24728		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) [i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [i] (if applicable)
102139029	TW	2013-10-29	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

(•) Assignee	( ) Legal Representative under 35 U.S.C. 117	( ) Joint Inventor
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. [X]

Organization Name	LARGAN PRECISION CO., LTD.

Mailing Address Information:

Address 1	No.11, Jingke Rd., Nantun District		
Address 2			
City	Taichung	**State/Province**	
Country [i]	TW	Postal Code	408
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).

Remove

If the Assignee is an Organization check here. [ ]

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14970-94702
	Application Number	
Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL	

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information:

Address 1	
Address 2	

City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the Add button. Add

Remove

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Tim Tingkang Xia/			Date (YYYY-MM-DD)	2013-12-13
First Name	Tim Tingkang	Last Name	Xia	Registration Number	45242

Additional Signature may be generated within this form by selecting the Add button. Add

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

RELATED APPLICATIONS

This application claims priority to Taiwan Application Serial Number 102139029, filed October 29, 2013, which is incorporated by reference herein in its entirety.

BACKGROUND

Technical Field

The present disclosure relates to an image capturing lens system. More particularly, the present disclosure relates to a compact image capturing lens system applicable to a mobile terminal.

Description of Related Art

In recent years, with the popularity of mobile terminals having camera functionalities, the demand of miniaturized optical systems has been increasing. As the advanced semiconductor manufacturing technologies have allowed the pixel size of sensors to be reduced and compact optical systems have gradually evolved toward the field of higher megapixels, there is an increasing demand for compact optical systems featuring better image quality.

A conventional compact optical system in a portable electronic product typically utilizes a three-element lens structure. Due to the popularity of mobile products with high-end specifications, such as smart phones, tablet personal computers, wearable apparatus and other high-end mobile terminals, the

requirements for high resolution and image quality of present compact optical systems increase significantly. However, the conventional optical systems cannot satisfy these requirements of the compact optical systems.

Another conventional compact optical system provides a four-element lens structure. However, it is hard to make a good balance between obtaining a large field of view and a short total track length. Furthermore, it is also not favorable for the resolving power and illumination in a peripheral region of an image; therefore, it cannot satisfy the requirements of the compact optical systems featuring better image quality.

SUMMARY

According to one aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the

image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f, a focal length of the fourth lens element is f4, a focal length of the second lens element is f2, and a focal length of the third lens element is f3, the following conditions are satisfied:

$0.5 \text{ mm} < Td < 3.2 \text{ mm}$;

$1.0 \text{ mm} < Td/\tan(HFOV) < 3.75 \text{ mm}$;

$|f/f4| < 1.20$; and

$f2/f3 < -0.65$.

According to another aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal

length of the image capturing lens system is f, a focal length of the fourth lens element is f4, and a focal length of the third lens element is f3, the following conditions are satisfied:

0.5 mm < Td < 3.2 mm;

1.0 mm < Td/tan(HFOV) < 3.75 mm;

|f/f4| < 1.20; and

-2.0 < f/f3 < -0.95.

According to still another aspect of the present disclosure, an image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power. When an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f, a focal length of the fourth lens

element is f4, and an f-number of the image capturing lens system is Fno, the following conditions are satisfied:

0.5 mm < Td < 3.2 mm;

1.0 mm < Td/tan(HFOV) < 3.75 mm;

|f/f4| < 1.20; and

1.40 < Fno ≤ 2.25.

According to yet another aspect of the present disclosure, an imaging device includes the image capturing lens system according to the aforementioned aspect and an image sensor, wherein the image sensor is located on an image plane of the image capturing lens system.

According to still yet another aspect of the present disclosure, a mobile terminal includes the imaging device according to the aforementioned aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure can be more fully understood by reading the following detailed description of the embodiments, with reference made to the accompanying drawings as follows:

Fig. 1A is a schematic view of an imaging device according to the 1st embodiment of the present disclosure;

Fig. 1B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 1st embodiment;

Fig. 2A is a schematic view of an imaging device according to the 2nd embodiment of the present disclosure;

Fig. 2B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 2nd embodiment;

Fig. 3A is a schematic view of an imaging device according to the 3rd embodiment of the present disclosure;

Fig. 3B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 3rd embodiment;

Fig. 4A is a schematic view of an imaging device according to the 4th embodiment of the present disclosure;

Fig. 4B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 4th embodiment;

Fig. 5A is a schematic view of an imaging device according to the 5th embodiment of the present disclosure;

Fig. 5B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 5th embodiment;

Fig. 6A is a schematic view of an imaging device according to the 6th embodiment of the present disclosure;

Fig. 6B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 6th embodiment;

Fig. 7A is a schematic view of an imaging device according to the 7th embodiment of the present disclosure;

Fig. 7B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 7th embodiment;

Fig. 8A is a schematic view of an imaging device according to the 8th embodiment of the present disclosure;

Fig. 8B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 8th embodiment;

Fig. 9A is a schematic view of an imaging device according to the 9th embodiment of the present disclosure;

Fig. 9B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 9th embodiment;

Fig. 10A is a schematic view of an imaging device according to the 10th embodiment of the present disclosure;

Fig. 10B shows spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 10th embodiment;

Fig. 11A shows a smart phone with an imaging device of the present disclosure installed therein;

Fig. 11B shows a tablet personal computer with an imaging device of the present disclosure installed therein; and

Fig. 11C shows a wearable device with an imaging device of the present disclosure installed therein.

DETAILED DESCRIPTION

An image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The image capturing lens system has a total of four lens elements with refractive power.

The first lens element can have positive refractive power, so that it provides the image capturing lens system with the positive refractive power as it needs to be so as to reduce the total track length of the image capturing lens system. The first lens element can have a convex object-side surface in a

paraxial region thereof, so that it is favorable for further reducing the total track length.

The second lens element has positive refractive power, so that it is favorable for the second lens element adjusting the light gathering ability of the first lens element. The second lens element has a convex image-side surface in a paraxial region thereof, so that it is favorable for correcting the astigmatism of the image capturing lens system.

The third lens element has negative refractive power, so that it is favorable for correcting the aberration of the image capturing lens system. The third lens element has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof, so that it is favorable for correcting the astigmatism of the image capturing lens system.

The fourth lens element can have a convex object-side surface in a paraxial region thereof and has a concave image-side surface in a paraxial region thereof. Furthermore, the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof. Therefore, it is favorable for correcting the astigmatism and aberration of the off-axis.

When an axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and the following condition is satisfied: $0.5\ mm < Td < 3.2\ mm$. Therefore, it is favorable for keeping the image capturing lens system compact. Preferably, the following condition is satisfied: $0.8\ mm < Td < 2.5\ mm$.

When the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and half of a maximal field of view of the image capturing lens system is HFOV, the

following condition is satisfied: 1.0 mm < Td/tan(HFOV) < 3.75 mm. Therefore, it is favorable for obtaining a large field of view and short total track length for the image capturing lens system. Preferably, the following condition is satisfied: 1.2 mm < Td/tan(HFOV) < 2.75 mm.

When a focal length of the image capturing lens system is f, and a focal length of the fourth lens element is f4, the following condition is satisfied: |f/f4| < 1.20. Therefore, it is favorable for the principal point of the image capturing lens system being positioned away from the image plane so as to reduce the total track length and keep the image capturing lens system compact.

When a focal length of the second lens element is f2, and a focal length of the third lens element is f3, the following condition is satisfied: f2/f3 < -0.65. Therefore, it is favorable for balancing the refractive powers of the second lens element and the third lens element so as to correct the aberration and reduce the photosensitivity. Preferably, the following condition is satisfied: f2/f3 < -0.75.

When the focal length of the image capturing lens system is f, and the focal length of the third lens element is f3, the following condition is satisfied: -2.0 < f/f3 < -0.95. Therefore, the third lens element serves as a correcting lens for balancing and correcting the aberrations of the image capturing lens system so as to obtain better image quality.

When an f-number of the image capturing lens system is Fno, and the following condition is satisfied: 1.40 < Fno ≤ 2.25. Therefore, it is favorable for improving the illumination in a peripheral region of the image capturing lens system.

When the focal length of the image capturing lens system is f, and a focal length of the first lens element is f1, the following condition is satisfied: $-0.25 < f/f1 < 0.75$. Therefore, the first lens element will have a more proper refractive power so as to avoid excess photosensitivity. Preferably, the following condition is satisfied: $0.25 < f/f1 < 0.75$.

When a curvature radius of the object-side surface of the second lens element is R3, and a curvature radius of the image-side surface of the second lens element is R4, the following condition is satisfied: $0.5 < (R3+R4)/(R3-R4) < 2.5$. Therefore, it is favorable for further correcting the aberration of the image capturing lens system.

When the focal length of the image capturing lens system is f, and the following condition is satisfied: $0.5 \text{ mm} < f < 2.0 \text{ mm}$. Therefore, it is favorable for providing a proper total track length.

When a sum of the central thicknesses of the first lens element, the second lens element, the third lens element, and the fourth lens element is ΣCT, and the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, the following condition is satisfied: $0.80 < \Sigma CT/Td < 0.95$. Therefore, it is favorable for assembling the lens elements of the image capturing lens system so as to reduce the photosensitivity.

When an Abbe number of the first lens element is V1, and the following condition is satisfied: $45 < V1$. Therefore, it is favorable for correcting the chromatic aberration of the image capturing lens system.

When a central thickness of the second lens element is CT2, a central thickness of the first lens element is CT1, a central thickness of the third lens

element is CT3, and a central thickness of the fourth lens element is CT4, the following condition is satisfied: $0.65 < CT2/(CT1+CT3+CT4) < 2.0$. Therefore, the thickness of each lens element is favorable for manufacturing and assembling the lens elements.

When a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied: 80 degrees < FOV < 110 degrees. Therefore, it is favorable for obtaining enough field of view.

According to the image capturing lens system of the present disclosure, the lens elements thereof can be made of glass or plastic material. When the lens elements are made of glass material, the distribution of the refractive power of the image capturing lens system may be more flexible to design. When the lens elements are made of plastic material, the manufacturing cost can be effectively reduced. Furthermore, surfaces of each lens element can be arranged to be aspheric, since the aspheric surface of the lens element is easy to form a shape other than spherical surface so as to have more controllable variables for eliminating the aberration thereof, and to further decrease the required number of the lens elements. Therefore, the total track length of the image capturing lens system can also be reduced.

According to the image capturing lens system of the present disclosure, each of an object-side surface in a paraxial region thereof and an image-side surface has a paraxial region and an off-axis region. The paraxial region refers to the region of the surface where light rays travel close to the optical axis, and the off-axis region refers to the region of the surface where light rays travel away from the optical axis. Particularly, when the lens element has a convex surface, it indicates that the surface is convex in the paraxial region thereof;

when the lens element has a concave surface, it indicates that the surface is concave in the paraxial region thereof.

According to the image capturing lens system of the present disclosure, the image capturing lens system can include at least one stop, such as an aperture stop, a glare stop or a field stop. Said glare stop or said field stop is for eliminating the stray light and thereby improving the image resolution thereof.

According to the image capturing lens system of the present disclosure, an aperture stop can be configured as a front stop or a middle stop. A front stop disposed between an imaged object and the first lens element can provide a longer distance between an exit pupil of the image capturing lens system and the image plane and thereby improves the image-sensing efficiency of an image sensor. A middle stop disposed between the first lens element and the image plane is favorable for enlarging the field of view of the image capturing lens system and thereby provides a wider field of view for the same.

The present image capturing lens system can be optionally applied to moving focus optical systems. According to the image capturing lens system of the present disclosure, the image capturing lens system is featured with good correction ability and high image quality, and can be applied to 3D (three-dimensional) image capturing applications, in products such as digital cameras, mobile devices, digital tablets, wearable devices and other mobile terminals.

According to the present disclosure, an imaging device is provided. The imaging device includes the image capturing lens system according to the aforementioned image capturing lens system of the present disclosure, and an

image sensor, wherein the image sensor is disposed on an image plane of the aforementioned image capturing lens system. As a result, it is favorable for reducing the total track length of the image capturing lens system while obtaining large field of view. Furthermore, it is also favorable for improving the resolving power and illumination so as to achieve the best image quality. Preferably, the imaging device can further include a barrel member, a holding member or a combination thereof.

According to the present disclosure, a mobile terminal is provided, wherein the mobile terminal includes the aforementioned imaging device. The imaging device includes the image capturing lens system according to the aforementioned image capturing lens system of the present disclosure, and the image sensor, wherein the image sensor is disposed on an image plane of the aforementioned image capturing lens system. As a result, it is favorable for reducing the total track length of the image capturing lens system while obtaining large field of view. Furthermore, it is also favorable for improving the resolving power and illumination so as to achieve the best image quality.

In Fig. 11A, Fig. 11B and Fig. 11C, an imaging device 1101 may be installed in but not limited to a mobile terminal, including a smart phone 1110, a tablet personal computer 1120 or a wearable device 1130. The three exemplary figures of different kinds of mobile terminal are only exemplary for showing the imaging device of present disclosure installing in a mobile terminal and is not limited thereto. Preferably, the mobile terminal can further include but not limited to display, control unit, random access memory unit (RAM) a read only memory unit (ROM) or a combination thereof.

According to the above description of the present disclosure, the following 1st – 10th specific embodiments are provided for further explanation.

1st Embodiment

Fig. 1A is a schematic view of an imaging device according to the 1st embodiment of the present disclosure. Fig. 1B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 1st embodiment.

In Fig. 1A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor 170. The image capturing lens system includes, in order from an object side to an image side, a first lens element 110, an aperture stop 100, a second lens element 120, a third lens element 130, a fourth lens element 140, an IR-cut filter 150 and an image plane 160, wherein the image capturing lens system has a total of four lens elements (110-140) with refractive power.

The first lens element 110 with positive refractive power has a convex object-side surface 111 in a paraxial region thereof and a concave image-side surface 112 in a paraxial region thereof, which are both aspheric, and the first lens element 110 is made of plastic material.

The second lens element 120 with positive refractive power has a convex object-side surface 121 in a paraxial region thereof and a convex image-side surface 122 in a paraxial region thereof, which are both aspheric, and the second lens element 120 is made of plastic material.

The third lens element 130 with negative refractive power has a concave object-side surface 131 in a paraxial region thereof and a convex image-side

surface 132 in a paraxial region thereof, which are both aspheric, and the third lens element 130 is made of plastic material.

The fourth lens element 140 with positive refractive power has a convex object-side surface 141 in a paraxial region thereof and a concave image-side surface 142 in a paraxial region thereof, which are both aspheric, and the fourth lens element 140 is made of plastic material. Furthermore, the image-side surface 142 of the fourth lens element 140 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 150 is made of glass and located between the fourth lens element 140 and the image plane 160, and will not affect the focal length of the image capturing lens system. The image sensor 170 is disposed on the image plane 160 of the image capturing lens system.

The equation of the aspheric surface profiles of the aforementioned lens elements of the 1st embodiment is expressed as follows:

$$X(Y)=(Y^2/R)/\left(1+sqrt\left(1-(1+k)\times(Y/R)^2\right)\right)+\sum_i(Ai)\times(Y^i)$$

, where,

X is the relative distance between a point on the aspheric surface spaced at a distance Y from the optical axis and the tangential plane at the aspheric surface vertex on the optical axis;

Y is the vertical distance from the point on the aspheric surface to the optical axis;

R is the curvature radius;

k is the conic coefficient; and

Ai is the i-th aspheric coefficient.

In the image capturing lens system of the imaging device according to the 1st embodiment, when a focal length of the image capturing lens system is f, an f-number of the image capturing lens system is Fno, and half of a maximal field of view of the image capturing lens system is HFOV, these parameters have the following values: f = 1.17 mm; Fno = 2.20; and HFOV = 46.7 degrees.

In the image capturing lens system of the imaging device according to the 1st embodiment, when an Abbe number of the first lens element 110 is V1, the following condition is satisfied: V1 = 21.4.

In the image capturing lens system according to the 1st embodiment, when a central thickness of the second lens element 120 is CT2, a central thickness of the first lens element 110 is CT1, a central thickness of the third lens element 130 is CT3, and a central thickness of the fourth lens element 140 is CT4, the following condition is satisfied: CT2/(CT1+CT3+CT4) = 0.69.

In the image capturing lens system according to the 1st embodiment, when a curvature radius of the object-side surface 121 of the second lens element 120 is R3, and a curvature radius of the image-side surface 122 of the second lens element 120 is R4, the following condition is satisfied: (R3+R4)/(R3-R4) = 0.85.

In the image capturing lens system of the imaging device according to the 1st embodiment, when the focal length of the image capturing lens system is f, and a focal length of the first lens element 110 is f1, the following condition is satisfied: f/f1 = 0.12.

In the image capturing lens system of the imaging device according to the 1st embodiment, when a focal length of the second lens element 120 is f2,

and a focal length of the third lens element 130 is f3, the following condition is satisfied: f2/f3 = -0.77.

In the image capturing lens system of the imaging device according to the 1st embodiment, when the focal length of the image capturing lens system is f, and a focal length of the fourth lens element 140 is f4, the following condition is satisfied: |f/f4| = 0.77.

In the image capturing lens system of the imaging device according to the 1st embodiment, when the focal length of the image capturing lens system is f, and the focal length of the third lens element 130 is f3, the following condition is satisfied: f/f3 = -1.10.

In the image capturing lens system according to the 1st embodiment, when an axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is Td, the following condition is satisfied: Td = 1.850 mm.

In the image capturing lens system according to the 1st embodiment, when a sum of the central thicknesses of the first lens element 110, the second lens element 120, the third lens element 130, and the fourth lens element 140 is ΣCT, and the axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is Td, the following condition is satisfied: ΣCT/Td = 0.89.

In the image capturing lens system according to the 1st embodiment, when the axial distance between the object-side surface 111 of the first lens element 110 and the image-side surface 142 of the fourth lens element 140 is Td, and half of the maximal field of view of the image capturing lens system is HFOV, the following condition is satisfied: Td/tan(HFOV) = 1.74 mm.

In the image capturing lens system of the imaging device according to the 1st embodiment, when a maximal field of view of the image capturing lens system is FOV, the following condition is satisfied: FOV = 93.4 degrees.

The detailed optical data of the 1st embodiment are shown in Table 1 and the aspheric surface data are shown in Table 2 below.

TABLE 1								
Embodiment 1								
f = 1.17 mm, Fno = 2.20, HFOV = 46.7 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.666	ASP	0.256	Plastic	1.650	21.4	9.56
2		2.139	ASP	0.031				
3	Ape. Stop	Plano		0.019				
4	Lens 2	5.712	ASP	0.671	Plastic	1.544	55.9	0.82
5		-0.464	ASP	0.130				
6	Lens 3	-0.228	ASP	0.230	Plastic	1.634	23.8	-1.06
7		-0.480	ASP	0.030				
8	Lens 4	0.679	ASP	0.483	Plastic	1.535	55.7	1.52
9		3.062	ASP	0.300				
10	IR-cut filter	Plano		0.145	Glass	1.517	64.2	-
11		Plano		0.204				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

TABLE 2				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.2237E+00	1.7244E+01	9.0000E+01	-6.9311E-01
A4 =	3.1416E-01	1.1703E+00	-4.1498E-01	-6.9345E-01
A6 =	-1.0010E+00	-2.0080E+01	3.6416E+00	1.3202E+00
A8 =	4.5872E+01	5.2569E+02	4.3035E+01	1.0955E+01
A10 =	-5.9339E+02	-3.0044E+03	-7.4996E+03	-3.8285E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0040E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
Surface #	6	7	8	9

k =	-9.8477E-01	-3.2669E+00	-6.1619E-01	-1.4636E+01
A4 =	3.5682E+00	-1.8915E+00	-1.2870E+00	1.2883E+00
A6 =	-3.7958E+00	8.7075E+00	3.1244E+00	-3.7603E+00
A8 =	-1.1135E+02	-3.6761E+01	-9.1933E+00	5.9040E+00
A10 =	1.5862E+03	1.7257E+02	1.7146E+01	-5.8521E+00
A12 =	-8.7685E+03	-4.8146E+02	-1.9850E+01	3.5356E+00
A14 =	2.3054E+04	6.7728E+02	1.2752E+01	-1.1759E+00
A16 =	-2.3557E+04	-3.6747E+02	-3.5165E+00	1.6169E-01

In Table 1, the curvature radius, the thickness and the focal length are shown in millimeters (mm). Surface numbers 0-12 represent the surfaces sequentially arranged from the object-side to the image-side along the optical axis. In Table 2, k represents the conic coefficient of the equation of the aspheric surface profiles. A1-A16 represent the aspheric coefficients ranging from the 1st order to the 16th order. The tables presented below for each embodiment are the corresponding schematic parameter and aberration curves, and the definitions of the tables are the same as Table 1 and Table 2 of the 1st embodiment. Therefore, an explanation in this regard will not be provided again.

2nd Embodiment

Fig. 2A is a schematic view of an imaging device according to the 2nd embodiment of the present disclosure. Fig. 2B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 2nd embodiment.

In Fig. 2A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor 270. The image capturing lens system includes, in order from an object side to

an image side, a first lens element 210, an aperture stop 200, a second lens element 220, a third lens element 230, a fourth lens element 240, an IR-cut filter 250 and an image plane 260, wherein the image capturing lens system has a total of four lens elements (210-240) with refractive power.

The first lens element 210 with positive refractive power has a convex object-side surface 211 in a paraxial region thereof and a concave image-side surface 212 in a paraxial region thereof, which are both aspheric, and the first lens element 210 is made of plastic material.

The second lens element 220 with positive refractive power has a convex object-side surface 221 in a paraxial region thereof and a convex image-side surface 222 in a paraxial region thereof, which are both aspheric, and the second lens element 220 is made of plastic material.

The third lens element 230 with negative refractive power has a concave object-side surface 231 in a paraxial region thereof and a convex image-side surface 232 in a paraxial region thereof, which are both aspheric, and the third lens element 230 is made of plastic material.

The fourth lens element 240 with positive refractive power has a convex object-side surface 241 in a paraxial region thereof and a concave image-side surface 242 in a paraxial region thereof, which are both aspheric, and the fourth lens element 240 is made of plastic material. Furthermore, the image-side surface 242 of the fourth lens element 240 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 250 is made of glass and located between the fourth lens element 240 and the image plane 260, and will not affect the focal length of the

image capturing lens system. The image sensor 270 is disposed on the image plane 260 of the image capturing lens system.

The detailed optical data of the 2nd embodiment are shown in Table 3 and the aspheric surface data are shown in Table 4 below.

TABLE 3								
Embodiment 2								
f = 1.23 mm, Fno = 2.45, HFOV = 45.6 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.728	ASP	0.217	Plastic	1.640	22.0	1207.16
2		1.647	ASP	0.041				
3	Ape. Stop	Plano		0.020				
4	Lens 2	2.201	ASP	0.685	Plastic	1.544	55.9	0.78
5		-0.465	ASP	0.138				
6	Lens 3	-0.213	ASP	0.222	Plastic	1.634	23.8	-0.90
7		-0.479	ASP	0.030				
8	Lens 4	0.691	ASP	0.430	Plastic	1.535	55.7	1.40
9		7.112	ASP	0.300				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.171				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 4				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-7.8611E-01	2.2256E+01	4.4287E+01	-6.8249E-01
A4 =	2.7433E-01	3.5449E-01	-1.1581E+00	-5.9944E-01
A6 =	-1.5466E+00	-2.9377E+01	8.9406E-01	3.6061E-01
A8 =	4.7455E+01	6.4129E+02	4.1870E+01	1.6896E+01
A10 =	-6.0092E+02	-3.8207E+03	-7.3180E+03	-3.8194E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0043E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
Surface #	6	7	8	9
k =	-1.0107E+00	-3.0532E+00	-7.4231E-01	2.2155E+01
A4 =	3.8803E+00	-1.7079E+00	-1.1152E+00	1.6267E+00
A6 =	-4.2860E+00	8.7245E+00	2.9613E+00	-4.5228E+00
A8 =	-1.1314E+02	-3.7291E+01	-9.2058E+00	6.4630E+00

A10 =	1.5859E+03	1.7181E+02	1.7048E+01	-5.8730E+00
A12 =	-8.7686E+03	-4.8143E+02	-1.9563E+01	3.4083E+00
A14 =	2.3054E+04	6.7878E+02	1.3110E+01	-1.1920E+00
A16 =	-2.3557E+04	-3.6776E+02	-4.1607E+00	1.9105E-01

In the 2nd embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 2nd embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 3 and Table 4 as the following values and satisfy the following conditions:

2nd Embodiment			
f [mm]	1.23	f2/f3	-0.87
Fno	2.45	|f/f4|	0.88
HFOV [deg.]	45.6	f/f3	-1.37
V1	22.0	Td [mm]	1.783
CT2/(CT1+CT3+CT4)	0.79	ΣCT/Td	0.87
(R3+R4)/(R3-R4)	0.65	Td/tan(HFOV) [mm]	1.75
f/f1	0.00	FOV [deg.]	91.2

3rd Embodiment

Fig. 3A is a schematic view of an imaging device according to the 3rd embodiment of the present disclosure. Fig. 3B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 3rd embodiment.

In Fig. 3A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

370. The image capturing lens system includes, in order from an object side to an image side, a first lens element 310, an aperture stop 300, a second lens element 320, a third lens element 330, a fourth lens element 340, an IR-cut filter 350 and an image plane 360, wherein the image capturing lens system has a total of four lens elements (310-340) with refractive power.

The first lens element 310 with positive refractive power has a convex object-side surface 311 in a paraxial region thereof and a concave image-side surface 312 in a paraxial region thereof, which are both aspheric, and the first lens element 310 is made of plastic material.

The second lens element 320 with positive refractive power has a concave object-side surface 321 in a paraxial region thereof and a convex image-side surface 322 in a paraxial region thereof, which are both aspheric, and the second lens element 320 is made of plastic material.

The third lens element 330 with negative refractive power has a concave object-side surface 331 in a paraxial region thereof and a convex image-side surface 332 in a paraxial region thereof, which are both aspheric, and the third lens element 330 is made of plastic material.

The fourth lens element 340 with positive refractive power has a convex object-side surface 341 in a paraxial region thereof and a concave image-side surface 342 in a paraxial region thereof, which are both aspheric, and the fourth lens element 340 is made of plastic material. Furthermore, the image-side surface 342 of the fourth lens element 340 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 350 is made of glass and located between the fourth lens element 340 and the image plane 360, and will not affect the focal length of the

image capturing lens system. The image sensor 370 is disposed on the image plane 360 of the image capturing lens system.

The detailed optical data of the 3rd embodiment are shown in Table 5 and the aspheric surface data are shown in Table 6 below.

TABLE 5								
Embodiment 3								
f = 1.66 mm, Fno = 2.15, HFOV = 46.8 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.333	ASP	0.286	Plastic	1.544	55.9	2.50
2		59.851	ASP	0.005				
3	Ape. Stop	Plano		0.195				
4	Lens 2	-1.920	ASP	0.409	Plastic	1.544	55.9	1.60
5		-0.644	ASP	0.156				
6	Lens 3	-0.263	ASP	0.200	Plastic	1.650	21.4	-1.49
7		-0.470	ASP	0.030				
8	Lens 4	0.677	ASP	0.363	Plastic	1.535	55.7	2.33
9		1.206	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.431				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								
The effective radius of Surface 1 is 0.510 mm.								

5

TABLE 6				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-2.4704E+00	9.0000E+01	5.8947E+00	-3.7972E-01
A4 =	-3.4848E-02	-3.8775E-01	-9.3075E-01	-3.3741E-01
A6 =	-4.4471E-01	-2.8417E+00	3.6516E+00	9.2277E-01
A8 =	-4.9925E-01	1.8185E+01	-4.0769E+01	-3.9461E+00
A10 =	-1.2166E+01	-2.0954E+01	-4.4351E+00	-1.9037E+01
A12 =	3.9114E+01	-1.4998E+03	1.2130E+03	4.9148E+01
A14 =	-1.7950E+02	1.2389E+04	-4.4615E+03	1.0076E+02
A16 =	3.3572E+02	-2.9058E+04	6.2425E+03	8.0489E+01
Surface #	6	7	8	9
k =	-1.1491E+00	-2.3808E+00	-1.7649E+00	-1.0689E+01
A4 =	4.2079E+00	2.1562E-01	-6.9591E-01	9.1971E-01
A6 =	-2.8310E+01	-4.4239E+00	1.2041E+00	-3.0958E+00

A8 =	1.2287E+02	1.8790E+01	-2.9023E+00	4.8713E+00
A10 =	-3.9035E+02	-4.1840E+01	4.4195E+00	-4.6279E+00
A12 =	8.5064E+02	5.5883E+01	-3.7857E+00	2.6418E+00
A14 =	-9.7331E+02	-4.0255E+01	1.6532E+00	-8.3581E-01
A16 =	4.7213E+02	1.4428E+01	-2.8192E-01	1.1204E-01

In the 3rd embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 3rd embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 5 and Table 6 as the following values and satisfy the following conditions:

3rd Embodiment			
f [mm]	1.66	f2/f3	-1.07
Fno	2.15	|f/f4|	0.71
HFOV [deg.]	46.8	f/f3	-1.11
V1	55.9	Td [mm]	1.644
CT2/(CT1+CT3+CT4)	0.48	ΣCT/Td	0.77
(R3+R4)/(R3-R4)	2.01	Td/tan(HFOV) [mm]	1.54
f/f1	0.66	FOV [deg.]	93.6

4th Embodiment

Fig. 4A is a schematic view of an imaging device according to the 4th embodiment of the present disclosure. Fig. 4B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 4th embodiment.

In Fig. 4A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

470. The image capturing lens system includes, in order from an object side to an image side, a first lens element 410, an aperture stop 400, a second lens element 420, a third lens element 430, a fourth lens element 440, an IR-cut filter 450 and an image plane 460, wherein the image capturing lens system has a total of four lens elements (410-440) with refractive power.

The first lens element 410 with negative refractive power has a convex object-side surface 411 in a paraxial region thereof and a concave image-side surface 412 in a paraxial region thereof, which are both aspheric, and the first lens element 410 is made of plastic material.

The second lens element 420 with positive refractive power has a convex object-side surface 421 in a paraxial region thereof and a convex image-side surface 422 in a paraxial region thereof, which are both aspheric, and the second lens element 420 is made of plastic material.

The third lens element 430 with negative refractive power has a concave object-side surface 431 in a paraxial region thereof and a convex image-side surface 432 in a paraxial region thereof, which are both aspheric, and the third lens element 430 is made of plastic material.

The fourth lens element 440 with positive refractive power has a convex object-side surface 441 in a paraxial region thereof and a concave image-side surface 442 in a paraxial region thereof, which are both aspheric, and the fourth lens element 440 is made of plastic material. Furthermore, the image-side surface 442 of the fourth lens element 440 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 450 is made of glass and located between the fourth lens element 440 and the image plane 460, and will not affect the focal length of the

image capturing lens system. The image sensor 470 is disposed on the image plane 460 of the image capturing lens system.

The detailed optical data of the 4th embodiment are shown in Table 7 and the aspheric surface data are shown in Table 8 below.

TABLE 7								
Embodiment 4								
f = 1.15 mm, Fno = 2.22, HFOV = 48.5 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.999	ASP	0.200	Plastic	1.544	55.9	-46.83
2		1.789	ASP	0.021				
3	Ape. Stop	Plano		0.037				
4	Lens 2	1.606	ASP	0.471	Plastic	1.544	55.9	0.81
5		-0.543	ASP	0.184				
6	Lens 3	-0.207	ASP	0.209	Plastic	1.634	23.8	-1.22
7		-0.393	ASP	0.030				
8	Lens 4	0.747	ASP	0.319	Plastic	1.535	55.7	1.62
9		4.607	ASP	0.300				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.130				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 8				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-2.2996E+01	3.4247E+01	9.8701E+00	-4.2975E-01
A4 =	-2.1353E-01	-2.0670E+00	-2.2221E+00	-6.3795E-01
A6 =	-3.6880E+00	-3.6063E+01	-8.7081E+00	-6.5092E+00
A8 =	5.2789E+01	6.9201E+02	1.4888E+02	4.6114E+01
A10 =	-6.4083E+02	-4.8238E+03	-8.2602E+03	-4.7532E+02
A12 =	4.0983E+03	-1.6432E+05	1.3290E+05	3.0044E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0679E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3828E+04
Surface #	6	7	8	9
k =	-1.0439E+00	-2.0056E+00	-6.4024E-01	-3.3636E+00
A4 =	4.2327E+00	-9.7476E-01	-8.3147E-01	1.0958E+00
A6 =	-3.4551E+00	1.0236E+01	2.1761E+00	-1.7086E+00
A8 =	-1.0303E+02	-3.7610E+01	-4.8336E+00	1.3575E+00

A10 =	1.5970E+03	1.6620E+02	5.0397E+00	-2.6285E+00
A12 =	-8.9315E+03	-4.9093E+02	-4.1411E+00	4.3863E+00
A14 =	2.3054E+04	6.8046E+02	3.4069E+00	-3.3963E+00
A16 =	-2.3558E+04	-3.4010E+02	-1.6576E+00	9.5967E-01

In the 4th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 4th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 7 and Table 8 as the following values and satisfy the following conditions:

4th Embodiment			
f [mm]	1.15	f2/f3	-0.66
Fno	2.22	|f/f4|	0.71
HFOV [deg.]	48.5	f/f3	-0.94
V1	55.9	Td [mm]	1.471
CT2/(CT1+CT3+CT4)	0.65	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	0.49	Td/tan(HFOV) [mm]	1.30
f/f1	-0.02	FOV [deg.]	97.0

5th Embodiment

Fig. 5A is a schematic view of an imaging device according to the 5th embodiment of the present disclosure. Fig. 5B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 5th embodiment.

In Fig. 5A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

570. The image capturing lens system includes, in order from an object side to an image side, a first lens element 510, an aperture stop 500, a second lens element 520, a third lens element 530, a fourth lens element 540, an IR-cut filter 550 and an image plane 560, wherein the image capturing lens system has a total of four lens elements (510-540) with refractive power.

The first lens element 510 with negative refractive power has a convex object-side surface 511 in a paraxial region thereof and a concave image-side surface 512 in a paraxial region thereof, which are both aspheric, and the first lens element 510 is made of glass material.

The second lens element 520 with positive refractive power has a convex object-side surface 521 in a paraxial region thereof and a convex image-side surface 522 in a paraxial region thereof, which are both aspheric, and the second lens element 520 is made of glass material.

The third lens element 530 with negative refractive power has a concave object-side surface 531 in a paraxial region thereof and a convex image-side surface 532 in a paraxial region thereof, which are both aspheric, and the third lens element 530 is made of plastic material.

The fourth lens element 540 with positive refractive power has a convex object-side surface 541 in a paraxial region thereof and a concave image-side surface 542 in a paraxial region thereof, which are both aspheric, and the fourth lens element 540 is made of plastic material. Furthermore, the image-side surface 542 of the fourth lens element 540 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 550 is made of glass and located between the fourth lens element 540 and the image plane 560, and will not affect the focal length of the

image capturing lens system. The image sensor 570 is disposed on the image plane 560 of the image capturing lens system.

The detailed optical data of the 5th embodiment are shown in Table 9 and the aspheric surface data are shown in Table 10 below.

TABLE 9								
Embodiment 5								
f = 2.24 mm, Fno = 2.51, HFOV = 44.2 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.367	ASP	0.300	Glass	2.144	17.8	-13.68
2		1.110	ASP	0.144				
3	Ape. Stop	Plano		-0.015				
4	Lens 2	3.909	ASP	1.483	Glass	1.525	70.3	1.60
5		-0.932	ASP	0.325				
6	Lens 3	-0.341	ASP	0.277	Plastic	1.639	23.5	-1.72
7		-0.651	ASP	0.030				
8	Lens 4	0.897	ASP	0.606	Plastic	1.565	57.0	2.00
9		3.302	ASP	0.800				
10	IR-cut filter	Plano		0.300	Glass	1.517	64.2	-
11		Plano		0.342				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 10				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.1992E+00	1.9195E+00	2.1734E+01	-7.2786E-01
A4 =	5.8324E-02	1.2422E-01	-9.9032E-02	-1.2252E-01
A6 =	-1.4402E-01	-5.2189E-01	5.9983E+00	5.2990E-01
A8 =	1.0028E+00	4.2713E+00	-1.1966E+02	-3.0301E+00
A10 =	-4.0021E+00	1.8016E+01	1.4083E+03	7.9248E+00
A12 =	8.9035E+00	-4.2193E+02	-9.4428E+03	-1.0795E+01
A14 =	-9.8479E+00	2.2697E+03	3.3923E+04	6.3429E+00
A16 =	3.0263E+00	-4.1004E+03	-5.0610E+04	-8.0066E-01
Surface #	6	7	8	9
k =	-9.8774E-01	-3.1767E+00	-8.3817E-01	-2.4331E+01
A4 =	2.5606E+00	-1.2881E-01	-4.2259E-01	3.5717E-01
A6 =	-7.9740E+00	-6.6170E-01	4.3675E-01	-4.5759E-01
A8 =	1.4853E+01	1.1888E+00	-4.6275E-01	2.9937E-01

A10 =	-1.1480E+01	-4.2607E-01	3.1380E-01	-1.1921E-01
A12 =	-4.4740E+00	-5.1720E-01	-1.2912E-01	2.8364E-02
A14 =	1.2594E+01	5.0722E-01	2.9275E-02	-3.7104E-03
A16 =	-5.4160E+00	-1.2485E-01	-2.8533E-03	2.0238E-04

In the 5th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 5th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 9 and Table 10 as the following values and satisfy the following conditions:

5th Embodiment			
f [mm]	2.24	f2/f3	-0.93
Fno	2.51	|f/f4|	1.12
HFOV [deg.]	44.2	f/f3	-1.30
V1	17.8	Td [mm]	3.150
CT2/(CT1+CT3+CT4)	1.25	ΣCT/Td	0.85
(R3+R4)/(R3-R4)	0.61	Td/tan(HFOV) [mm]	3.24
f/f1	-0.16	FOV [deg.]	88.4

6th Embodiment

Fig. 6A is a schematic view of an imaging device according to the 6th embodiment of the present disclosure. Fig. 6B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 6th embodiment.

In Fig. 6A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

670. The image capturing lens system includes, in order from an object side to an image side, a first lens element 610, an aperture stop 600, a second lens element 620, a third lens element 630, a fourth lens element 640, an IR-cut filter 650 and an image plane 660, wherein the image capturing lens system has a total of four lens elements (610-640) with refractive power.

The first lens element 610 with positive refractive power has a convex object-side surface 611 in a paraxial region thereof and a convex image-side surface 612 in a paraxial region thereof, which are both aspheric, and the first lens element 610 is made of plastic material.

The second lens element 620 with positive refractive power has a concave object-side surface 621 in a paraxial region thereof and a convex image-side surface 622 in a paraxial region thereof, which are both aspheric, and the second lens element 620 is made of plastic material.

The third lens element 630 with negative refractive power has a concave object-side surface 631 in a paraxial region thereof and a convex image-side surface 632 in a paraxial region thereof, which are both aspheric, and the third lens element 630 is made of plastic material.

The fourth lens element 640 with positive refractive power has a convex object-side surface 641 in a paraxial region thereof and a concave image-side surface 642 in a paraxial region thereof, which are both aspheric, and the fourth lens element 640 is made of plastic material. Furthermore, the image-side surface 642 of the fourth lens element 640 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 650 is made of glass and located between the fourth lens element 640 and the image plane 660, and will not affect the focal length of the

image capturing lens system. The image sensor 670 is disposed on the image plane 660 of the image capturing lens system.

The detailed optical data of the 6th embodiment are shown in Table 11 and the aspheric surface data are shown in Table 12 below.

TABLE 11								
Embodiment 6								
f = 1.27 mm, Fno = 2.10, HFOV = 44.4 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	2.393	ASP	0.280	Plastic	1.544	55.9	3.85
2		-16.057	ASP	0.017				
3	Ape. Stop	Plano		0.044				
4	Lens 2	-30.373	ASP	0.755	Plastic	1.544	55.9	0.87
5		-0.468	ASP	0.121				
6	Lens 3	-0.246	ASP	0.240	Plastic	1.639	23.5	-0.90
7		-0.594	ASP	0.030				
8	Lens 4	0.639	ASP	0.522	Plastic	1.530	55.8	1.47
9		2.521	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.073				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 12				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	1.7241E+00	-8.9754E+01	-9.0000E+01	-7.5923E-01
A4 =	2.1410E-01	1.4516E+00	1.5168E-01	-5.4982E-01
A6 =	-2.3810E-01	-1.0826E+01	4.8929E+00	2.0791E+00
A8 =	2.3555E+01	1.9495E+02	-3.2116E+01	8.2787E-01
A10 =	-2.5034E+02	-5.1780E+02	-2.6801E+03	-1.4893E+02
A12 =	1.4357E+03	-5.7593E+04	4.6579E+04	1.0534E+03
A14 =	-4.2381E+03	9.2351E+05	-3.3256E+05	-3.0936E+03
A16 =	4.9589E+03	-4.2045E+06	9.0327E+05	3.3098E+03
Surface #	6	7	8	9
k =	-9.9704E-01	-3.7851E+00	-7.3474E-01	-2.0751E+00
A4 =	2.9255E+00	-1.3600E+00	-1.2133E+00	1.8260E+00
A6 =	-2.4852E+00	5.5927E+00	3.0817E+00	-5.9653E+00
A8 =	-5.7718E+01	-1.8755E+01	-1.0034E+01	9.6816E+00

A10 =	6.7135E+02	7.3016E+01	1.9498E+01	-9.2466E+00
A12 =	-3.0733E+03	-1.6937E+02	-2.1549E+01	5.1894E+00
A14 =	6.6780E+03	1.9522E+02	1.2590E+01	-1.5760E+00
A16 =	-5.6393E+03	-8.6932E+01	-3.0510E+00	1.9769E-01

In the 6th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 6th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 11 and Table 12 as the following values and satisfy the following conditions:

6th Embodiment			
f [mm]	1.27	f2/f3	-0.97
Fno	2.10	|f/f4|	0.86
HFOV [deg.]	44.4	f/f3	-1.41
V1	55.9	Td [mm]	2.009
CT2/(CT1+CT3+CT4)	0.72	ΣCT/Td	0.89
(R3+R4)/(R3-R4)	1.03	Td/tan(HFOV) [mm]	2.05
f/f1	0.33	FOV [deg.]	88.8

7th Embodiment

Fig. 7A is a schematic view of an imaging device according to the 7th embodiment of the present disclosure. Fig. 7B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 7th embodiment.

In Fig. 7A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

770. The image capturing lens system includes, in order from an object side to an image side, an aperture stop 700, a first lens element 710, a second lens element 720, a third lens element 730, a fourth lens element 740, an IR-cut filter 750 and an image plane 760, wherein the image capturing lens system has a total of four lens elements (710-740) with refractive power.

The first lens element 710 with positive refractive power has a convex object-side surface 711 in a paraxial region thereof and a concave image-side surface 712 in a paraxial region thereof, which are both aspheric, and the first lens element 710 is made of plastic material.

The second lens element 720 with positive refractive power has a concave object-side surface 721 in a paraxial region thereof and a convex image-side surface 722 in a paraxial region thereof, which are both aspheric, and the second lens element 720 is made of plastic material.

The third lens element 730 with negative refractive power has a concave object-side surface 731 in a paraxial region thereof and a convex image-side surface 732 in a paraxial region thereof, which are both aspheric, and the third lens element 730 is made of plastic material.

The fourth lens element 740 with positive refractive power has a convex object-side surface 741 in a paraxial region thereof and a concave image-side surface 742 in a paraxial region thereof, which are both aspheric, and the fourth lens element 740 is made of plastic material. Furthermore, the image-side surface 742 of the fourth lens element 740 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 750 is made of glass and located between the fourth lens element 740 and the image plane 760, and will not affect the focal length of

the image capturing lens system. The image sensor 770 is disposed on the image plane 760 of the image capturing lens system.

The detailed optical data of the 7th embodiment are shown in Table 13 and the aspheric surface data are shown in Table 14 below.

TABLE 13								
Embodiment 7								
f = 1.57 mm, Fno = 2.05, HFOV = 48.5 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Ape. Stop	Plano		-0.052				
2	Lens 1	1.142	ASP	0.279	Plastic	1.544	55.9	2.84
3		4.008	ASP	0.159				
4	Lens 2	-4.075	ASP	0.614	Plastic	1.544	55.9	1.24
5		-0.608	ASP	0.142				
6	Lens 3	-0.255	ASP	0.230	Plastic	1.634	23.8	-1.37
7		-0.487	ASP	0.030				
8	Lens 4	0.636	ASP	0.414	Plastic	1.535	55.7	2.35
9		0.998	ASP	0.500				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.141				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 14				
Aspheric Coefficients				
Surface #	2	3	4	5
k =	-5.4318E-01	6.9324E+01	6.0179E+01	-4.8138E-01
A4 =	1.1275E-01	-3.4138E-01	-6.6571E-01	-8.5384E-02
A6 =	-1.4350E+00	-2.7321E+00	4.9846E-01	-6.6518E-01
A8 =	6.0529E+00	2.0740E+01	-4.5807E+00	-2.1554E-01
A10 =	4.7148E+01	-7.0776E+01	-1.7027E+02	-7.9977E+00
A12 =	-1.4571E+02	-1.4998E+03	1.2130E+03	2.5638E+01
A14 =	-3.8164E+03	1.2389E+04	-4.4615E+03	-4.3167E+01
A16 =	1.5882E+04	-2.9058E+04	6.2425E+03	7.2938E+01
Surface #	6	7	8	9
k =	-1.1103E+00	-3.0258E+00	-9.3042E-01	-5.1455E+00
A4 =	5.4423E+00	4.5345E-01	-7.7223E-01	7.0200E-01
A6 =	-3.5666E+01	-4.9768E+00	9.4468E-01	-1.5850E+00
A8 =	1.3446E+02	1.9752E+01	-1.3669E+00	1.7028E+00

A10 =	-2.5131E+02	-4.2912E+01	1.1409E+00	-1.1082E+00
A12 =	-7.3665E+01	5.3544E+01	-5.2307E-01	4.3302E-01
A14 =	1.1117E+03	-3.5702E+01	1.2365E-01	-9.2838E-02
A16 =	-1.2600E+03	1.0063E+01	-1.1645E-02	8.3092E-03

In the 7th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 7th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 13 and Table 14 as the following values and satisfy the following conditions:

7th Embodiment			
f [mm]	1.57	f2/f3	-0.91
Fno	2.05	|f/f4|	0.67
HFOV [deg.]	48.5	f/f3	-1.15
V1	55.9	Td [mm]	1.868
CT2/(CT1+CT3+CT4)	0.67	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	1.35	Td/tan(HFOV) [mm]	1.65
f/f1	0.55	FOV [deg.]	97.0

8th Embodiment

Fig. 8A is a schematic view of an imaging device according to the 8th embodiment of the present disclosure. Fig. 8B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 8th embodiment.

In Fig. 8A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

870. The image capturing lens system includes, in order from an object side to an image side, a first lens element 810, an aperture stop 800, a second lens element 820, a third lens element 830, a fourth lens element 840, an IR-cut filter 850 and an image plane 860, wherein the image capturing lens system has a total of four lens elements (810-840) with refractive power.

The first lens element 810 with positive refractive power has a convex object-side surface 811 in a paraxial region thereof and a concave image-side surface 812 in a paraxial region thereof, which are both aspheric, and the first lens element 810 is made of plastic material.

The second lens element 820 with positive refractive power has a concave object-side surface 821 in a paraxial region thereof and a convex image-side surface 822 in a paraxial region thereof, which are both aspheric, and the second lens element 820 is made of plastic material.

The third lens element 830 with negative refractive power has a concave object-side surface 831 in a paraxial region thereof and a convex image-side surface 832 in a paraxial region thereof, which are both aspheric, and the third lens element 830 is made of plastic material.

The fourth lens element 840 with positive refractive power has a convex object-side surface 841 in a paraxial region thereof and a concave image-side surface 842 in a paraxial region thereof, which are both aspheric, and the fourth lens element 840 is made of plastic material. Furthermore, the image-side surface 842 of the fourth lens element 840 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 850 is made of glass and located between the fourth lens element 840 and the image plane 860, and will not affect the focal length of

the image capturing lens system. The image sensor 870 is disposed on the image plane 860 of the image capturing lens system.

The detailed optical data of the 8th embodiment are shown in Table 15 and the aspheric surface data are shown in Table 16 below.

TABLE 15								
Embodiment 8								
f = 1.68 mm, Fno = 2.10, HFOV = 46.0 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	1.787	ASP	0.278	Plastic	1.544	55.9	3.81
2		12.133	ASP	0.022				
3	Ape. Stop	Plano		0.145				
4	Lens 2	-3.839	ASP	0.668	Plastic	1.544	55.9	1.38
5		-0.668	ASP	0.194				
6	Lens 3	-0.273	ASP	0.230	Plastic	1.639	23.5	-1.18
7		-0.569	ASP	0.030				
8	Lens 4	0.784	ASP	0.496	Plastic	1.530	55.8	1.65
9		5.992	ASP	0.400				
10	IR-cut filter	Plano		0.175	Glass	1.517	64.2	-
11		Plano		0.472				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 16				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-1.3232E+00	5.3151E+01	5.1693E+01	-5.9308E-01
A4 =	1.6281E-02	-1.2122E-02	-2.5602E-01	-1.1508E-01
A6 =	1.5823E-01	-1.1940E+00	-1.0332E+00	-6.8787E-01
A8 =	5.9941E-01	1.2093E+01	1.0464E+01	-9.7964E-02
A10 =	-1.3812E+01	-2.0003E+01	-1.9940E+02	-6.2734E+00
A12 =	4.5317E+01	-1.4998E+03	1.2130E+03	2.8529E+01
A14 =	-4.4460E+01	1.2389E+04	-4.4615E+03	-4.4589E+01
A16 =	-4.7734E+01	-2.9058E+04	6.2425E+03	2.7908E+01
Surface #	6	7	8	9
k =	-1.0578E+00	-3.0032E+00	-8.6121E-01	5.6610E+00
A4 =	4.0391E+00	9.4553E-02	-6.6716E-01	7.7788E-01
A6 =	-2.6571E+01	-4.4170E+00	1.1395E+00	-1.2944E+00
A8 =	1.2417E+02	1.9085E+01	-1.7698E+00	1.0967E+00

A10 =	-3.9394E+02	-4.1568E+01	1.6239E+00	-5.7605E-01
A12 =	8.2748E+02	5.5376E+01	-8.6944E-01	1.8609E-01
A14 =	-9.7331E+02	-4.1902E+01	2.5418E-01	-3.3617E-02
A16 =	4.7213E+02	1.3653E+01	-3.1838E-02	2.5144E-03

In the 8th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 8th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 15 and Table 16 as the following values and satisfy the following conditions:

8th Embodiment			
f [mm]	1.68	f2/f3	-1.17
Fno	2.10	|f/f4|	1.02
HFOV [deg.]	46.0	f/f3	-1.42
V1	55.9	Td [mm]	2.063
CT2/(CT1+CT3+CT4)	0.67	ΣCT/Td	0.81
(R3+R4)/(R3-R4)	1.42	Td/tan(HFOV) [mm]	1.99
f/f1	0.44	FOV [deg.]	92.0

9th Embodiment

Fig. 9A is a schematic view of an imaging device according to the 9th embodiment of the present disclosure. Fig. 9B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 9th embodiment.

In Fig. 9A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

970. The image capturing lens system includes, in order from an object side to an image side, a first lens element 910, an aperture stop 900, a second lens element 920, a third lens element 930, a fourth lens element 940, an IR-cut filter 950 and an image plane 960, wherein the image capturing lens system has a total of four lens elements (910-940) with refractive power.

The first lens element 910 with positive refractive power has a convex object-side surface 911 in a paraxial region thereof and a convex image-side surface 912 in a paraxial region thereof, which are both aspheric, and the first lens element 910 is made of plastic material.

The second lens element 920 with positive refractive power has a convex object-side surface 921 in a paraxial region thereof and a convex image-side surface 922 in a paraxial region thereof, which are both aspheric, and the second lens element 920 is made of plastic material.

The third lens element 930 with negative refractive power has a concave object-side surface 931 in a paraxial region thereof and a convex image-side surface 932 in a paraxial region thereof, which are both aspheric, and the third lens element 930 is made of plastic material.

The fourth lens element 940 with positive refractive power has a convex object-side surface 941 in a paraxial region thereof and a concave image-side surface 942 in a paraxial region thereof, which are both aspheric, and the fourth lens element 940 is made of plastic material. Furthermore, the image-side surface 942 of the fourth lens element 940 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 950 is made of glass and located between the fourth lens element 940 and the image plane 960, and will not affect the focal length of

the image capturing lens system. The image sensor 970 is disposed on the image plane 960 of the image capturing lens system.

The detailed optical data of the 9th embodiment are shown in Table 17 and the aspheric surface data are shown in Table 18 below.

TABLE 17								
Embodiment 9								
f = 0.92 mm, Fno = 2.45, HFOV = 43.9 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Lens 1	100.000	ASP	0.205	Plastic	1.633	23.4	13.12
2		-9.046	ASP	0.017				
3	Ape. Stop	Plano		0.024				
4	Lens 2	1.695	ASP	0.475	Plastic	1.544	55.9	0.54
5		-0.319	ASP	0.100				
6	Lens 3	-0.148	ASP	0.160	Plastic	1.634	23.8	-0.65
7		-0.329	ASP	0.030				
8	Lens 4	0.595	ASP	0.239	Plastic	1.530	55.8	1.28
9		4.109	ASP	0.300				
10	IR-cut filter	Plano		0.145	Glass	1.517	64.2	-
11		Plano		0.151				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								

5

TABLE 18				
Aspheric Coefficients				
Surface #	1	2	4	5
k =	-9.0000E+01	9.0000E+01	3.3243E+01	-6.6437E-01
A4 =	2.5656E-01	2.4894E+00	-1.9077E+00	-1.5093E+00
A6 =	-1.0613E+00	-9.5530E+01	-1.3506E+01	4.3096E+00
A8 =	1.6769E+02	3.0126E+03	1.0928E+01	1.6065E+02
A10 =	-3.7307E+03	-2.3016E+04	-4.4021E+04	-2.9203E+03
A12 =	3.9786E+04	-1.5960E+06	1.2908E+06	2.9181E+04
A14 =	-2.1485E+05	4.6819E+07	-1.6860E+07	-1.5683E+05
A16 =	4.5990E+05	-3.8994E+08	8.3772E+07	3.0696E+05
Surface #	6	7	8	9
k =	-1.0921E+00	-2.4247E+00	-6.0015E-01	3.3921E+01
A4 =	8.8579E+00	-1.7457E+00	-1.8642E+00	3.4965E+00
A6 =	-9.7201E+00	2.7059E+01	4.2816E+00	-1.7965E+01
A8 =	-4.6210E+02	-1.6609E+02	-3.6842E+01	3.3243E+01

A10 =	1.0079E+04	1.0699E+03	9.4802E+01	-3.1178E+01
A12 =	-8.5169E+04	-4.7330E+03	-1.9140E+02	1.8452E+01
A14 =	3.3855E+05	1.0605E+04	3.6755E+02	-3.7397E+01
A16 =	-5.2300E+05	-7.7191E+03	-9.3365E+02	3.7762E+01

In the 9th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 9th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 17 and Table 18 as the following values and satisfy the following conditions:

9th Embodiment			
f [mm]	0.92	f2/f3	-0.83
Fno	2.45	|f/f4|	0.72
HFOV [deg.]	43.9	f/f3	-1.42
V1	23.4	Td [mm]	1.250
CT2/(CT1+CT3+CT4)	0.79	ΣCT/Td	0.86
(R3+R4)/(R3-R4)	0.68	Td/tan(HFOV) [mm]	1.30
f/f1	0.07	FOV [deg.]	87.8

10th Embodiment

Fig. 10A is a schematic view of an imaging device according to the 10th embodiment of the present disclosure. Fig. 10B shows, in order from left to right, spherical aberration curves, astigmatic field curves and a distortion curve of the imaging device according to the 10th embodiment.

In Fig. 10A, the imaging device includes the image capturing lens system (not otherwise herein labeled) of the present disclosure and an image sensor

1070. The image capturing lens system includes, in order from an object side to an image side, an aperture stop 1000, a first lens element 1010, a second lens element 1020, a third lens element 1030, a fourth lens element 1040, an IR-cut filter 1050 and an image plane 1060, wherein the image capturing lens system has a total of four lens elements (1010-1040) with refractive power.

The first lens element 1010 with positive refractive power has a convex object-side surface 1011 in a paraxial region thereof and a concave image-side surface 1012 in a paraxial region thereof, which are both aspheric, and the first lens element 1010 is made of plastic material.

The second lens element 1020 with positive refractive power has a concave object-side surface 1021 in a paraxial region thereof and a convex image-side surface 1022 in a paraxial region thereof, which are both aspheric, and the second lens element 1020 is made of plastic material.

The third lens element 1030 with negative refractive power has a concave object-side surface 1031 in a paraxial region thereof and a convex image-side surface 1032 in a paraxial region thereof, which are both aspheric, and the third lens element 1030 is made of plastic material.

The fourth lens element 1040 with positive refractive power has a convex object-side surface 1041 in a paraxial region thereof and a concave image-side surface 1042 in a paraxial region thereof, which are both aspheric, and the fourth lens element 1040 is made of plastic material. Furthermore, the image-side surface 1042 of the fourth lens element 1040 has at least one convex shape in an off-axis region thereof.

The IR-cut filter 1050 is made of glass and located between the fourth lens element 1040 and the image plane 1060, and will not affect the focal length

of the image capturing lens system. The image sensor 1070 is disposed on the image plane 1060 of the image capturing lens system.

The detailed optical data of the 10th embodiment are shown in Table 19 and the aspheric surface data are shown in Table 20 below.

TABLE 19								
Embodiment 10								
f = 1.80 mm, Fno = 2.12, HFOV = 47.2 deg.								
Surface #		Curvature Radius		Thickness	Material	Index	Abbe #	Focal Length
0	Object	Plano		Infinity				
1	Ape. Stop	Plano		-0.060				
2	Lens 1	1.246	ASP	0.289	Plastic	1.544	55.9	2.97
3		5.018	ASP	0.191				
4	Lens 2	-3.749	ASP	0.593	Plastic	1.544	55.9	1.57
5		-0.733	ASP	0.156				
6	Lens 3	-0.288	ASP	0.248	Plastic	1.634	23.8	-1.33
7		-0.584	ASP	0.030				
8	Lens 4	0.704	ASP	0.601	Plastic	1.535	55.7	2.05
9		1.382	ASP	0.500				
10	IR-cut filter	Plano		0.210	Glass	1.517	64.2	-
11		Plano		0.198				
12	Image	Plano		-				
Note: Reference wavelength is 587.6 nm (d-line).								
The effective radius of Surface 9 is 1.676 mm.								

5

TABLE 20				
Aspheric Coefficients				
Surface #	2	3	4	5
k =	-5.0585E-01	9.0000E+01	3.6143E+01	-3.9805E-01
A4 =	8.6099E-02	-2.2970E-01	-4.8540E-01	-1.5034E-01
A6 =	-9.1382E-01	-1.8900E+00	2.7508E-01	-5.1276E-01
A8 =	1.9706E+00	1.1233E+01	-2.0152E+00	-1.5742E-01
A10 =	1.9492E+01	-3.0654E+01	-6.3534E+01	-3.0117E+00
A12 =	-3.5519E+01	-4.4967E+02	3.6120E+02	7.3424E+00
A14 =	-8.0910E+02	2.9681E+03	-1.0702E+03	-1.0241E+01
A16 =	2.4600E+03	-5.5960E+03	1.2022E+03	1.7746E+01
Surface #	6	7	8	9
k =	-1.1070E+00	-2.9894E+00	-9.3316E-01	-5.2865E+00
A3 =			-1.4739E-01	5.0831E-01
A4 =	4.3809E+00	4.3352E-01	-3.5412E+00	2.6512E+00

A5 =			2.4672E-02	1.3099E-01
A6 =	-2.6437E+01	-3.7903E+00	1.0303E+01	-3.1255E+01
A7 =			3.7082E-02	2.0652E-01
A8 =	9.1296E+01	1.0965E+01	-3.1616E+01	1.1148E+02
A9 =			-2.2687E-03	-9.0797E-01
A10 =	-1.5853E+02	-1.4675E+01	6.3626E+01	-2.2327E+02
A11 =			-2.3794E-03	3.6058E-01
A12 =	8.3141E+00	7.7310E+00	-7.5604E+01	2.6201E+02
A13 =			8.0966E-03	1.7201E-01
A14 =	3.8963E+02	1.2159E+00	4.7652E+01	-1.7041E+02
A15 =			-5.5857E-02	1.0396E-01
A16 =	-3.9976E+02	-1.8447E+00	-1.2153E+01	4.7523E+01

In the 10th embodiment, the equation of the aspheric surface profiles of the aforementioned lens elements is the same as the equation of the 1st embodiment. Also, the definitions of these parameters shown in the following table are the same as those stated in the 1st embodiment with corresponding values for the 10th embodiment, so an explanation in this regard will not be provided again.

Moreover, these parameters can be calculated from Table 19 and Table 20 as the following values and satisfy the following conditions:

10th Embodiment			
f [mm]	1.80	f2/f3	-1.18
Fno	2.12	|f/f4|	0.88
HFOV [deg.]	47.2	f/f3	-1.35
V1	55.9	Td [mm]	2.108
CT2/(CT1+CT3+CT4)	0.52	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	1.49	Td/tan(HFOV) [mm]	1.95
f/f1	0.61	FOV [deg.]	94.4

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. It is to be noted that

TABLES 1-20 show different data of the different embodiments; however, the data of the different embodiments are obtained from experiments. The embodiments were chosen and described in order to best explain the principles of the disclosure and its practical applications, to thereby enable others skilled in the art to best utilize the disclosure and various embodiments with various modifications as are suited to the particular use contemplated. The embodiments depicted above and the appended drawings are exemplary and are not intended to be exhaustive or to limit the scope of the present disclosure to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings.

CLAIMS

WHAT IS CLAIMED IS:

1. An image capturing lens system comprising, in order from an object side to an image side:

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f, a focal length of the fourth lens element is f4, a focal length of the second lens element is f2, a focal length of the third lens element is f3, and the following conditions are satisfied:

$0.5\ mm < Td < 3.2\ mm$;

$1.0\ mm < Td/\tan(HFOV) < 3.75\ mm$;

|f/f4| < 1.20; and

f2/f3 < -0.65.

2. The image capturing lens system of claim 1, wherein the fourth lens element has the object-side surface being convex in a paraxial region thereof.

3. The image capturing lens system of claim 2, wherein the focal length of the image capturing lens system is f, a focal length of the first lens element is f1, and the following condition is satisfied:

-0.25 < f/f1 < 0.75.

4. The image capturing lens system of claim 2, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and the following condition is satisfied:

0.8 mm < Td < 2.5 mm.

5. The image capturing lens system of claim 2, wherein an f-number of the image capturing lens system is Fno, and the following condition is satisfied:

1.40 < Fno ≤ 2.25.

6. The image capturing lens system of claim 2, wherein a curvature radius of the object-side surface of the second lens element is R3, a curvature radius of the image-side surface of the second lens element is R4, and the following condition is satisfied:

$0.5 < (R3+R4)/(R3-R4) < 2.5$.

7. The image capturing lens system of claim 2, wherein the focal length of the image capturing lens system is f, and the following condition is satisfied:

$0.5 \text{ mm} < f < 2.0 \text{ mm}$.

8. The image capturing lens system of claim 1, wherein the first lens element has a convex object-side surface in a paraxial region thereof.

9. The image capturing lens system of claim 8, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of the maximal field of view of the image capturing lens system is HFOV, and the following condition is satisfied:

$1.2 \text{ mm} < Td/\tan(HFOV) < 2.75 \text{ mm}$.

10. The image capturing lens system of claim 8, wherein a sum of the central thicknesses of the first lens element, the second lens element, the third lens element, and the fourth lens element is ΣCT, the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and the following condition is satisfied:

$0.80 < \Sigma CT/Td < 0.95$.

11. The image capturing lens system of claim 8, wherein an Abbe number of the first lens element is V1, and the following condition is satisfied:

45 < V1.

12. The image capturing lens system of claim 8, wherein a central thickness of the second lens element is CT2, a central thickness of the first lens element is CT1, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following condition is satisfied:

0.65 < CT2/(CT1+CT3+CT4) < 2.0.

13. An imaging device, comprising:

the image capturing lens system of claim 1; and

an image sensor.

14. A mobile terminal, comprising:

the imaging device of claim 13.

15. An image capturing lens system comprising, in order from an object side to an image side:

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between an object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f, a focal length of the fourth lens element is f4, a focal length of the third lens element is f3, and the following conditions are satisfied:

$0.5\ mm < Td < 3.2\ mm$;

$1.0\ mm < Td/\tan(HFOV) < 3.75\ mm$;

$|f/f4| < 1.20$; and

$-2.0 < f/f3 < -0.95$.

16. The image capturing lens system of claim 15, wherein an Abbe number of the first lens element is V1, and the following condition is satisfied:

$45 < V1$.

17. The image capturing lens system of claim 15, wherein the focal length of the image capturing lens system is f, a focal length of the first lens element is f1, and the following condition is satisfied:

$-0.25 < f/f1 < 0.75$.

18. The image capturing lens system of claim 15, wherein a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied:

80 degrees < FOV < 110 degrees.

19. The image capturing lens system of claim 15, wherein the axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, and the following condition is satisfied:

0.8 mm < Td < 2.5 mm.

20. The image capturing lens system of claim 15, wherein a focal length of the second lens element is f2, the focal length of the third lens element is f3, and the following condition is satisfied:

f2/f3 < -0.75.

21. An image capturing lens system comprising, in order from an object side to an image side:

a first lens element having refractive power;

a second lens element with positive refractive power having a convex image-side surface in a paraxial region thereof;

a third lens element with negative refractive power having a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof; and

a fourth lens element with refractive power having a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface of the fourth lens element are aspheric, and the image-side surface of the fourth lens element has at least one convex shape in an off-axis region thereof;

wherein the image capturing lens system has a total of four lens elements with refractive power, an axial distance between the object-side surface of the first lens element and the image-side surface of the fourth lens element is Td, half of a maximal field of view of the image capturing lens system is HFOV, a focal length of the image capturing lens system is f, a focal length of the fourth lens element is f4, an f-number of the image capturing lens system is Fno, and the following conditions are satisfied:

$0.5\ mm < Td < 3.2\ mm$;

$1.0\ mm < Td/\tan(HFOV) < 3.75\ mm$;

$|f/f4| < 1.20$; and

$1.40 < Fno \leq 2.25$.

22. The image capturing lens system of claim 21, wherein a focal length of the second lens element is f2, a focal length of the third lens element is f3, and the following condition is satisfied:

$f2/f3 < -0.65$.

23. The image capturing lens system of claim 21, wherein an Abbe number of the first lens element is V1, and the following condition is satisfied:

$45 < V1$.

24. The image capturing lens system of claim 21, wherein the first lens element has positive refractive power, the focal length of the image capturing lens system is f, a focal length of the first lens element is f1, and the following condition is satisfied:

$0.25 < f/f1 < 0.75$.

25. The image capturing lens system of claim 21, wherein a maximal field of view of the image capturing lens system is FOV, and the following condition is satisfied:

80 degrees < FOV < 110 degrees.

26. The image capturing lens system of claim 21, wherein a central thickness of the second lens element is CT2, a central thickness of the first lens element is CT1, a central thickness of the third lens element is CT3, a central thickness of the fourth lens element is CT4, and the following condition is satisfied:

$0.65 < CT2/(CT1+CT3+CT4) < 2.0$.

ABSTRACT OF THE DISCLOSURE

An image capturing lens system includes, in order from an object side to an image side, a first lens element, a second lens element, a third lens element and a fourth lens element. The first lens element has refractive power. The second lens element with positive refractive power has a convex image-side surface in a paraxial region thereof. The third lens element with negative refractive power has a concave object-side surface in a paraxial region thereof and a convex image-side surface in a paraxial region thereof. The fourth lens element with refractive power has a concave image-side surface in a paraxial region thereof, wherein both of an object-side surface and the image-side surface thereof are aspheric, and the image-side surface thereof has at least one convex shape in an off-axis region thereof. The image capturing lens system has a total of four lens elements with refractive power.

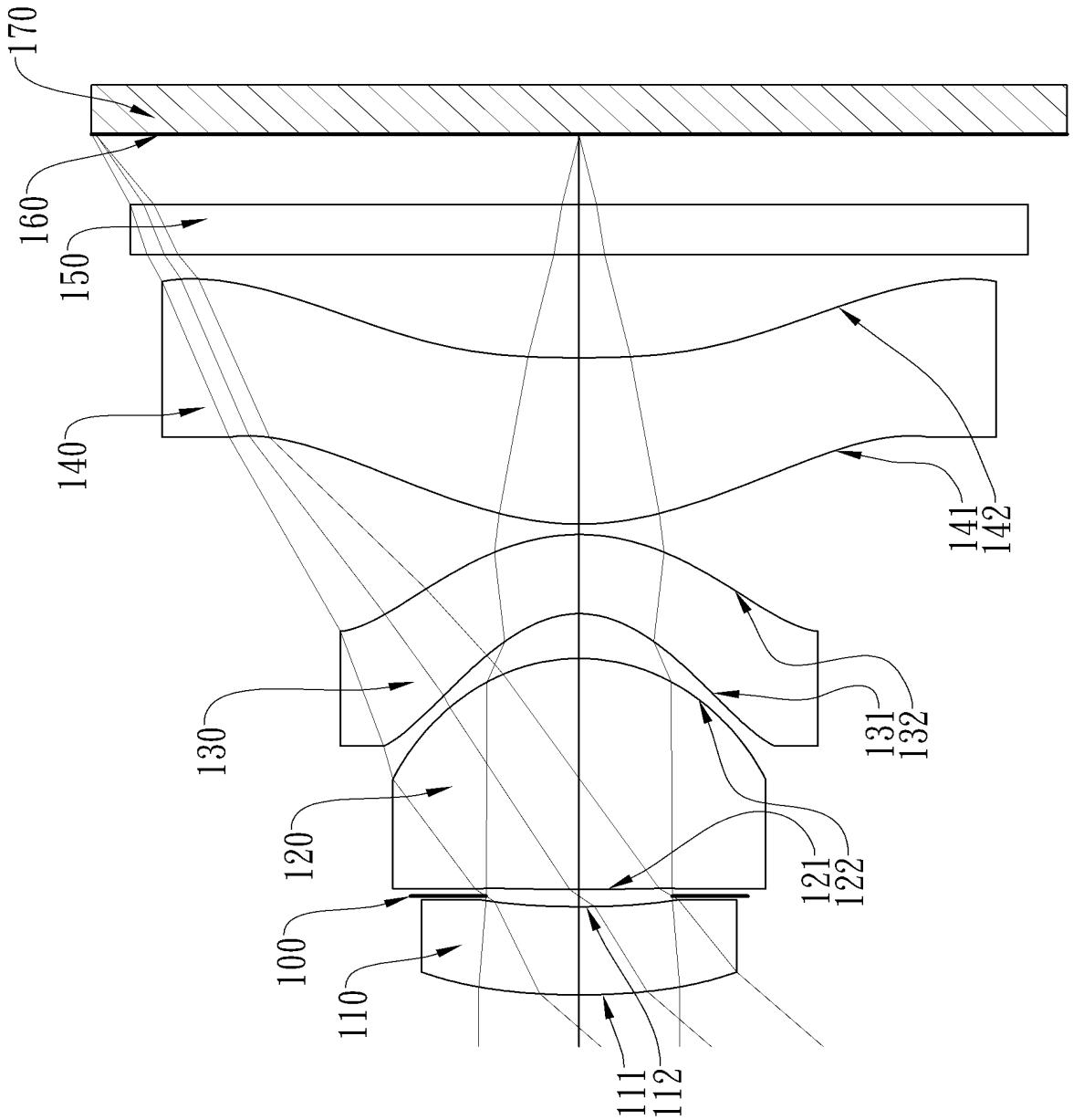


Fig. 1A

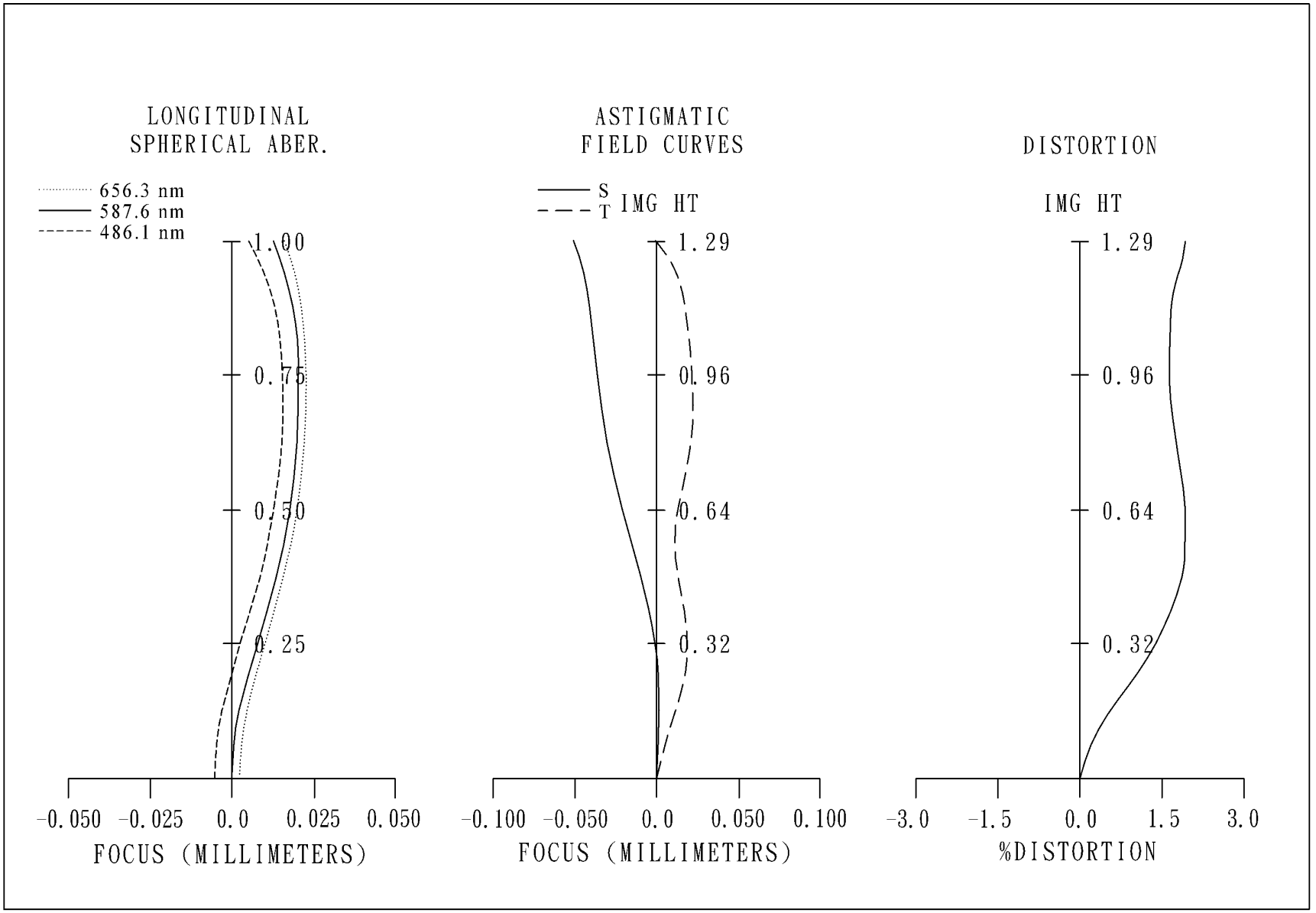


Fig. 1B

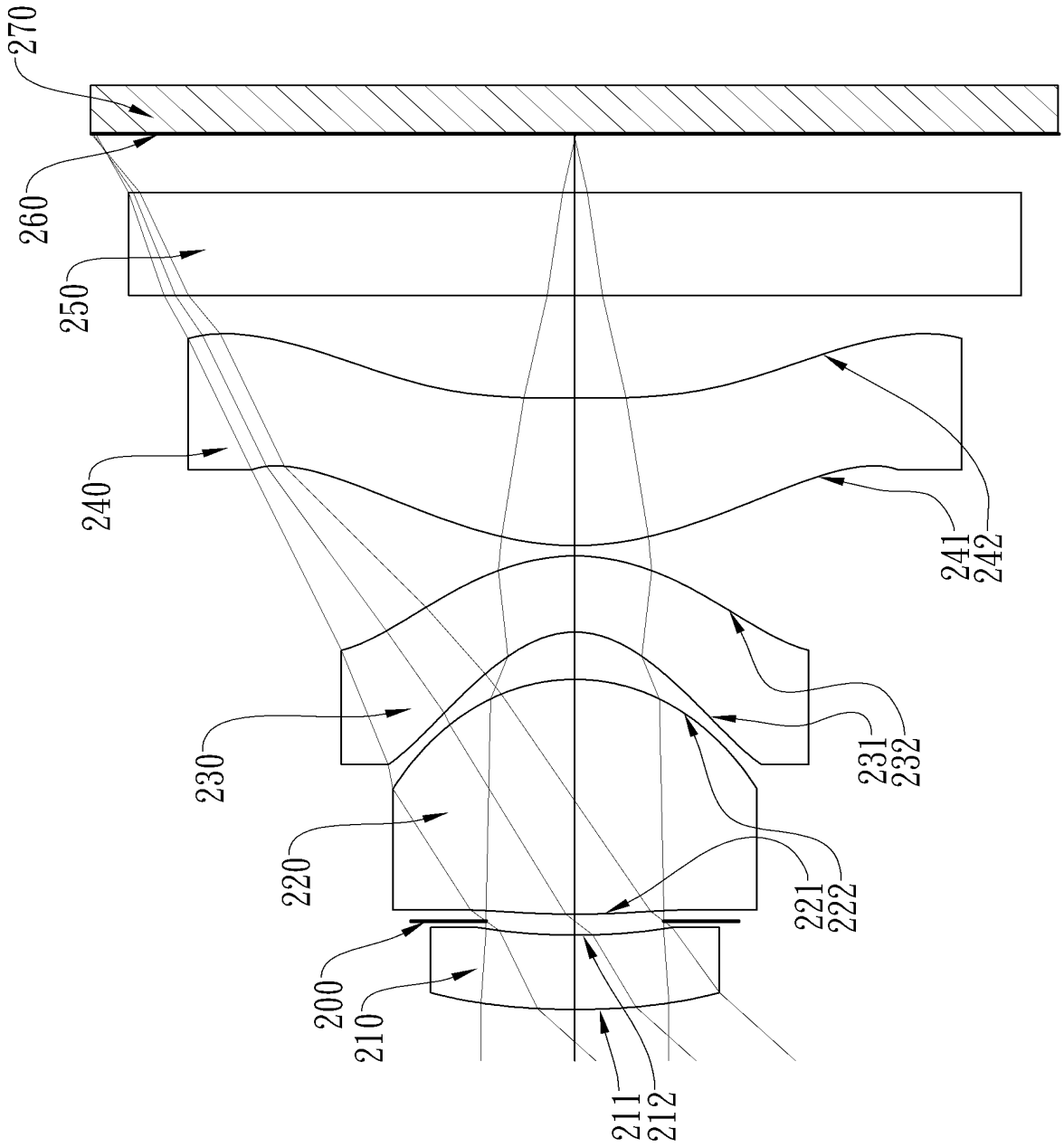


Fig. 2A

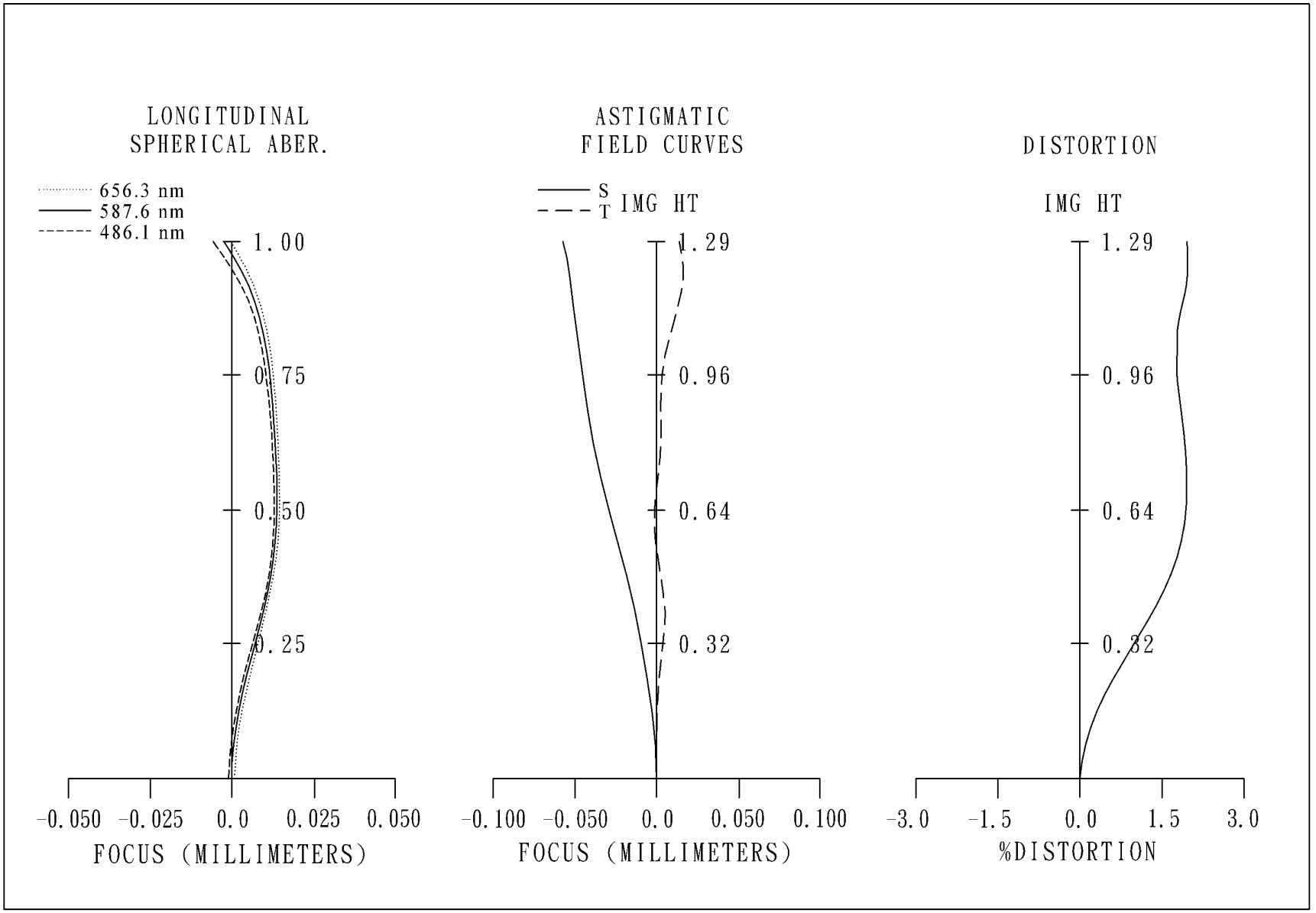


Fig. 2B

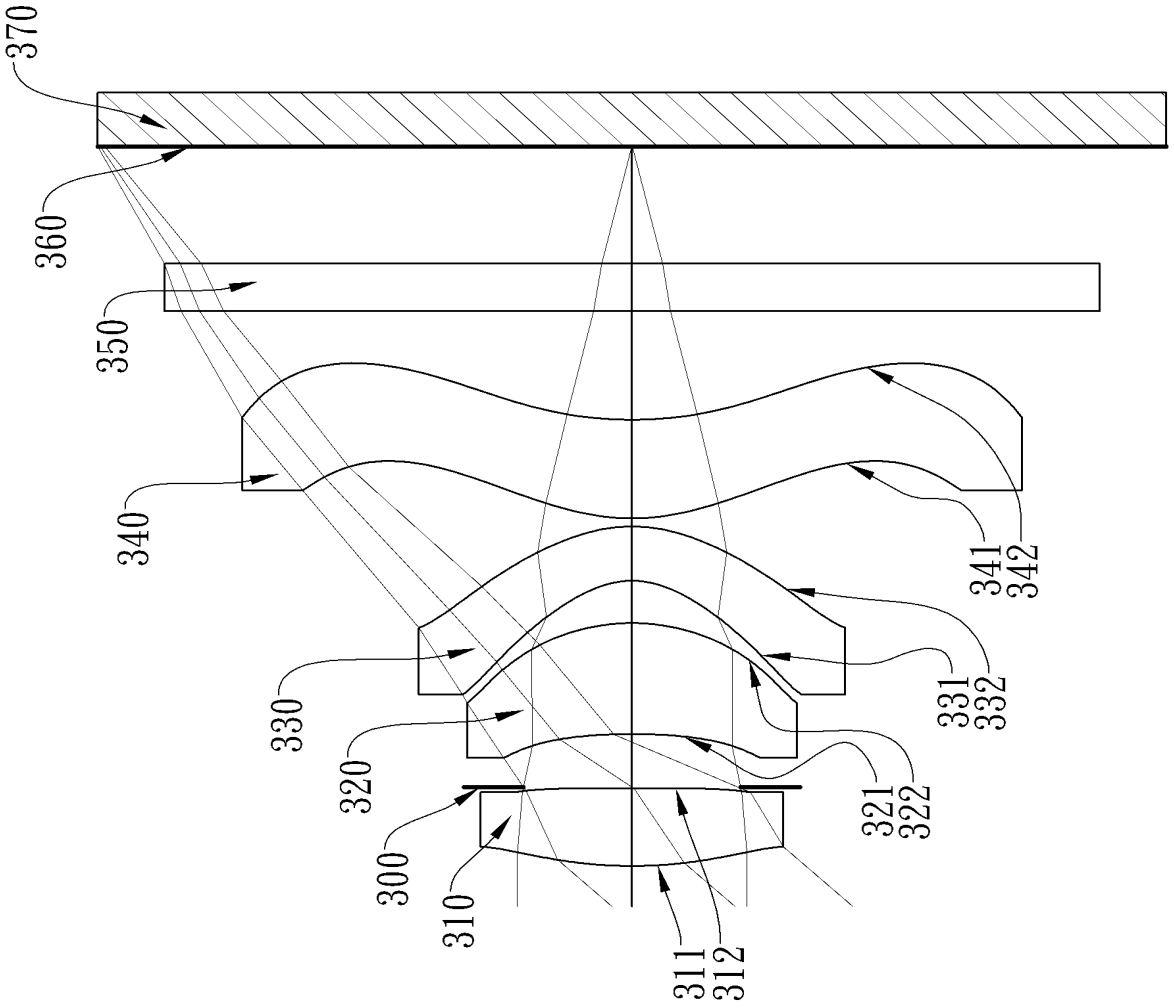


Fig. 3A

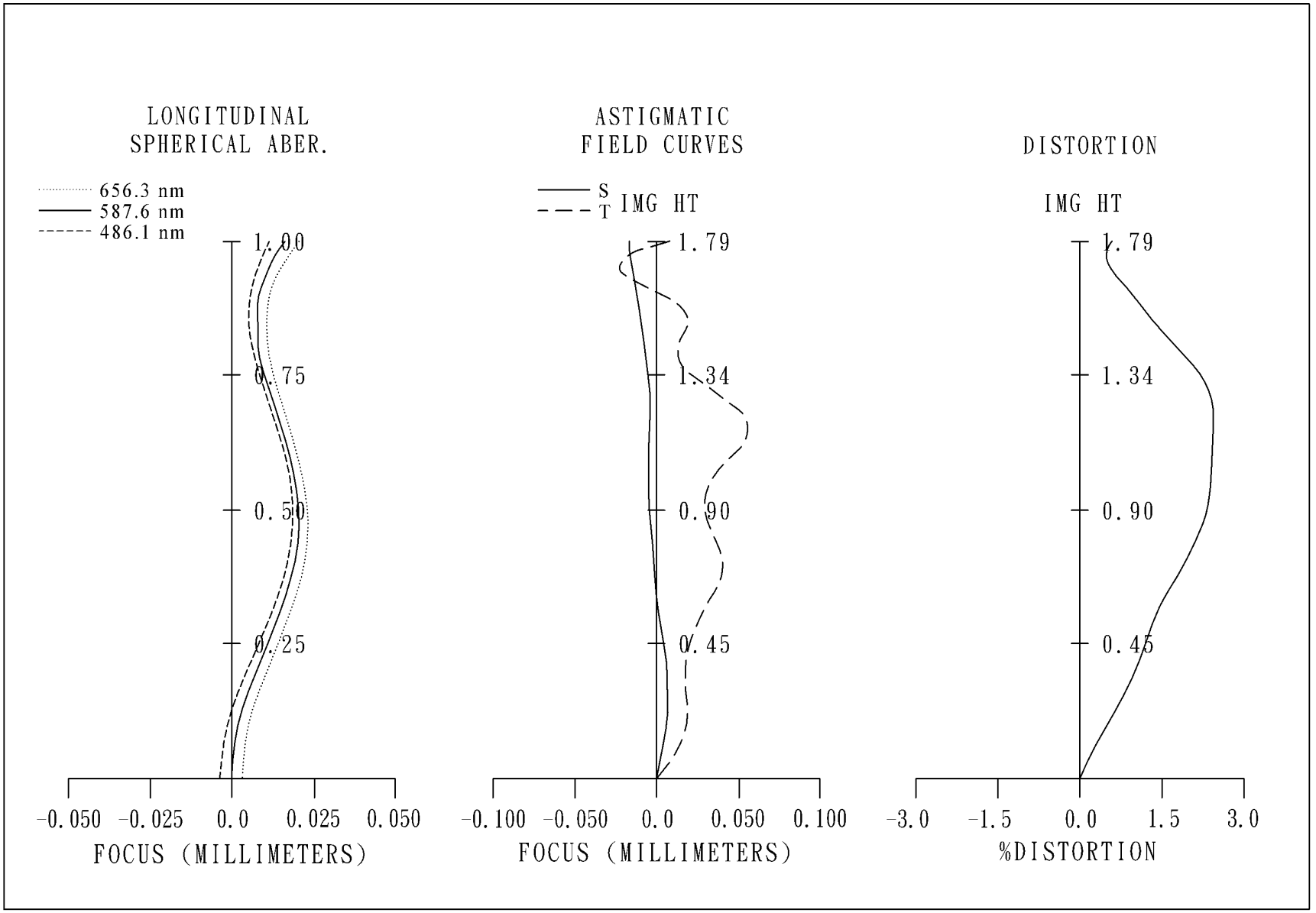


Fig. 3B

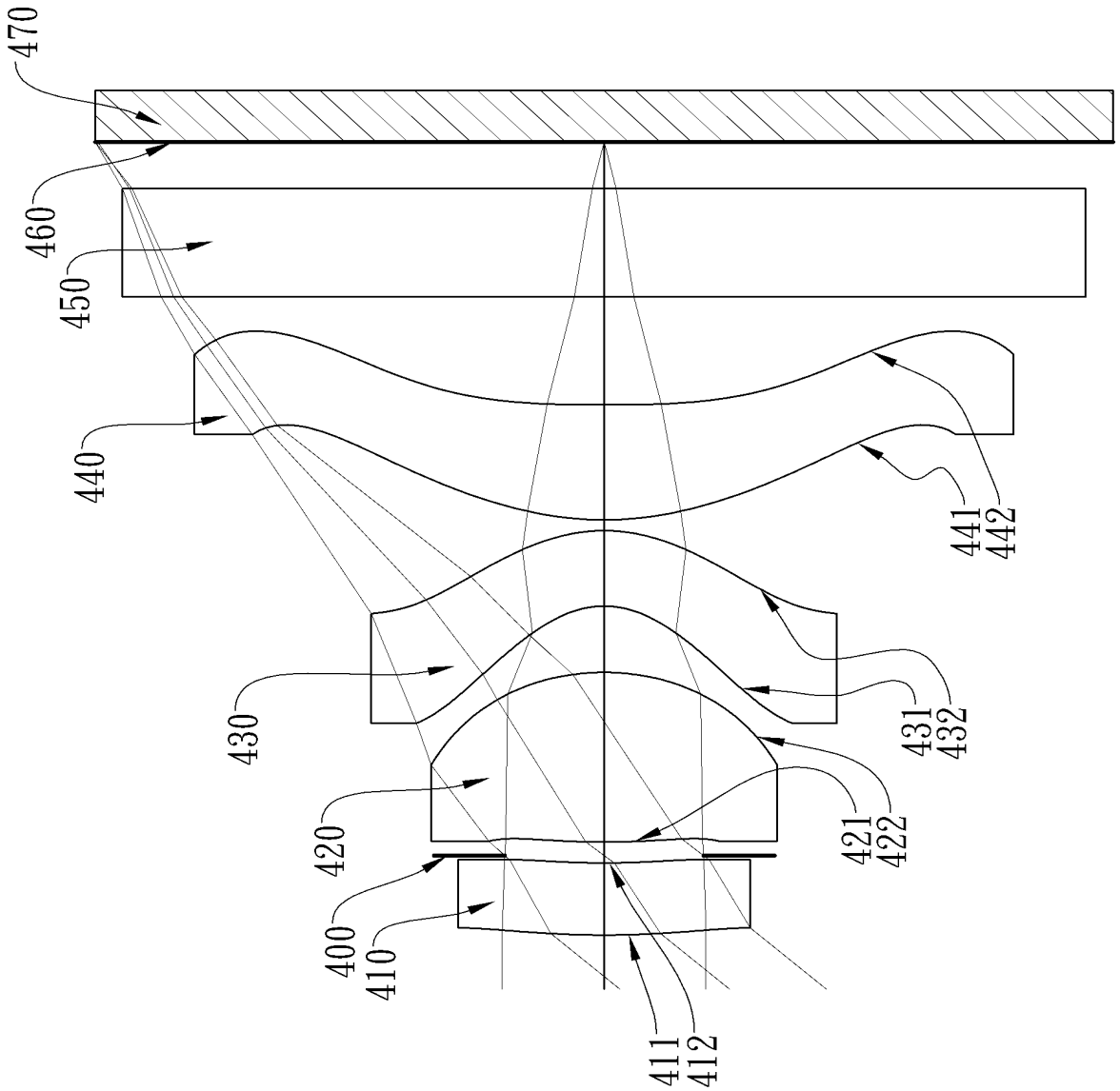


Fig. 4A

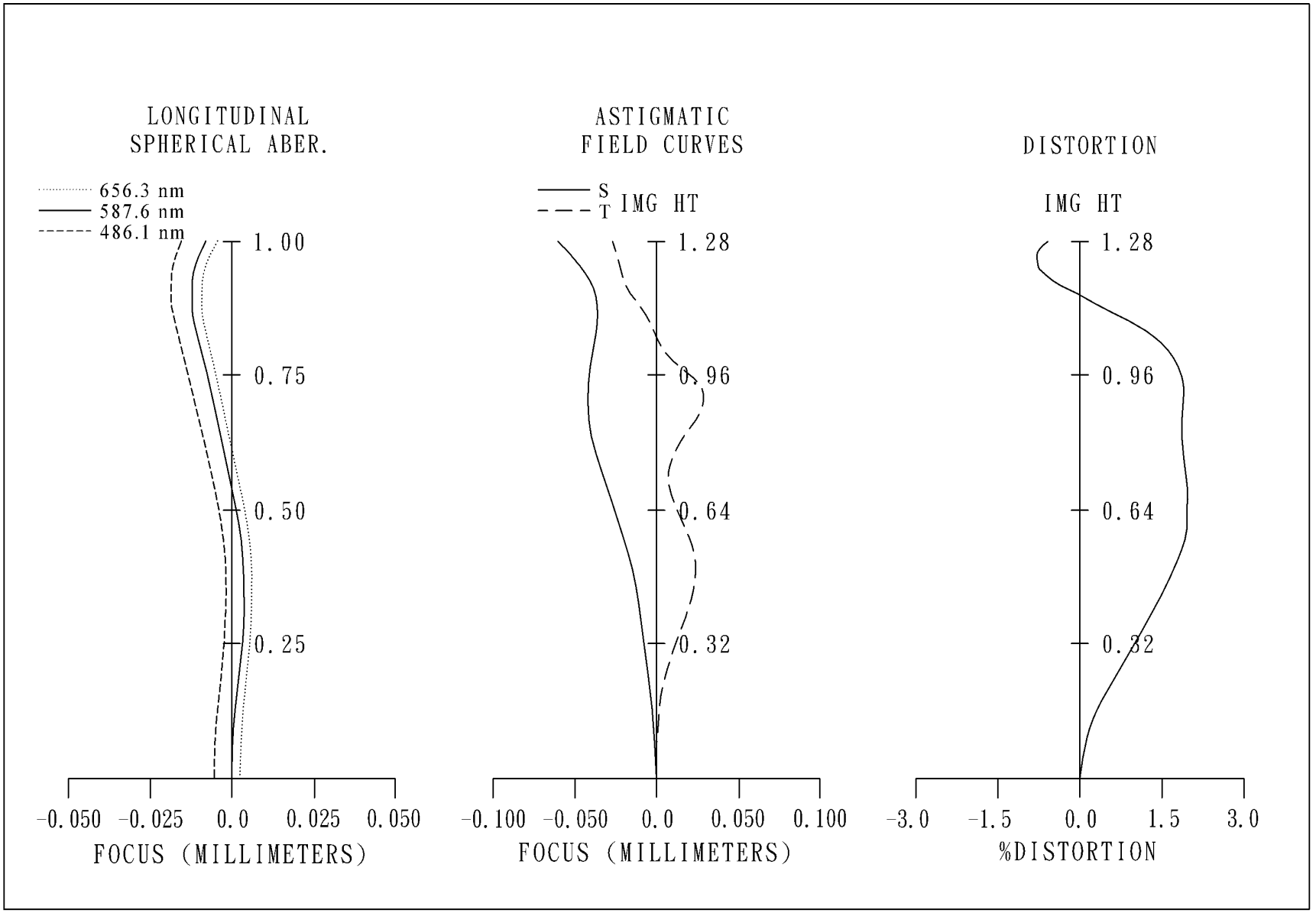


Fig. 4B

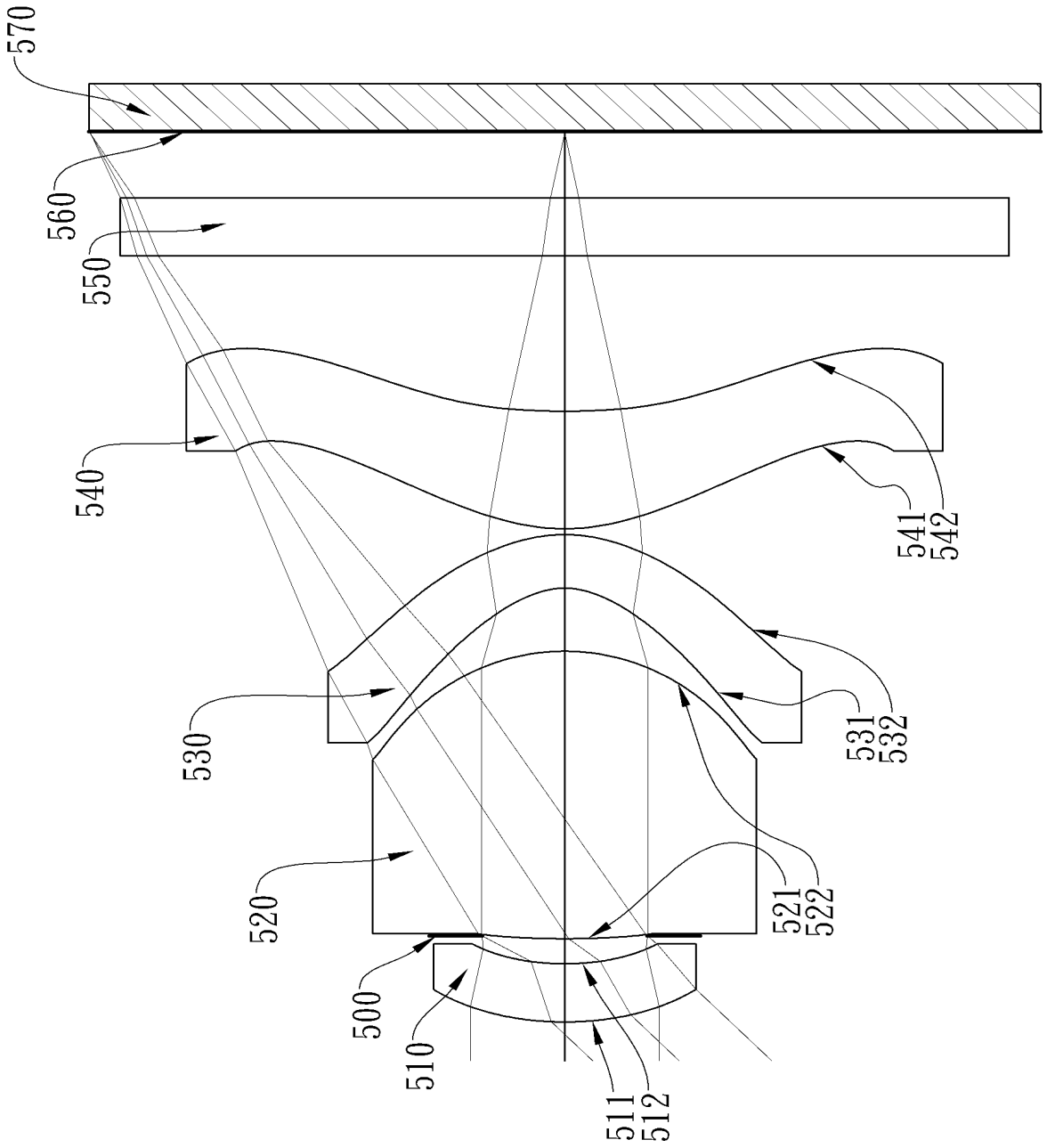


Fig. 5A

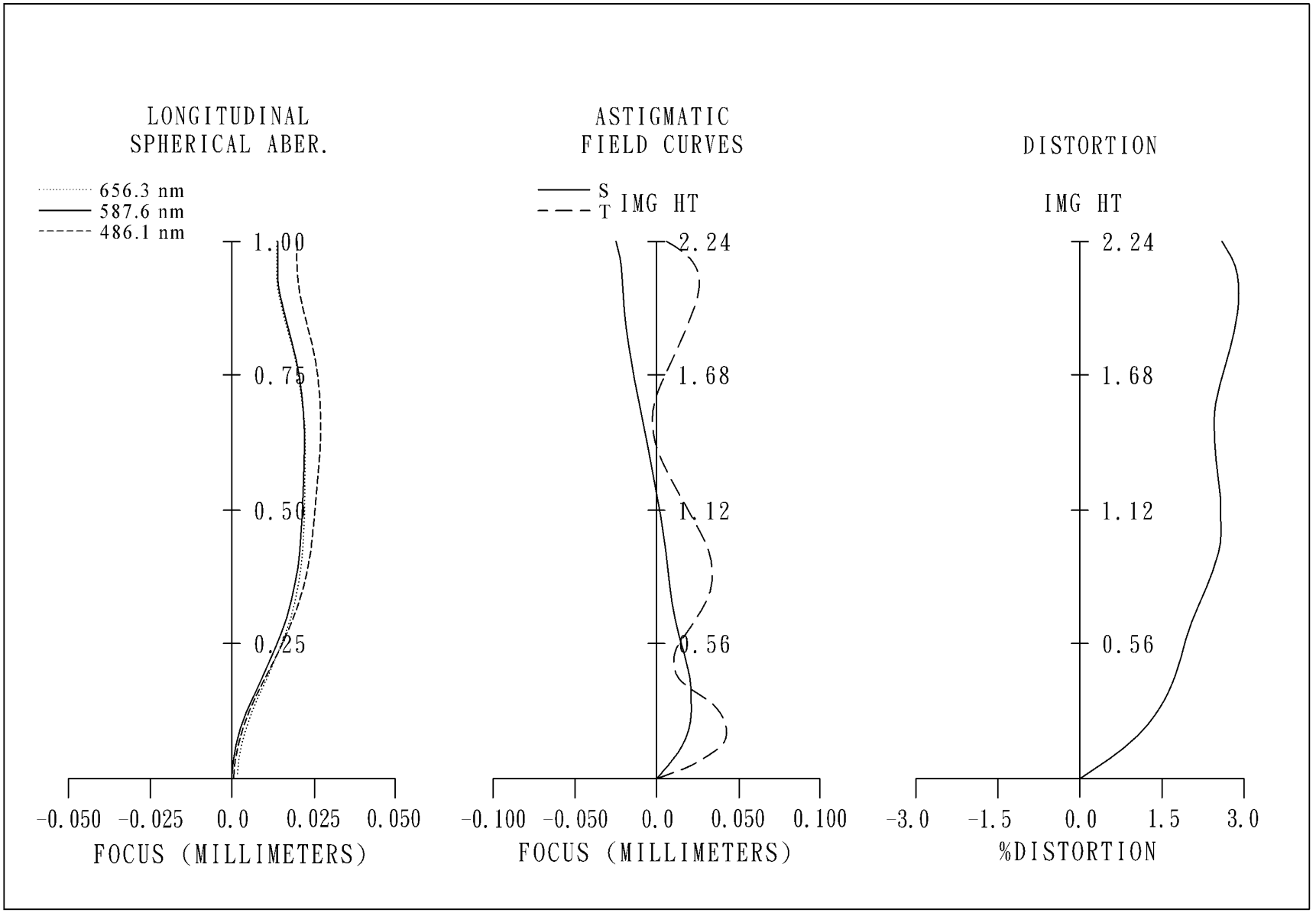


Fig. 5B

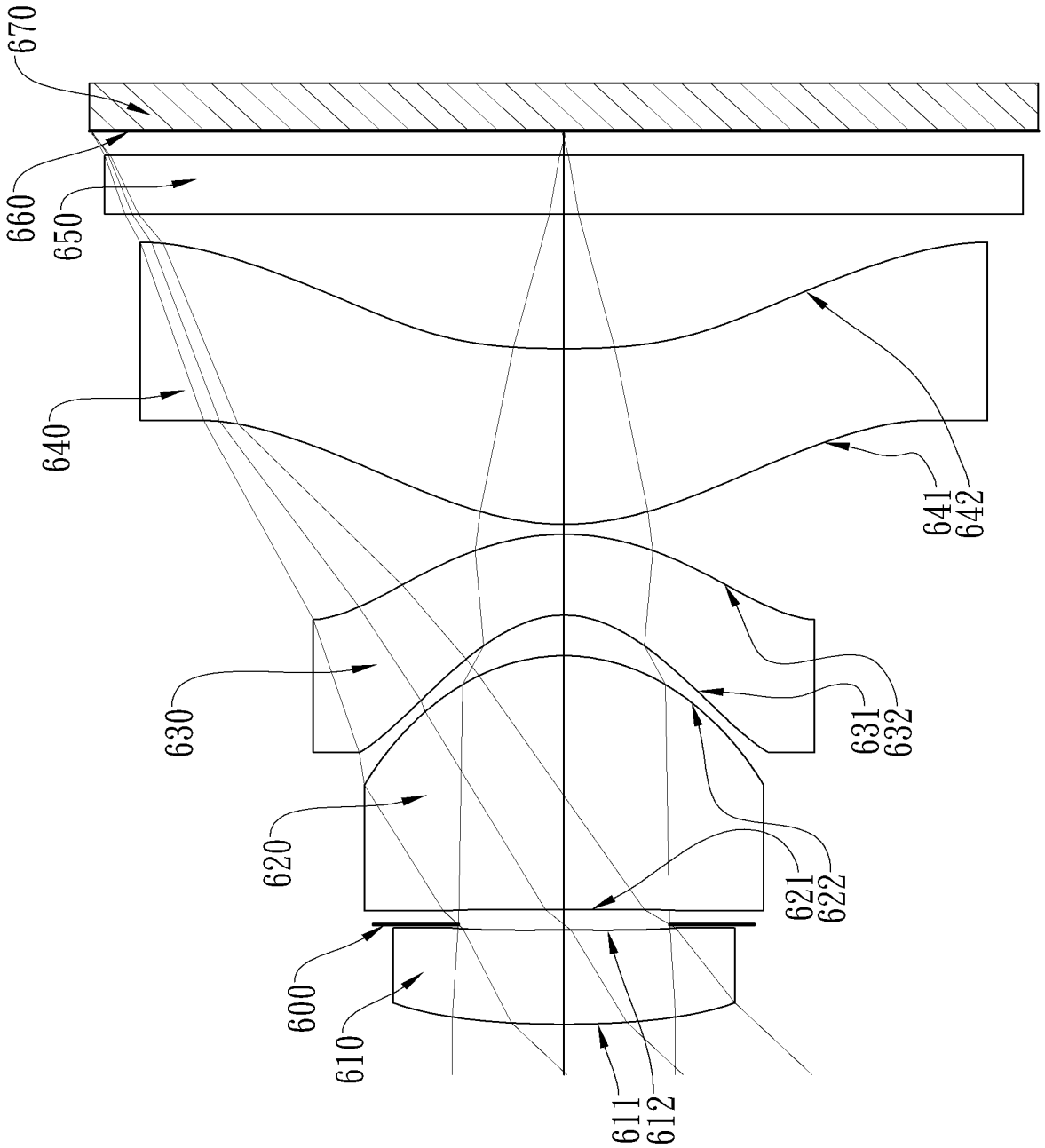


Fig. 6A

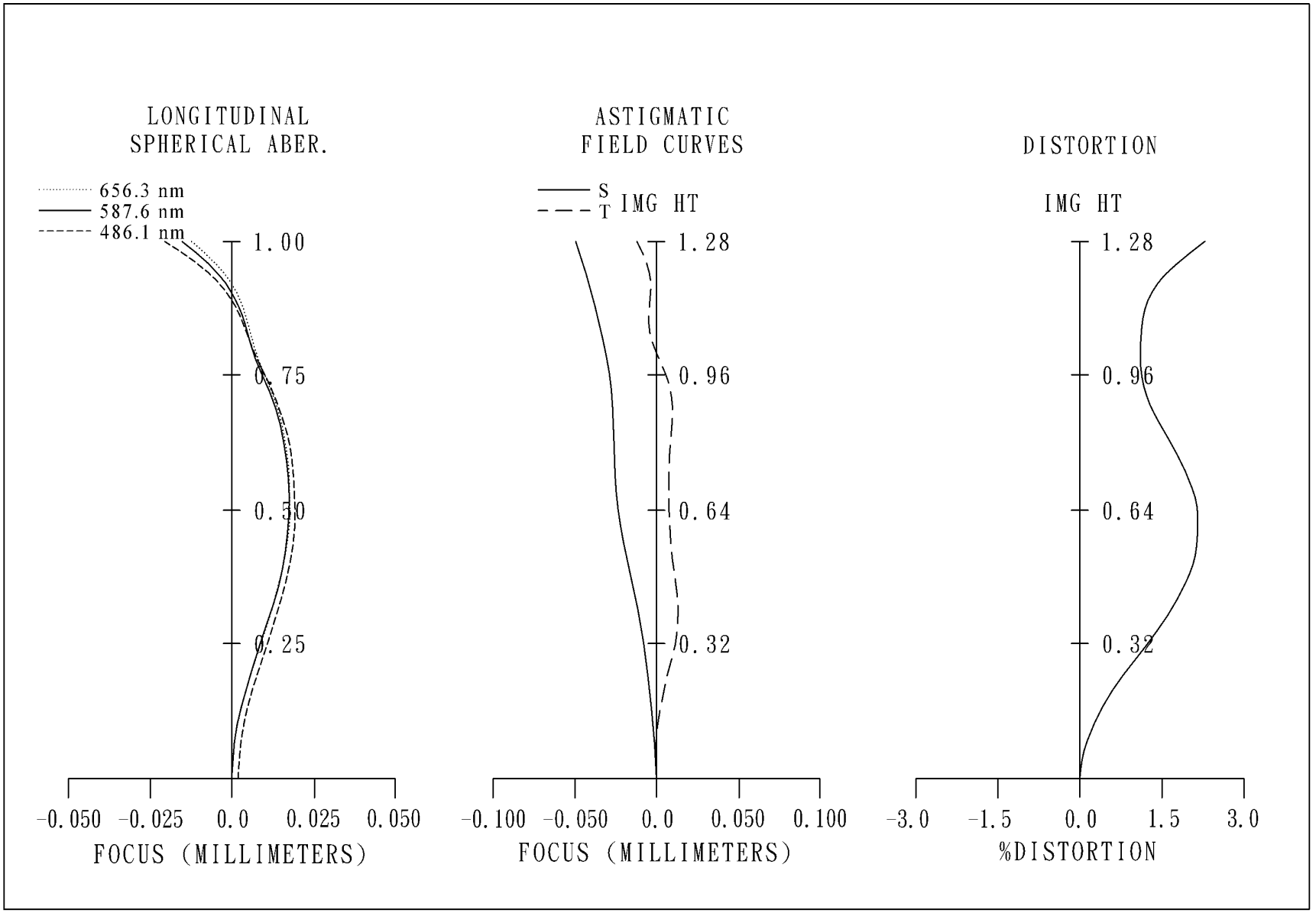


Fig. 6B

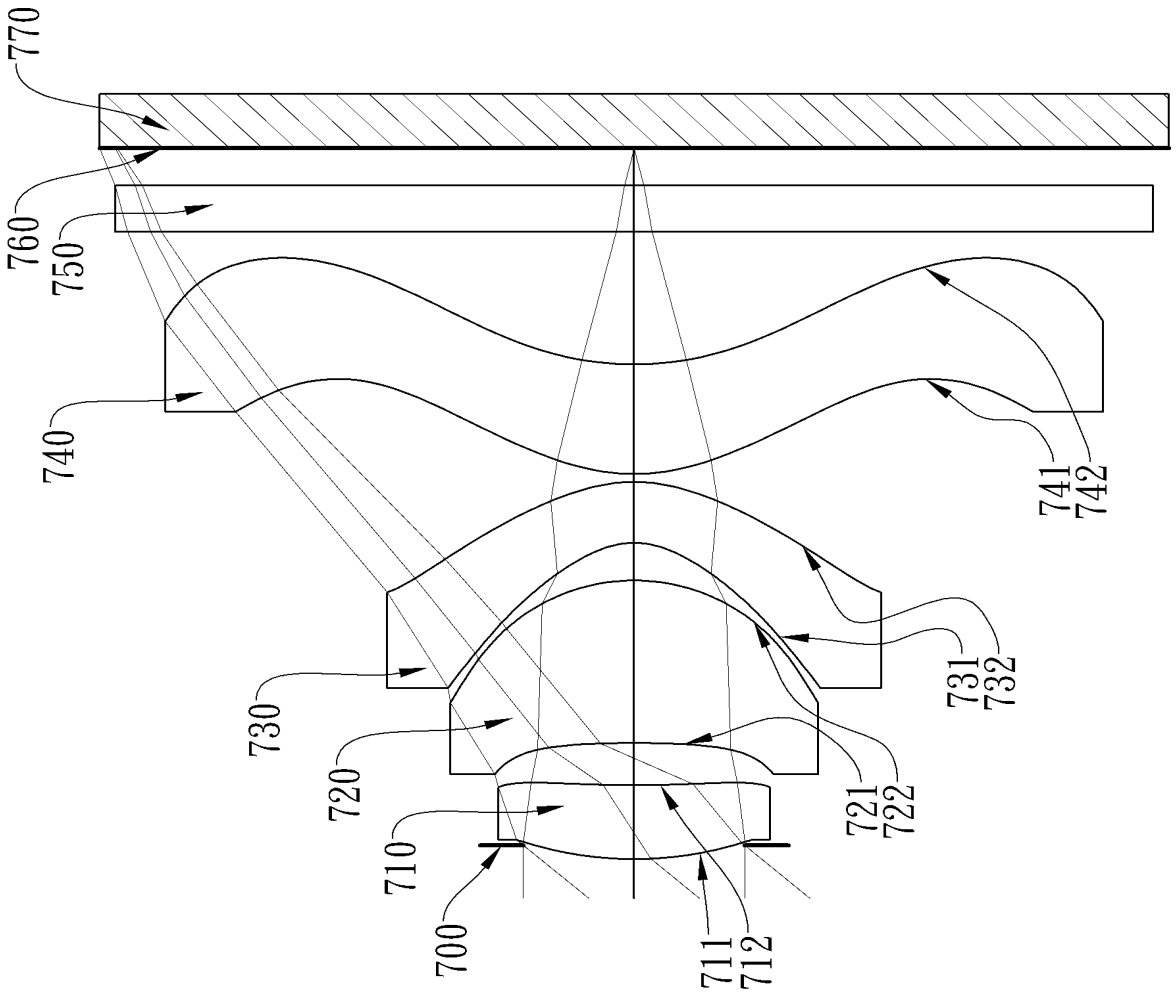


Fig. 7A

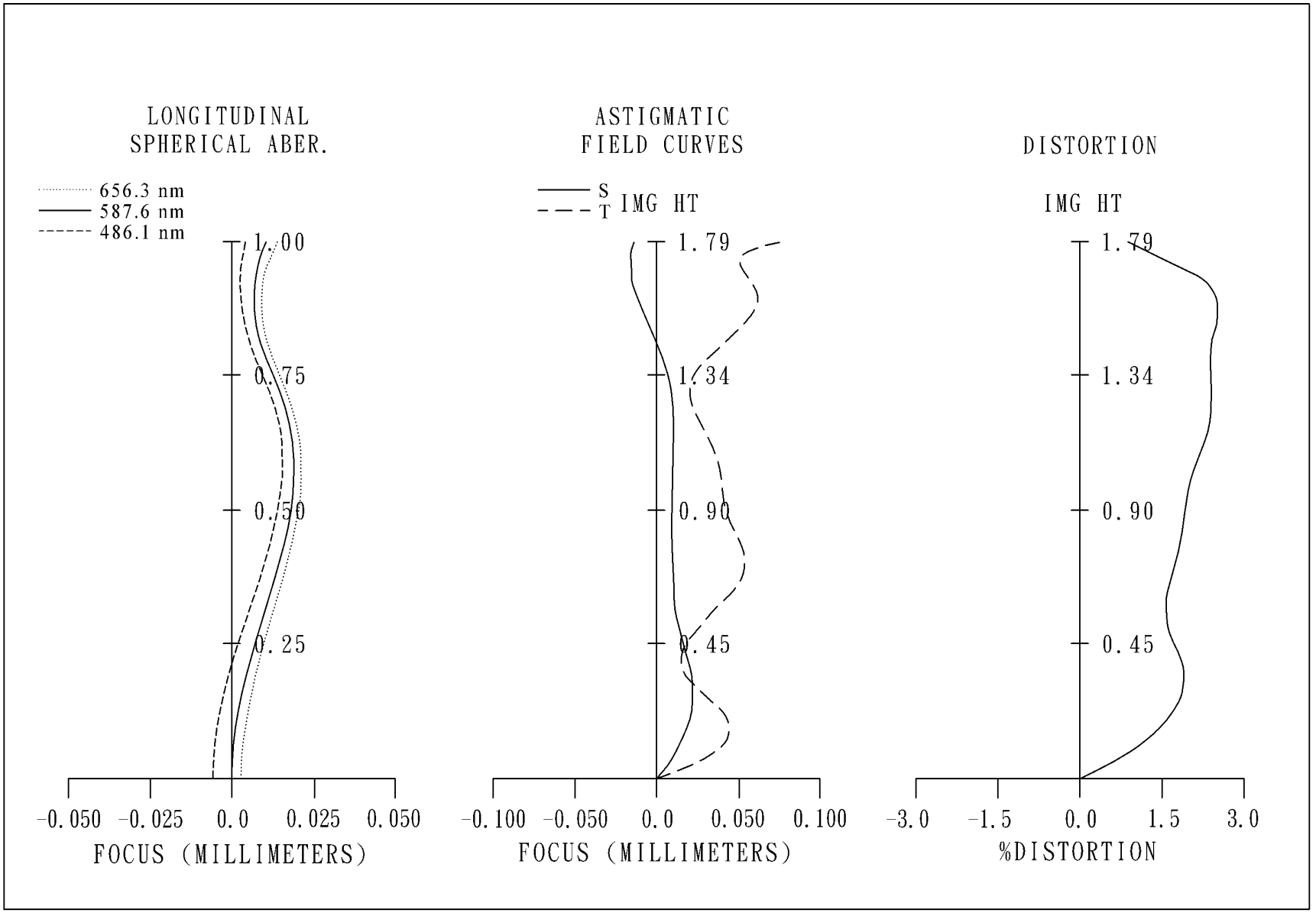


Fig. 7B

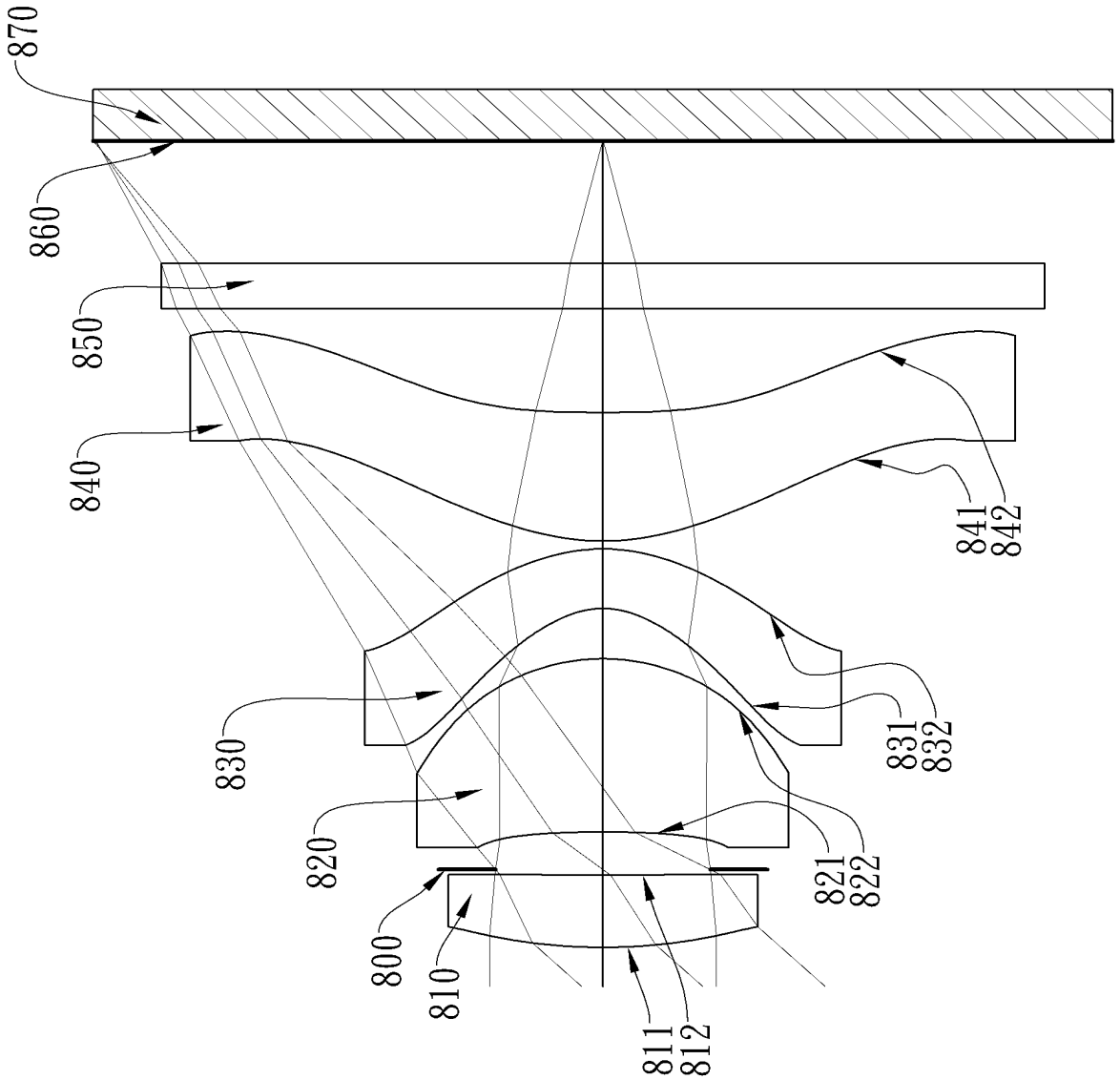


Fig. 8A

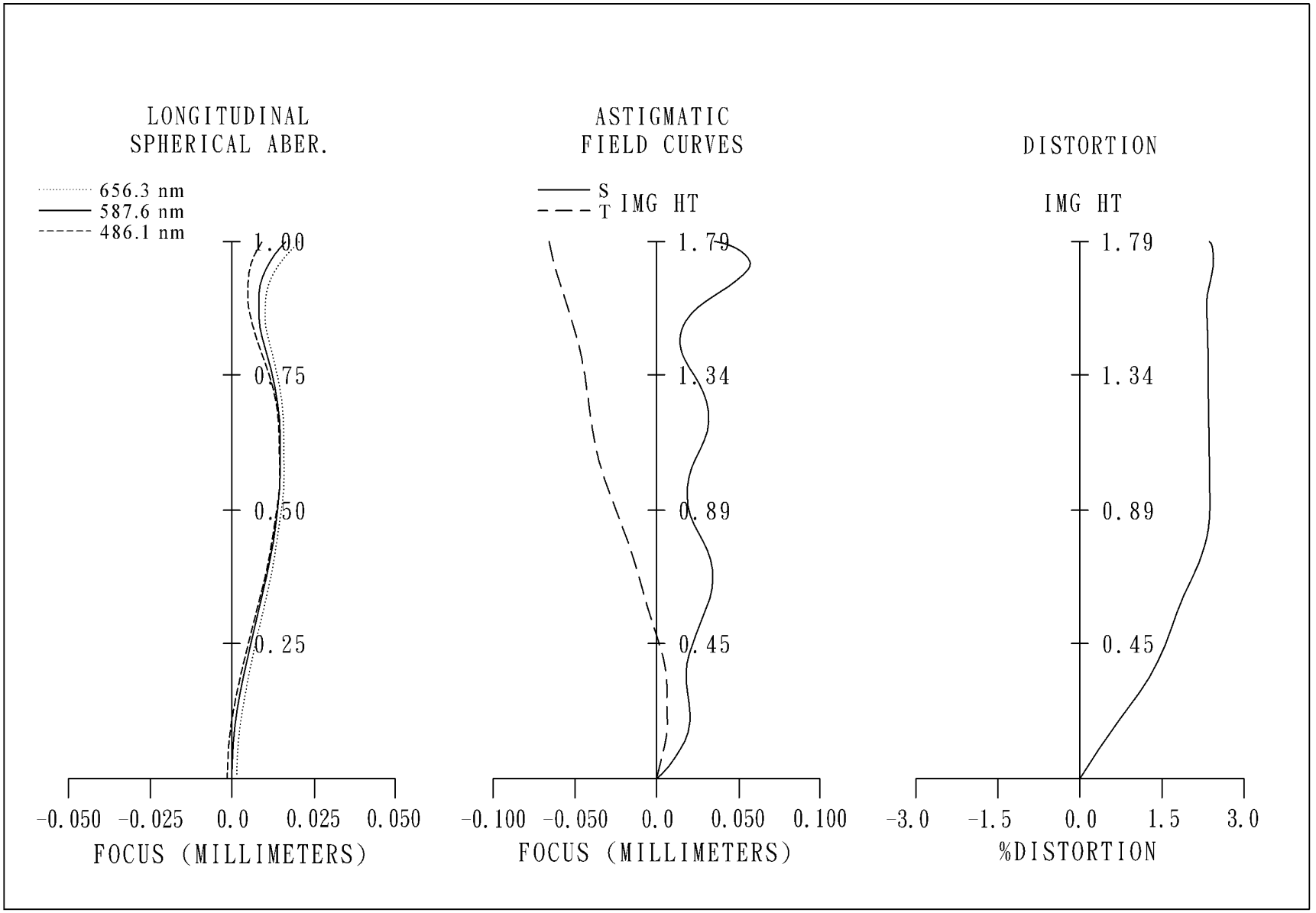


Fig. 8B

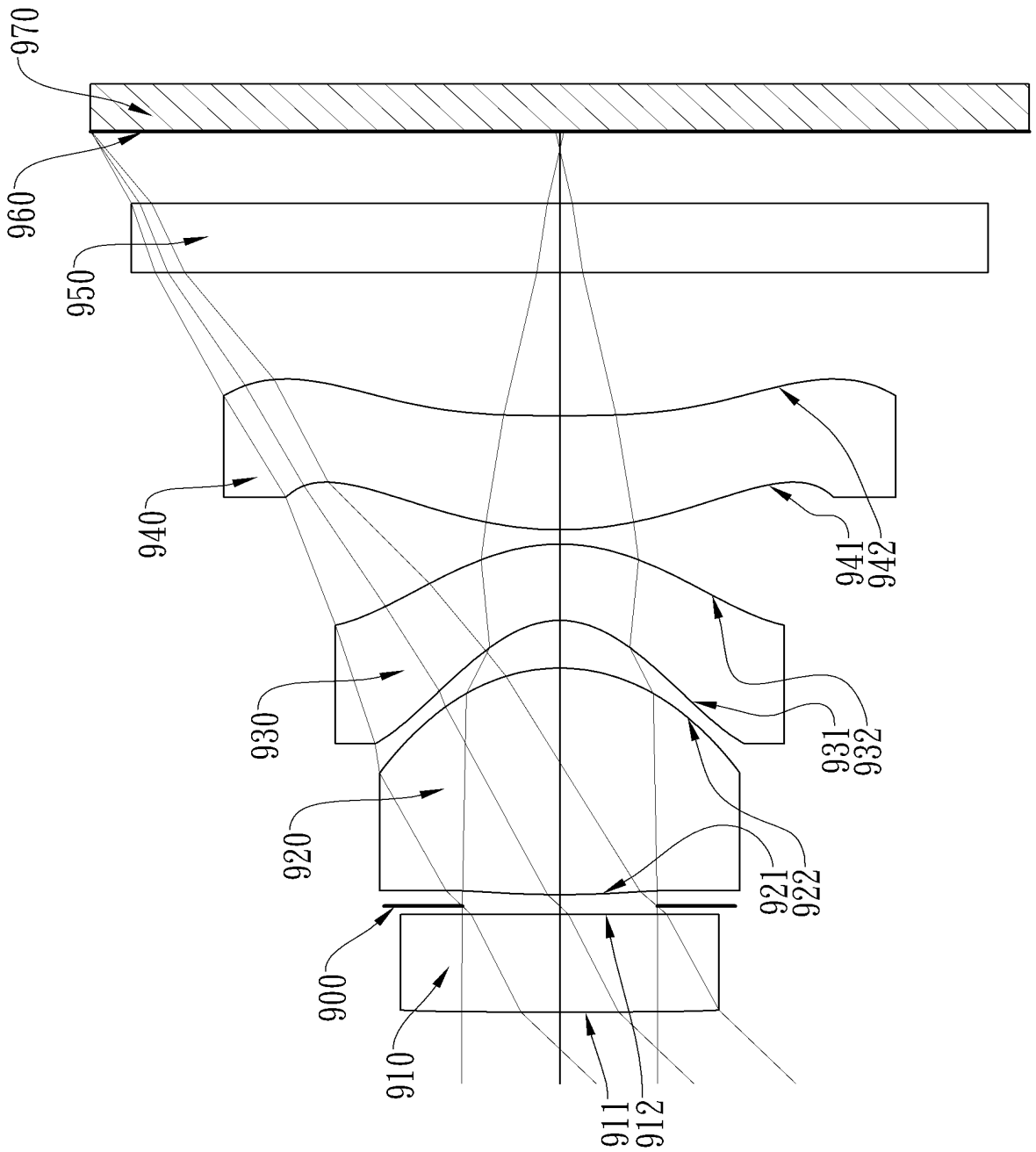


Fig. 9A

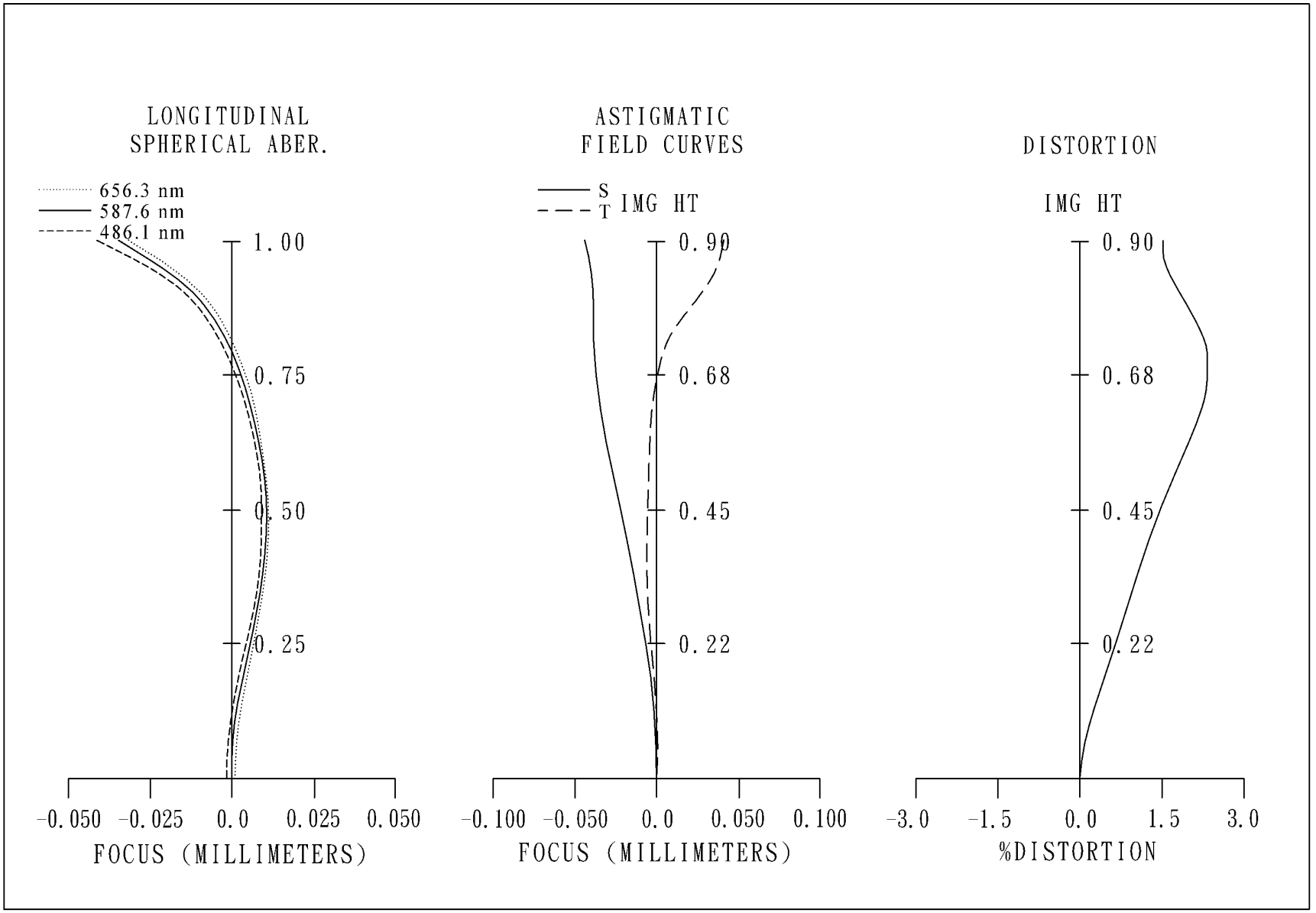


Fig. 9B

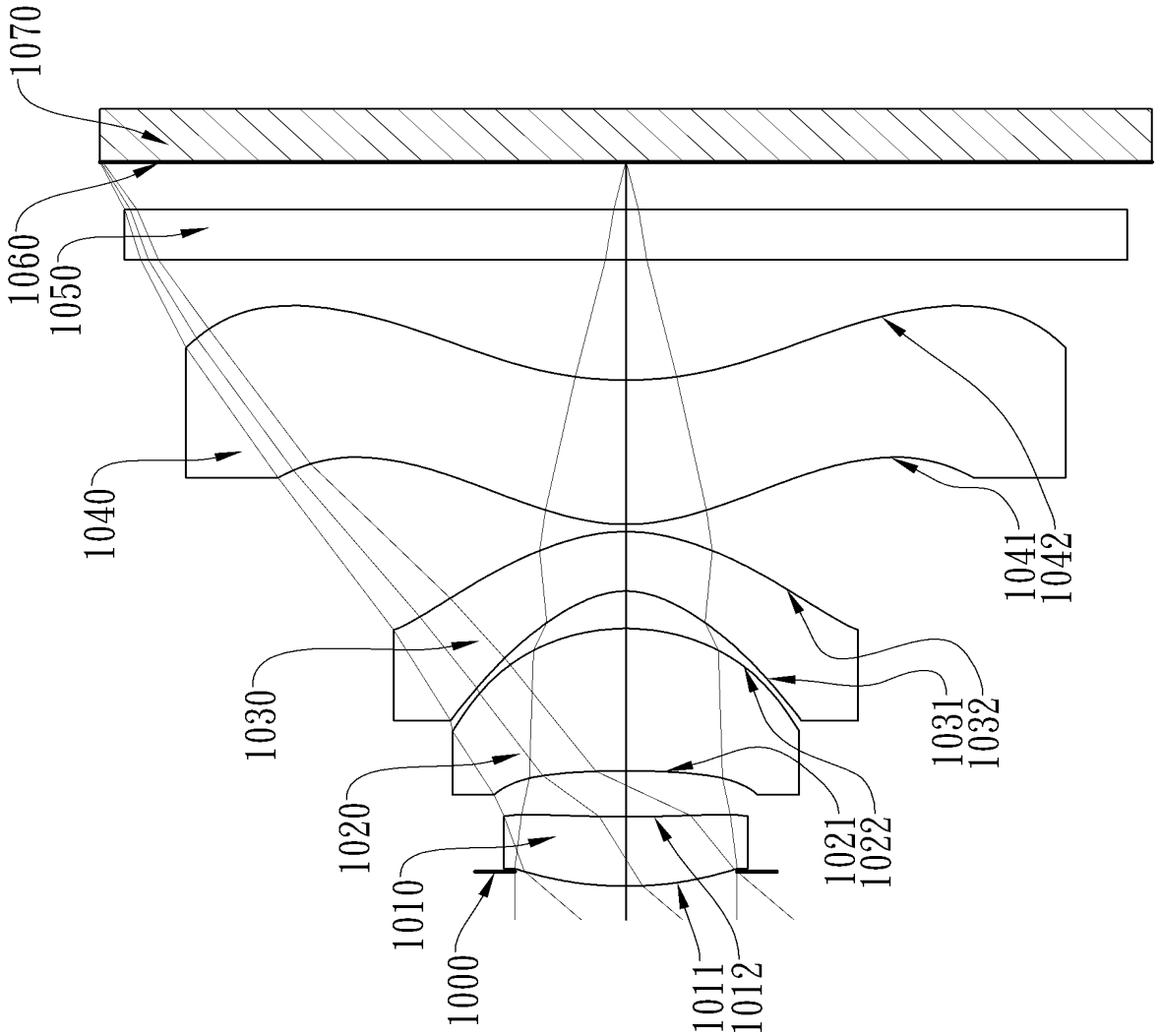

1070
1060
1050
1040
1041
1042
1030
1031
1032
1020
1021
1022
1010
1000
1011
1012

Fig. 10A

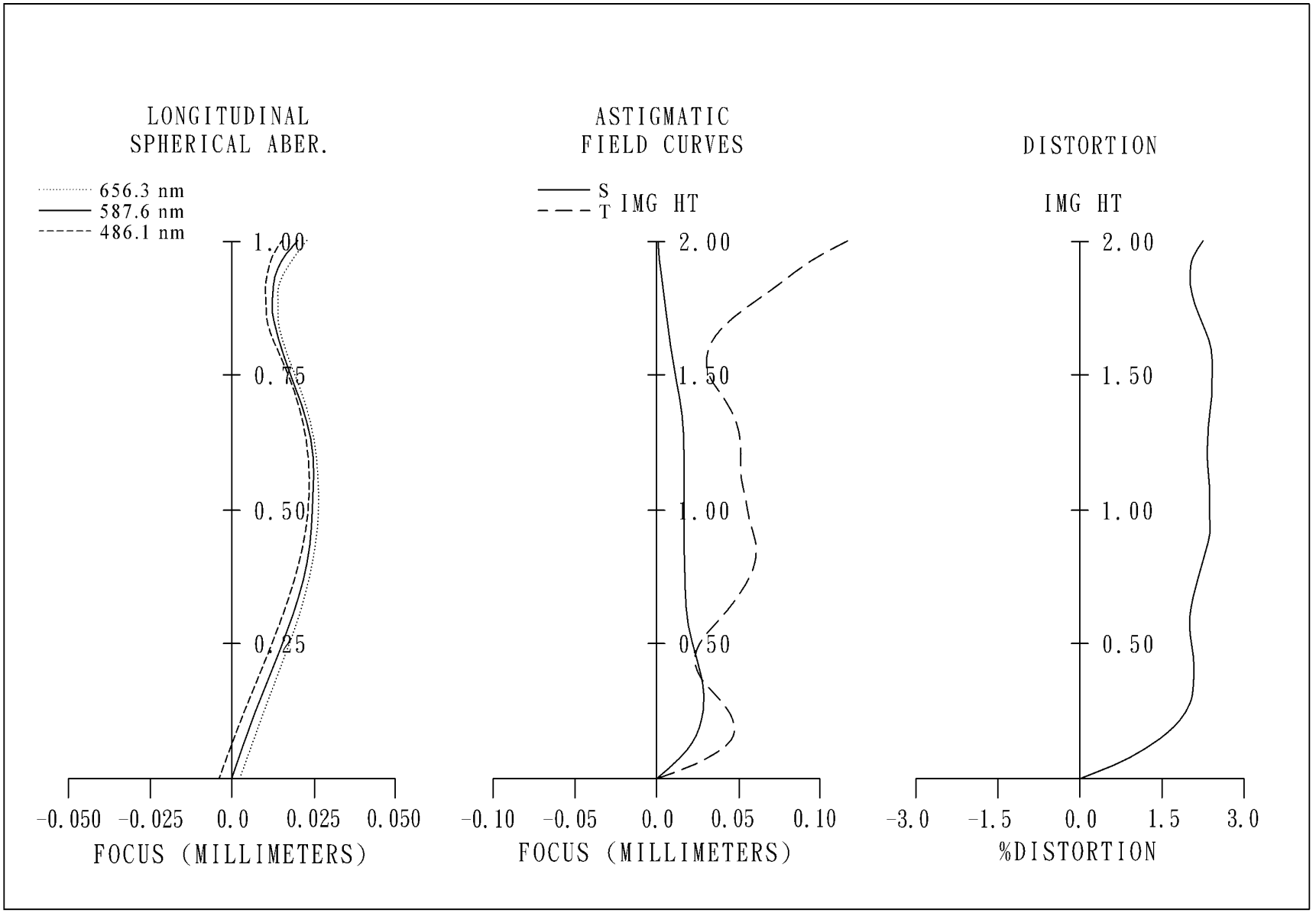


Fig. 10B

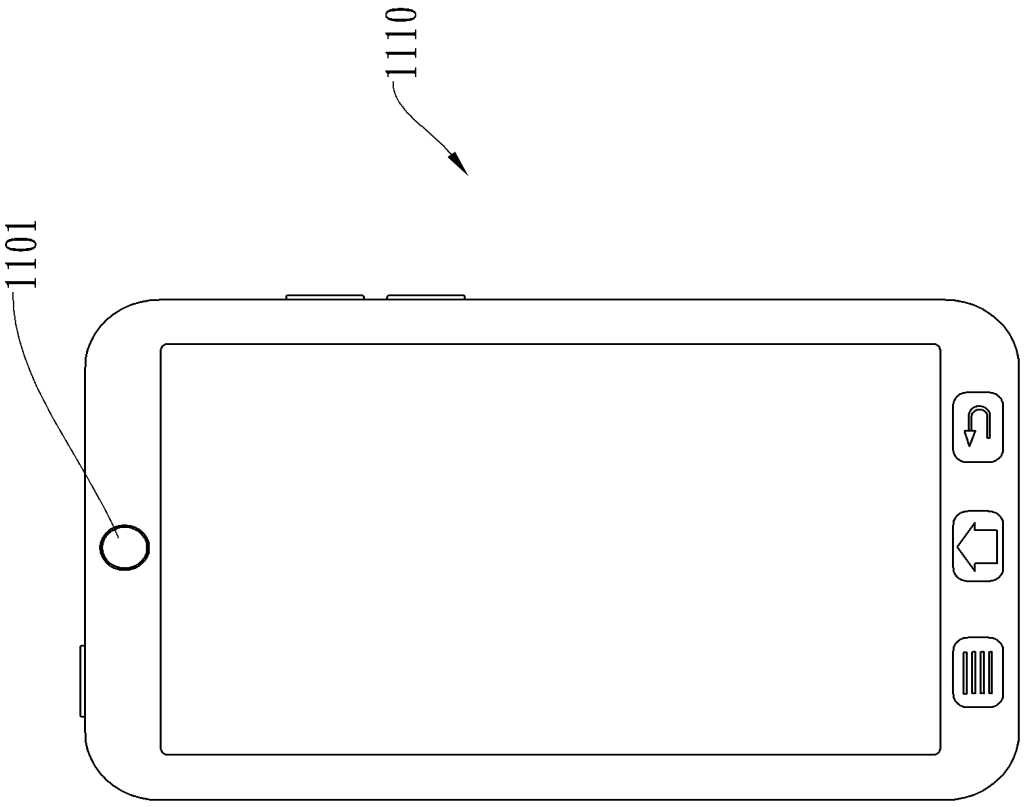


Fig. 11A

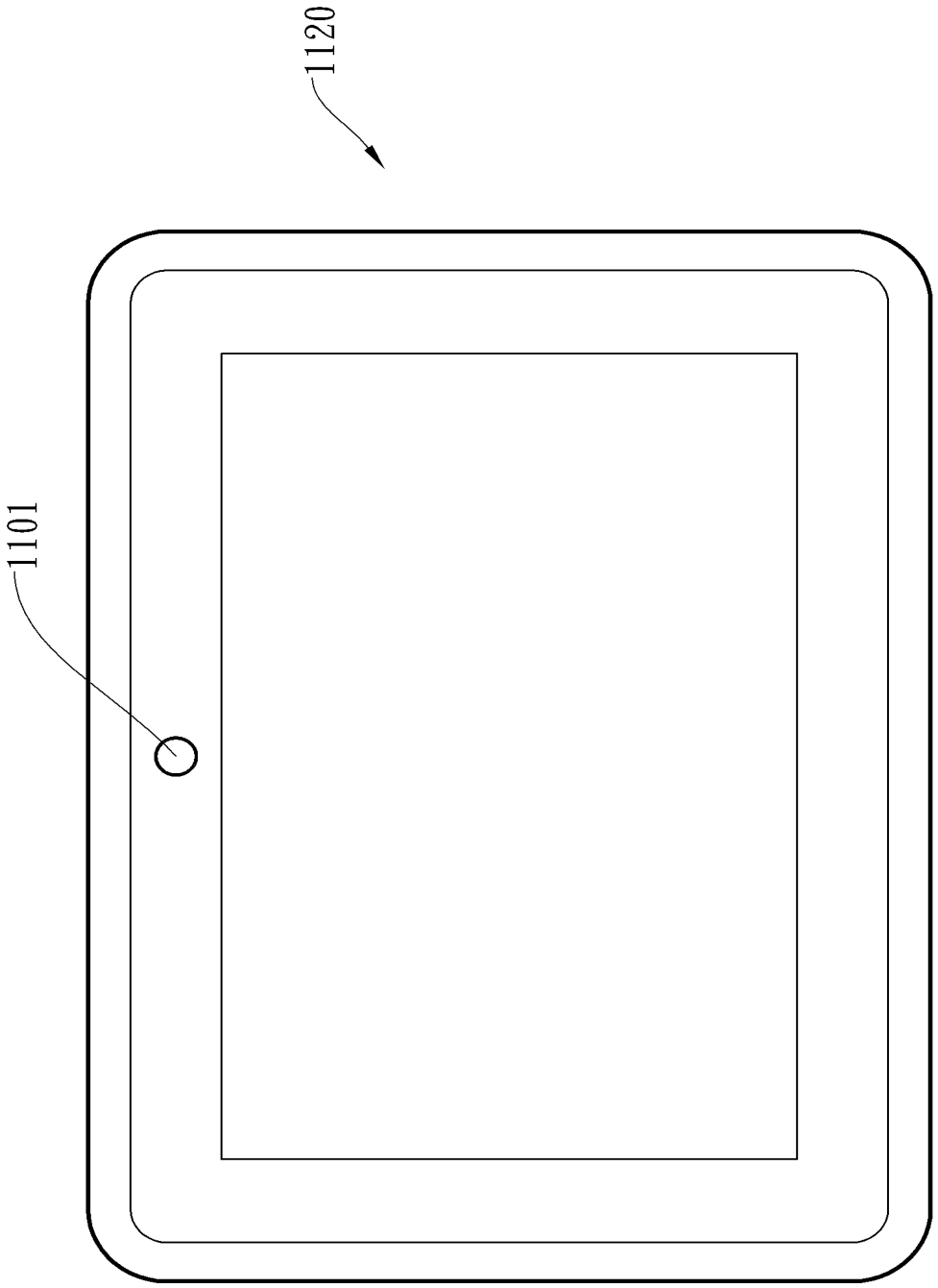


Fig. 11B

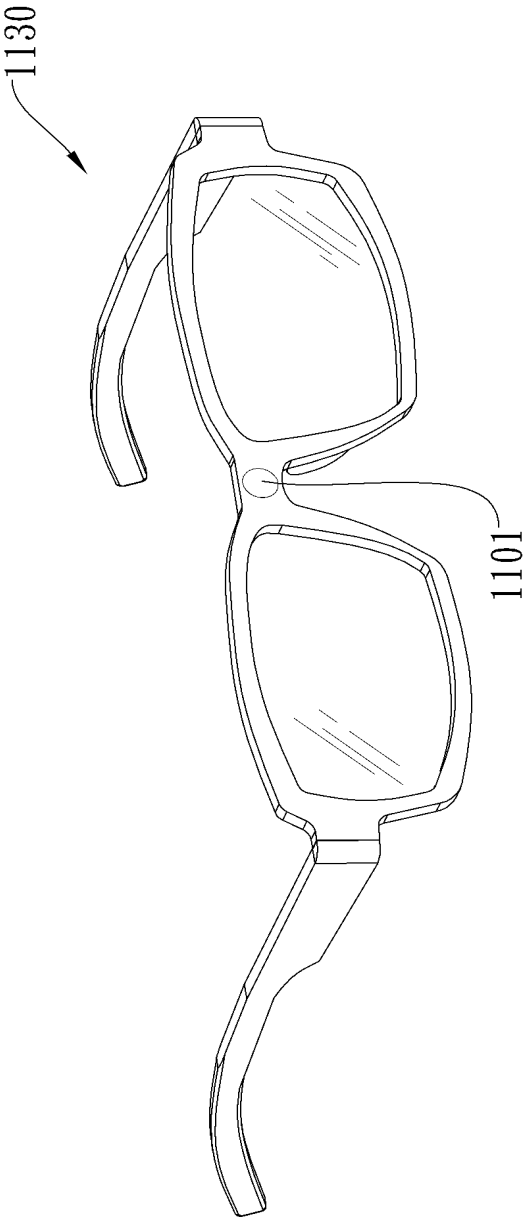


Fig. 11C

PTO/AIA/82A (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	December 13, 2013
First Named Inventor	WEI-YU CHEN
Title	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
Art Unit	
Examiner Name	
Attorney Docket Number	14970-94702

SIGNATURE of Applicant or Patent Practitioner

Signature	/Tim Tingkang Xia/	Date	December 13, 2013
Name	Tim Tingkang Xia	Telephone	4044953678
Registration Number	45242		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

■ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/82B(07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

■ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent): 24728

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number	Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

■ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant:

☐ Inventor or Joint Inventor

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

■ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	CHEN, CHUN-SHAN	Date	10/19/12
Name	CHEN, CHUN-SHAN	Telephone	886-04-3600-2345
Title and Company	Manager, LARGAN PRECISION CO. LTD		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below*.

■ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Chen, Wei-Yu Date (Optional): 21st Nov 2013

Signature: Wei-Yu Chen

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

13P0339

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Filer:	Tim Tingkang Xia/Debby Yew
Attorney Docket Number:	14970-94702

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Pages:				
Claims:				
Claims in Excess of 20	1202	6	80	480
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2080**

Electronic Acknowledgement Receipt

EFS ID:	17655791
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Debby Yew
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	13-DEC-2013
Filing Date:	
Time Stamp:	14:55:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2080
RAM confirmation Number	1437
Deposit Account	503537
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	1497094702Trans.pdf	191208 c911943ffb92207dc234e0ab91fe63eb9832931f	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	1497094702FeeTrans.pdf	169762 6a72dbc31ee8e1ad06a105b03d9d230aa92a63fb	no	1
Warnings:					
Information:					
3	Application Data Sheet	1497094702ADS.pdf	1505518 d1e35235108adc89f4784a7b68494652a15af800	no	6
Warnings:					
Information:					
4		1497094702Spec.pdf	296526 832ad976d3e8915629b09063f87e1e982584299f	yes	56

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	47
Claims	48	55
Abstract	56	56

Warnings:					
Information:					
5	Drawings-only black and white line drawings	1497094702Drawings.pdf	619675 c0565e7bd2ed4bfa2dbfc4191ecf76326662d2e0	no	23
Warnings:					
Information:					
6	Power of Attorney	1497094702POA.pdf	374075 6db2169529065c90f140c5297ce56f97e547deaf	no	2
Warnings:					
Information:					

7	Oath or Declaration filed	1497094702Dec.pdf	442888 acf5d5ef1ae069bf729dd454b2bc3aa80d36b133	no	1
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	37137 ce80c93b35e126b657e711b774b52e7114277f93	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	3636789	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/105,811

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	26 minus 20 =	* 6			OR	x 80 =	480
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
			TOTAL			TOTAL	2080

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/105,811	12/13/2013	2872	2080	14970-94702	26	3

CONFIRMATION NO. 5836

24728
MORRIS MANNING MARTIN LLP
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

FILING RECEIPT

OC000000065866426

Date Mailed: 01/08/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
WEI-YU CHEN, Taichung, TAIWAN;

Applicant(s)
LARGAN PRECISION CO., LTD., Taichung, TAIWAN

Assignment For Published Patent Application
LARGAN PRECISION CO., LTD., Taichung, TAIWAN

Power of Attorney: The patent practitioners associated with Customer Number 24728

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
TAIWAN 102139029 10/29/2013

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 01/02/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/105,811**
Projected Publication Date: 04/30/2015
Non-Publication Request: No
Early Publication Request: No

Title

IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

Preliminary Class

359

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702

CONFIRMATION NO. 5836

24728
MORRIS MANNING MARTIN LLP
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

POA ACCEPTANCE LETTER

OC000000065866449

Date Mailed: 01/08/2014

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/13/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/hnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

中華民國經濟部智慧財產局

INTELLECTUAL PROPERTY OFFICE
MINISTRY OF ECONOMIC AFFAIRS
REPUBLIC OF CHINA

茲證明所附文件，係本局存檔中原申請案的副本，正確無訛，
其申請資料如下 ：

This is to certify that annexed is a true copy from the records of this office of the application as originally filed which is identified hereunder：

申　　請　　日 ： 西元 2013 年 10 月 29 日
Application Date　　Oct. 29, 2013

申　請　案　號 ： 102139029
Application No.

申　　請　　人 ： 大立光電股份有限公司
Applicant(s)

發　　明　　人 ： 陳緯彧
Inventor(s)

局　　長
Director General
王美花

西元 2013 年 11 月 11 日
Nov. 11, 2013

發明摘要

※ 申請案號：

※ 申請日：　　※IPC 分類：

【發明名稱】(中文/英文)

影像拾取系統透鏡組、取像裝置及可攜裝置/ Image Capturing Lens System, Imaging Device and Mobile Terminal

【中文】

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面。藉由上述結構，在滿足特定條件下，可有利於具備大視角及縮短系統總長度，並提升周邊解像力和照度。

【英文】

This invention provides an image capturing lens system comprising from object-side to image-side: a first lens element with refractive power; a positive second lens element having a convex image-side surface in a paraxial region; a negative third lens element having a concave object-side surface in a paraxial region and a convex image-side surface in a paraxial region; and a fourth lens element with refractive power having a concave image-side surface in a paraxial region, both of the object-side and image-side surfaces being aspheric, and the image-side surface has at least a convex shape at an off-axis region thereof. When particular relations are satisfied with the aforesaid structure configuration, wide field of view can be obtained, the total track length can be favorably reduced and the resolution for peripheral image and illumination can be improved.

【代表圖】

【本案指定代表圖】：第（ 一A ）圖。

【本代表圖之符號簡單說明】：

光圈 100

第一透鏡 110

物側面 111 像側面 112

第二透鏡 120

物側面 121 像側面 122

第三透鏡 130

物側面 131 像側面 132

第四透鏡 140

物側面 141 像側面 142

紅外線濾除濾光元件 150

成像面 160

電子感光元件 170

【本案若有化學式時，請揭示最能顯示發明特徵的化學式】：

無

發明專利說明書

（本說明書格式、順序，請勿任意更動）

【發明名稱】（中文/英文）

影像拾取系統透鏡組、取像裝置及可攜裝置/ Image Capturing Lens System, Imaging Device and Mobile Terminal

【技術領域】

本發明係關於一種影像拾取系統透鏡組，特別是關於一種應用於可攜式電子產品的影像拾取系統透鏡組。

【先前技術】

隨著個人電子產品逐漸輕薄化，電子產品內部各零組件被要求具有更小的尺寸。攝影鏡頭的尺寸在這個趨勢下同樣面臨著小型化的要求。除了小型化的要求之外，因為半導體製程技術的進步使得感光元件的畫素面積縮小，攝影鏡頭逐漸往高畫素領域發展，因此，對成像品質的要求也日益增加。

傳統搭載於可攜式電子產品上的小型化光學系統，多採用三片式透鏡結構為主，但由於智慧型手機(Smart Phone)、平板電腦(Tablet PC)與可穿戴式設備(Wearable Apparatus)等高規格可攜裝置(Mobile Terminal)的盛行，使得攝影鏡頭在畫素與成像品質上的迅速攀升，習知的三片式攝影鏡頭已無法滿足更高階的攝影需求。

領域中亦提出四片式透鏡組，期能提供更優異的成像品質。然而，習用四片式透鏡組往往未能在大視角及鏡頭總長度之間取得良好的平衡，且對於周邊影像的解像力與照度也不甚理想，尚未能滿足領域中所要求的高階成像品質。

因此，領域中急需一種在滿足小型化的條件下，具有良好之

申請案號：102139029

周邊解像力與照度的攝影鏡頭。

【發明內容】

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該第二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，係滿足下列關係式：0.5 mm < Td < 3.2 mm；1.0 mm < Td / tan(HFOV) < 3.75 mm；|f / f4| < 1.20；及 f2 / f3 < -0.65。

另一方面，本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該第三透鏡的焦距為 f3，係滿足下列關係式：0.5 mm < Td < 3.2 mm；1.0 mm < Td / tan(HFOV) < 3.75 mm；|f / f4| < 1.20；及 -2.0 < f / f3 < -0.95。

又一方面，本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含：一具屈折力的第一透鏡；一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該影像拾取系統透鏡組的光圈值為 Fno，係滿足下列關係式：$0.5\ mm < Td < 3.2\ mm$；$1.0\ mm < Td / \tan(HFOV) < 3.75\ mm$；$|f / f4| < 1.20$；及 $1.40 < Fno \leq 2.25$。

再一方面，本發明提供一種取像裝置，包含如前述的影像拾取系統透鏡組及一電子感光元件。

更一方面，本發明提供一種可攜裝置，包含如前述的取像裝置。

當 Td 滿足上述條件時，有利於維持系統的小型化。

當 Td / tan(HFOV)滿足上述條件時，有助於使該影像拾取系統透鏡組同時具備大視角及短總長的特性。

當|f / f4|滿足上述條件時，可使系統的主點更遠離成像面，有利於縮短系統的光學總長度，以維持鏡頭的小型化。

當 f2 / f3 滿足上述條件時，該第二透鏡與該第三透鏡的屈折力配置較為平衡，可有助於像差的修正與敏感度的降低。

當 f / f3 滿足上述條件時，該第三透鏡的作用如同補正透鏡，其功能為平衡及修正系統所產生的各項像差，進而可使系統獲得更高的成像品質。

當 Fno 滿足上述條件時，有助於提升系統的周邊照度。

申請案號：102139029

【圖式簡單說明】

第一 A 圖係本發明第一實施例的取像裝置示意圖。

第一 B 圖係本發明第一實施例的像差曲線圖。

第二 A 圖係本發明第二實施例的取像裝置示意圖。

第二 B 圖係本發明第二實施例的像差曲線圖。

第三 A 圖係本發明第三實施例的取像裝置示意圖。

第三 B 圖係本發明第三實施例的像差曲線圖。

第四 A 圖係本發明第四實施例的取像裝置示意圖。

第四 B 圖係本發明第四實施例的像差曲線圖。

第五 A 圖係本發明第五實施例的取像裝置示意圖。

第五 B 圖係本發明第五實施例的像差曲線圖。

第六 A 圖係本發明第六實施例的取像裝置示意圖。

第六 B 圖係本發明第六實施例的像差曲線圖。

第七 A 圖係本發明第七實施例的取像裝置示意圖。

第七 B 圖係本發明第七實施例的像差曲線圖。

第八 A 圖係本發明第八實施例的取像裝置示意圖。

第八 B 圖係本發明第八實施例的像差曲線圖。

第九 A 圖係本發明第九實施例的取像裝置示意圖。

第九 B 圖係本發明第九實施例的像差曲線圖。

第十 A 圖係本發明第十實施例的取像裝置示意圖。

第十 B 圖係本發明第十實施例的像差曲線圖。

第十一 A 圖係示意裝設有本發明之取像裝置的智慧型手機。

第十一 B 圖係示意裝設有本發明之取像裝置的平板電腦。

第十一 C 圖係示意裝設有本發明之取像裝置的可穿戴式設備。

【實施方式】

本發明提供一種影像拾取系統透鏡組，由物側至像側依序包含具屈折力的第一透鏡、第二透鏡、第三透鏡、及第四透鏡。

該第一透鏡可具有正屈折力，可提供系統所需的正屈折力，有助於縮短系統的總長度。該第一透鏡物側面可為凸面，可有效加強縮短光學總長度的功效。

該第二透鏡具正屈折力，有助於利用第二透鏡調和第一透鏡的匯聚能力。該第二透鏡的像側面於近光軸處為凸面，有助於修正系統的像散。

該第三透鏡具負屈折力，有助於系統的像差修正。該第三透鏡物側面近光軸處為凹面，其像側面近光軸處為凸面，可有助於修正系統的像散。

該第四透鏡物側面近光軸處可為凸面，其像側面近光軸處為凹面，且其像側面於離軸處具有至少一凸面，有助於修正系統非點收差(Astigmatism)，並可有效修正離軸像差。

該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，當影像拾取系統透鏡組滿足下列關係式：0.5 mm < Td < 3.2 mm 時，有利於維持系統的小型化；較佳地，滿足下列關係式：0.8 mm < Td < 2.5 mm。

該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，當影像拾取系統透鏡組滿足下列關係式：1.0 mm < Td / tan(HFOV) < 3.75 mm 時，有助於使該影像拾取系統透鏡組同時具備大視角及短總長的特性；較佳地，滿足下列關係式：1.2 mm < Td / tan(HFOV) < 2.75 mm。

該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，當影像拾取系統透鏡組滿足下列關係式：|f / f4| < 1.20 時，可使系統的主點更遠離成像面，有利於縮短系統的光學總長度，以維持鏡頭的小型化。

該第二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，當影像拾取系統透鏡組滿足下列關係式：f2 / f3 < -0.65 時，該第二透鏡與該第三透鏡的屈折力配置較為平衡，可有助於像差的修正與敏感

度的降低；較佳地，滿足下列關係式：f2 / f3 < -0.75。

該影像拾取系統透鏡組的焦距為 f，該第三透鏡的焦距為 f3，當影像拾取系統透鏡組滿足下列關係式：-2.0 < f / f3 < -0.95 時，該第三透鏡的作用如同補正透鏡，其功能為平衡及修正系統所產生的各項像差，進而可使系統獲得更高的成像品質。

該影像拾取系統透鏡組的光圈值為 Fno，當影像拾取系統透鏡組滿足下列關係式：1.40 < Fno ≤ 2.25 時，有助於提升系統的周邊照度。

該影像拾取系統透鏡組的焦距為 f，該第一透鏡的焦距為 f1，當影像拾取系統透鏡組滿足下列關係式：-0.25 < f / f1 < 0.75 時，該第一透鏡的屈折力較為合適，避免敏感度過高；較佳地，滿足下列關係式：0.25 < f / f1 < 0.75。

該第二透鏡物側面的曲率半徑為 R3，該第二透鏡像側面的曲率半徑為 R4。當影像拾取系統透鏡組滿足下列關係式：0.5 < (R3+R4) / (R3-R4) < 2.5 時，有助於加強像差的修正。

該影像拾取系統透鏡組的焦距為 f，當影像拾取系統透鏡組滿足下列關係式：0.5 mm < f < 2.0 mm 時，有助於提供適當的光學總長度。

該第一透鏡、該第二透鏡、該第三透鏡、及該第四透鏡於光軸上之厚度的總合為∑CT，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，當影像拾取系統透鏡組滿足下列關係式：0.80 < ∑CT / Td < 0.95 時，有利於該影像拾取系統透鏡組的組裝，並降低敏感度。

該第一透鏡的色散係數為 V1，當影像拾取系統透鏡組滿足下列關係式：45 < V1 時，可有效修正系統色差。

該第二透鏡於光軸上的厚度為 CT2，該第一透鏡於光軸上的厚度為 CT1，該第三透鏡於光軸上的厚度為 CT3，該第四透鏡於光軸上的厚度為 CT4，當影像拾取系統透鏡組滿足下列關係式：0.65 < CT2 / (CT1+CT3+CT4) < 2.0 時，各透鏡的厚度較為合適，

有助於鏡片的製作及組裝。

該影像拾取系統透鏡組的最大視角為 FOV，當影像拾取系統透鏡組滿足下列關係式：80 度 < FOV < 110 度時，有利於取得足夠的視場角。

本發明的影像拾取系統透鏡組中，透鏡的材質可為玻璃或塑膠，若透鏡的材質為玻璃，則可以增加該影像拾取系統透鏡組屈折力配置的自由度，若透鏡材質為塑膠，則可以有效降低生產成本。此外，可於鏡面上設置非球面(ASP)，非球面可以容易製作成球面以外的形狀，獲得較多的控制變數，用以消減像差，進而縮減透鏡使用的數目，因此可以有效降低本發明的影像拾取系統透鏡組的總長度。

本發明的影像拾取系統透鏡組中，可至少設置一光闌，如孔徑光闌(Aperture Stop)、耀光光闌(Glare Stop)或視場光闌(Field Stop)等。

本發明影像拾取系統透鏡組中，光圈配置可為前置或中置，其中前置光圈意即光圈設置於被攝物與第一透鏡間，中置光圈則表示光圈設置於第一透鏡與成像面間，前置光圈可使影像拾取系統透鏡組的出射瞳(Exit Pupil)與成像面產生較長的距離，使之具有遠心(Telecentric)效果，可增加電子感光元件如 CCD 或 CMOS 接收影像的效率；中置光圈則有助於擴大系統的視場角，使影像拾取系統透鏡組具有廣角鏡頭之優勢。

本發明影像拾取系統透鏡組中，就以具有屈折力的透鏡而言，若透鏡表面係為凸面且未界定該凸面位置時，則表示該透鏡表面於近光軸處為凸面；若透鏡表面係為凹面且未界定該凹面位置時，則表示該透鏡表面於近光軸處為凹面。

本發明的影像拾取系統透鏡組更可視需求應用於變焦的光學系統中，並兼具優良像差修正與良好成像品質的特色可多方面應用於 3D(三維)影像擷取、數位相機、行動裝置、數位平板與可穿戴式設備等可攜裝置中。

本發明更提供一種取像裝置，其包含前述影像拾取系統透鏡組以及電子感光元件，其中該電子感光元件設置於該影像拾取系統透鏡組的成像面，因此取像裝置可藉由影像拾取系統透鏡組的系統設計，有利於縮短大視角的系統總長，並提升周邊解像力與照度，進而達到最佳成像效果。較佳地，該取像裝置可進一步包含鏡筒(Barrel Member)、支持裝置(Holder Member)或其組合。

請參第十一 A 圖、第十一 B 圖、第十一 C 圖，該取像裝置(1101)可搭載於可攜裝置，其包括，但不限於：智慧型手機(1110)、平板電腦(1120)、或可穿戴式設備(1130)。前揭可攜裝置僅是示範性地說明本發明之取像裝置的實際運用例子，並非限制本發明之取像裝置的運用範圍。較佳地，該可攜裝置可進一步包含控制單元(Control Unit)、顯示單元(Display)、儲存單元(ROM)、暫儲存單元(RAM)或其組合。

本發明的取像裝置及影像拾取系統透鏡組將藉由以下具體實施例配合所附圖式予以詳細說明。

《第一實施例》

本發明第一實施例請參閱第一 A 圖，第一實施例的像差曲線請參閱第一 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(170)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(110)，其材質為塑膠，其物側面(111)於近光軸處為凸面，其像側面(112)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(120)，其材質為塑膠，其物側面(121)於近光軸處為凸面，其像側面(122)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(130)，其材質為塑膠，其物側面(131)於近光軸處為凹面，其像側面(132)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(140)，其材質為塑膠，其物側面(141)於近光軸處為凸面，其像側面(142)於近光軸處為凹面，其兩面皆為非球面，且其像側面(142)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(100)，置於該第一透鏡(110)與該第二透鏡(120)間；另包含有一紅外線濾除濾光元件(IR-cut filter)(150)置於該第四透鏡(140)與一成像面(160)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(170)設置於該成像面(160)上。

第一實施例詳細的光學數據如表一所示，其非球面數據如表二所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表一

(第一實施例)

f = 1.17 mm, Fno = 2.20, HFOV = 46.7 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.666	ASP	0.256	塑膠	1.650	21.4	9.56
2		2.139	ASP	0.031				
3	光圈	平面		0.019				
4	第二透鏡	5.712	ASP	0.671	塑膠	1.544	55.9	0.82
5		-0.464	ASP	0.130				
6	第三透鏡	-0.228	ASP	0.230	塑膠	1.634	23.8	-1.06
7		-0.480	ASP	0.030				
8	第四透鏡	0.679	ASP	0.483	塑膠	1.535	55.7	1.52
9		3.062	ASP	0.300				
10	紅外線濾除	平面		0.145	玻璃	1.517	64.2	-
11	濾光片	平面		0.204				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表二				
非球面係數				
表面 #	1	2	4	5
k =	1.2237E+00	1.7244E+01	9.0000E+01	-6.9311E-01
A4 =	3.1416E-01	1.1703E+00	-4.1498E-01	-6.9345E-01
A6 =	-1.0010E+00	-2.0080E+01	3.6416E+00	1.3202E+00
A8 =	4.5872E+01	5.2569E+02	4.3035E+01	1.0955E+01
A10 =	-5.9339E+02	-3.0044E+03	-7.4996E+03	-3.8285E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0040E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
表面 #	6	7	8	9
k =	-9.8477E-01	-3.2669E+00	-6.1619E-01	-1.4636E+01
A4 =	3.5682E+00	-1.8915E+00	-1.2870E+00	1.2883E+00
A6 =	-3.7958E+00	8.7075E+00	3.1244E+00	-3.7603E+00
A8 =	-1.1135E+02	-3.6761E+01	-9.1933E+00	5.9040E+00
A10 =	1.5862E+03	1.7257E+02	1.7146E+01	-5.8521E+00
A12 =	-8.7685E+03	-4.8146E+02	-1.9850E+01	3.5356E+00
A14 =	2.3054E+04	6.7728E+02	1.2752E+01	-1.1759E+00
A16 =	-2.3557E+04	-3.6747E+02	-3.5165E+00	1.6169E-01

上述的非球面曲線的方程式表示如下：

$$X(Y)=(Y^2/R)/(1+\mathrm{sqrt}(1-(1+k)*(Y/R)^2))+\sum_i (Ai)*(Y^i)$$

其中：

X：非球面上距離光軸為 Y 的點，其與相切於非球面光軸上頂點之切面的相對距離；

Y：非球面曲線上的點與光軸的垂直距離；

R：曲率半徑；

k：錐面係數；

Ai：第 i 階非球面係數。

影像拾取系統透鏡組的焦距為 f，影像拾取系統透鏡組的光圈值為 Fno，影像拾取系統透鏡組中最大視角的一半為 HFOV，其數值為：f = 1.17 (毫米)，Fno = 2.20，HFOV = 46.7 (度)。

該第一透鏡(110)的色散係數為 V1，其關係式為：V1 = 21.4。

該第二透鏡(120)於光軸上的厚度為 CT2，該第一透鏡(110)於光軸上的厚度為 CT1，該第三透鏡(130)於光軸上的厚度為 CT3，該第四透鏡(140)於光軸上的厚度為 CT4，其關係式為：CT2 / (CT1+CT3+CT4) = 0.69。

該第二透鏡物側面(121)的曲率半徑為 R3，該第二透鏡像側面(122)的曲率半徑為 R4，其關係式為：(R3+R4) / (R3-R4) = 0.85。

該影像拾取系統透鏡組的焦距為 f，該第一透鏡(110)的焦距為 f1，其關係式為：f / f1 = 0.12。

該第二透鏡(120)的焦距為 f2，該第三透鏡(130)的焦距為 f3，其關係式為：f2 / f3 = -0.77。

該影像拾取系統透鏡組的焦距為 f，該第四透鏡(140)的焦距為 f4，其關係式為：|f / f4| = 0.77。

該影像拾取系統透鏡組的焦距為 f，該第三透鏡(130)的焦距為 f3，其關係式為：f / f3 = -1.10。

該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，其關係式為：Td = 1.850(毫米)。

該第一透鏡(110)、該第二透鏡(120)、該第三透鏡(130)、及該第四透鏡(140)於光軸上之厚度的總合為∑CT，該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，其關係式為：∑CT / Td = 0.89。

該第一透鏡物側面(111)至該第四透鏡像側面(142)於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，其關係式為：Td / tan(HFOV) = 1.74(毫米)。

該影像拾取系統透鏡組的最大視角為 FOV，其關係式為：FOV = 93.4(度)。

《第二實施例》

本發明第二實施例請參閱第二 A 圖，第二實施例的像差曲線請參閱第二 B 圖。第二實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(270)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(210)，其材質為塑膠，其物側面(211)於近光軸處為凸面，其像側面(212)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(220)，其材質為塑膠，其物側面(221)於近光軸處為凸面，其像側面(222)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(230)，其材質為塑膠，其物側面(231)於近光軸處為凹面，其像側面(232)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(240)，其材質為塑膠，其物側面(241)於近光軸處為凸面，其像側面(242)於近光軸處為凹面，其兩面皆為非球面，且其像側面(242)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(200)，置於該第一透鏡(210)與該第二透鏡(220)間；另包含有一紅外線濾除濾光元件(250)置於該第四透鏡(240)與一成像面(260)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(270)設置於該成像面(260)上。

第二實施例詳細的光學數據如表三所示，其非球面數據如表四所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表三

(第二實施例)

f = 1.23 mm, Fno = 2.45, HFOV = 45.6 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.728	ASP	0.217	塑膠	1.640	22.0	1207.16
2		1.647	ASP	0.041				
3	光圈	平面		0.020				

4	第二透鏡	2.201	ASP	0.685	塑膠	1.544	55.9	0.78
5		-0.465	ASP	0.138				
6	第三透鏡	-0.213	ASP	0.222	塑膠	1.634	23.8	-0.90
7		-0.479	ASP	0.030				
8	第四透鏡	0.691	ASP	0.430	塑膠	1.535	55.7	1.40
9		7.112	ASP	0.300				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.171				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								

表四				
非球面係數				
表面 #	1	2	4	5
k =	-7.8611E-01	2.2256E+01	4.4287E+01	-6.8249E-01
A4 =	2.7433E-01	3.5449E-01	-1.1581E+00	-5.9944E-01
A6 =	-1.5466E+00	-2.9377E+01	8.9406E-01	3.6061E-01
A8 =	4.7455E+01	6.4129E+02	4.1870E+01	1.6896E+01
A10 =	-6.0092E+02	-3.8207E+03	-7.3180E+03	-3.8194E+02
A12 =	4.0961E+03	-1.6432E+05	1.3290E+05	3.0043E+03
A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0680E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3826E+04
表面 #	6	7	8	9
k =	-1.0107E+00	-3.0532E+00	-7.4231E-01	2.2155E+01
A4 =	3.8803E+00	-1.7079E+00	-1.1152E+00	1.6267E+00
A6 =	-4.2860E+00	8.7245E+00	2.9613E+00	-4.5228E+00
A8 =	-1.1314E+02	-3.7291E+01	-9.2058E+00	6.4630E+00
A10 =	1.5859E+03	1.7181E+02	1.7048E+01	-5.8730E+00
A12 =	-8.7686E+03	-4.8143E+02	-1.9563E+01	3.4083E+00
A14 =	2.3054E+04	6.7878E+02	1.3110E+01	-1.1920E+00
A16 =	-2.3557E+04	-3.6776E+02	-4.1607E+00	1.9105E-01

第二實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表五中所列。

表五			
第二實施例			
f [mm]	1.23	f2/f3	-0.87
Fno	2.45	|f/f4|	0.88
HFOV [deg.]	45.6	f/f3	-1.37

V1	22.0	Td [mm]	1.783
CT2/(CT1+CT3+CT4)	0.79	ΣCT/Td	0.87
(R3+R4)/(R3-R4)	0.65	Td/tan(HFOV) [mm]	1.75
f/f1	0.00	FOV [deg.]	91.2

《第三實施例》

本發明第三實施例請參閱第三 A 圖，第三實施例的像差曲線請參閱第三 B 圖。第三實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(370)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(310)，其材質為塑膠，其物側面(311)於近光軸處為凸面，其像側面(312)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(320)，其材質為塑膠，其物側面(321)於近光軸處為凹面，其像側面(322)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(330)，其材質為塑膠，其物側面(331)於近光軸處為凹面，其像側面(332)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(340)，其材質為塑膠，其物側面(341)於近光軸處為凸面，其像側面(342)於近光軸處為凹面，其兩面皆為非球面，且其像側面(342)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(300)，置於該第一透鏡(310)與該第二透鏡(320)間；另包含有一紅外線濾除濾光元件(350)置於該第四透鏡(340)與一成像面(360)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(370)設置於該成像面(360)上。

第三實施例詳細的光學數據如表六所示，其非球面數據如表七所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表六								
(第三實施例)								
f = 1.66 mm, Fno = 2.15, HFOV = 46.8 deg.								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.333	ASP	0.286	塑膠	1.544	55.9	2.50
2		59.851	ASP	0.005				
3	光圈	平面		0.195				
4	第二透鏡	-1.920	ASP	0.409	塑膠	1.544	55.9	1.60
5		-0.644	ASP	0.156				
6	第三透鏡	-0.263	ASP	0.200	塑膠	1.650	21.4	-1.49
7		-0.470	ASP	0.030				
8	第四透鏡	0.677	ASP	0.363	塑膠	1.535	55.7	2.33
9		1.206	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.431				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								
第 1 面有效半徑為 0.510 mm								

表七				
非球面係數				
表面 #	1	2	4	5
k =	-2.4704E+00	9.0000E+01	5.8947E+00	-3.7972E-01
A4 =	-3.4848E-02	-3.8775E-01	-9.3075E-01	-3.3741E-01
A6 =	-4.4471E-01	-2.8417E+00	3.6516E+00	9.2277E-01
A8 =	-4.9925E-01	1.8185E+01	-4.0769E+01	-3.9461E+00
A10 =	-1.2166E+01	-2.0954E+01	-4.4351E+00	-1.9037E+01
A12 =	3.9114E+01	-1.4998E+03	1.2130E+03	4.9148E+01
A14 =	-1.7950E+02	1.2389E+04	-4.4615E+03	1.0076E+02
A16 =	3.3572E+02	-2.9058E+04	6.2425E+03	8.0489E+01
表面 #	6	7	8	9
k =	-1.1491E+00	-2.3808E+00	-1.7649E+00	-1.0689E+01
A4 =	4.2079E+00	2.1562E-01	-6.9591E-01	9.1971E-01
A6 =	-2.8310E+01	-4.4239E+00	1.2041E+00	-3.0958E+00
A8 =	1.2287E+02	1.8790E+01	-2.9023E+00	4.8713E+00
A10 =	-3.9035E+02	-4.1840E+01	4.4195E+00	-4.6279E+00
A12 =	8.5064E+02	5.5883E+01	-3.7857E+00	2.6418E+00
A14 =	-9.7331E+02	-4.0255E+01	1.6532E+00	-8.3581E-01
A16 =	4.7213E+02	1.4428E+01	-2.8192E-01	1.1204E-01

第三實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表八中所列。

表八

第三實施例			
f [mm]	1.66	f2/f3	-1.07
Fno	2.15	|f/f4|	0.71
HFOV [deg.]	46.8	f/f3	-1.11
V1	55.9	Td [mm]	1.644
CT2/(CT1+CT3+CT4)	0.48	ΣCT/Td	0.77
(R3+R4)/(R3-R4)	2.01	Td/tan(HFOV) [mm]	1.54
f/f1	0.66	FOV [deg.]	93.6

《第四實施例》

本發明第四實施例請參閱第四 A 圖，第四實施例的像差曲線請參閱第四 B 圖。第四實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(470)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具負屈折力的第一透鏡(410)，其材質為塑膠，其物側面(411)於近光軸處為凸面，其像側面(412)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(420)，其材質為塑膠，其物側面(421)於近光軸處為凸面，其像側面(422)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(430)，其材質為塑膠，其物側面(431)於近光軸處為凹面，其像側面(432)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(440)，其材質為塑膠，其物側面(441)於近光軸處為凸面，其像側面(442)於近光軸處為凹面，其兩面皆為非球面，且其像側面(442)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(400)，置於該第一透鏡(410)與該第二透鏡(420)間；另包含有一紅外線濾除濾光元件(450)置於該第四透鏡(440)與一成像面(460)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(470)設置於該成像面(460)上。

第四實施例詳細的光學數據如表九所示，其非球面數據如表十所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表九

(第四實施例)

f = 1.15 mm, Fno = 2.22, HFOV = 48.5 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.999	ASP	0.200	塑膠	1.544	55.9	-46.83
2		1.789	ASP	0.021				
3	光圈	平面		0.037				
4	第二透鏡	1.606	ASP	0.471	塑膠	1.544	55.9	0.81
5		-0.543	ASP	0.184				
6	第三透鏡	-0.207	ASP	0.209	塑膠	1.634	23.8	-1.22
7		-0.393	ASP	0.030				
8	第四透鏡	0.747	ASP	0.319	塑膠	1.535	55.7	1.62
9		4.607	ASP	0.300				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.130				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表十

非球面係數

表面 #	1	2	4	5
k =	-2.2996E+01	3.4247E+01	9.8701E+00	-4.2975E-01
A4 =	-2.1353E-01	-2.0670E+00	-2.2221E+00	-6.3795E-01
A6 =	-3.6880E+00	-3.6063E+01	-8.7081E+00	-6.5092E+00
A8 =	5.2789E+01	6.9201E+02	1.4888E+02	4.6114E+01
A10 =	-6.4083E+02	-4.8238E+03	-8.2602E+03	-4.7532E+02
A12 =	4.0983E+03	-1.6432E+05	1.3290E+05	3.0044E+03

申請案號：102139029

A14 =	-1.4631E+04	3.1882E+06	-1.1481E+06	-1.0679E+04
A16 =	2.0715E+04	-1.7563E+07	3.7732E+06	1.3828E+04
表面 #	6	7	8	9
k =	-1.0439E+00	-2.0056E+00	-6.4024E-01	-3.3636E+00
A4 =	4.2327E+00	-9.7476E-01	-8.3147E-01	1.0958E+00
A6 =	-3.4551E+00	1.0236E+01	2.1761E+00	-1.7086E+00
A8 =	-1.0303E+02	-3.7610E+01	-4.8336E+00	1.3575E+00
A10 =	1.5970E+03	1.6620E+02	5.0397E+00	-2.6285E+00
A12 =	-8.9315E+03	-4.9093E+02	-4.1411E+00	4.3863E+00
A14 =	2.3054E+04	6.8046E+02	3.4069E+00	-3.3963E+00
A16 =	-2.3558E+04	-3.4010E+02	-1.6576E+00	9.5967E-01

第四實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十一中所列。

表十一

第四實施例

f [mm]	1.15	f2/f3	-0.66
Fno	2.22	|f/f4|	0.71
HFOV [deg.]	48.5	f/f3	-0.94
V1	55.9	Td [mm]	1.471
CT2/(CT1+CT3+CT4)	0.65	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	0.49	Td/tan(HFOV) [mm]	1.30
f/f1	-0.02	FOV [deg.]	97.0

《第五實施例》

本發明第五實施例請參閱第五 A 圖，第五實施例的像差曲線請參閱第五 B 圖。第五實施例的取像裝置包含該影像拾取系統透鏡組與一電子感光元件(570)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具負屈折力的第一透鏡(510)，其材質為玻璃，其物側面(511)於近光軸處為凸面，其像側面(512)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(520)，其材質為玻璃，其物側面(521)於近光軸處為凸面，其像側面(522)於近光軸處為凸面，且

其兩面皆為非球面；

一具負屈折力的第三透鏡(530)，其材質為塑膠，其物側面(531)於近光軸處為凹面，其像側面(532)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(540)，其材質為塑膠，其物側面(541)於近光軸處為凸面，其像側面(542)於近光軸處為凹面，其兩面皆為非球面，且其像側面(542)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(500)，置於該第一透鏡(510)與該第二透鏡(520)間；另包含有一紅外線濾除濾光元件(550)置於該第四透鏡(540)與一成像面(560)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(570)設置於該成像面(560)上。

第五實施例詳細的光學數據如表十二所示，其非球面數據如表十三所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV定義為最大視角的一半。

表十二

(第五實施例)

f = 2.24 mm, Fno = 2.51, HFOV = 44.2 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.367	ASP	0.300	玻璃	2.144	17.8	-13.68
2		1.110	ASP	0.144				
3	光圈	平面		-0.015				
4	第二透鏡	3.909	ASP	1.483	玻璃	1.525	70.3	1.60
5		-0.932	ASP	0.325				
6	第三透鏡	-0.341	ASP	0.277	塑膠	1.639	23.5	-1.72
7		-0.651	ASP	0.030				
8	第四透鏡	0.897	ASP	0.606	塑膠	1.565	57.0	2.00
9		3.302	ASP	0.800				
10	紅外線濾除	平面		0.300	玻璃	1.517	64.2	-
11	濾光片	平面		0.342				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表十三				
非球面係數				
表面 #	1	2	4	5
k =	1.1992E+00	1.9195E+00	2.1734E+01	-7.2786E-01
A4 =	5.8324E-02	1.2422E-01	-9.9032E-02	-1.2252E-01
A6 =	-1.4402E-01	-5.2189E-01	5.9983E+00	5.2990E-01
A8 =	1.0028E+00	4.2713E+00	-1.1966E+02	-3.0301E+00
A10 =	-4.0021E+00	1.8016E+01	1.4083E+03	7.9248E+00
A12 =	8.9035E+00	-4.2193E+02	-9.4428E+03	-1.0795E+01
A14 =	-9.8479E+00	2.2697E+03	3.3923E+04	6.3429E+00
A16 =	3.0263E+00	-4.1004E+03	-5.0610E+04	-8.0066E-01
表面 #	6	7	8	9
k =	-9.8774E-01	-3.1767E+00	-8.3817E-01	-2.4331E+01
A4 =	2.5606E+00	-1.2881E-01	-4.2259E-01	3.5717E-01
A6 =	-7.9740E+00	-6.6170E-01	4.3675E-01	-4.5759E-01
A8 =	1.4853E+01	1.1888E+00	-4.6275E-01	2.9937E-01
A10 =	-1.1480E+01	-4.2607E-01	3.1380E-01	-1.1921E-01
A12 =	-4.4740E+00	-5.1720E-01	-1.2912E-01	2.8364E-02
A14 =	1.2594E+01	5.0722E-01	2.9275E-02	-3.7104E-03
A16 =	-5.4160E+00	-1.2485E-01	-2.8533E-03	2.0238E-04

第五實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十四中所列。

表十四			
第五實施例			
f [mm]	2.24	f2/f3	-0.93
Fno	2.51	|f/f4|	1.12
HFOV [deg.]	44.2	f/f3	-1.30
V1	17.8	Td [mm]	3.150
CT2/(CT1+CT3+CT4)	1.25	ΣCT/Td	0.85
(R3+R4)/(R3-R4)	0.61	Td/tan(HFOV) [mm]	3.24
f/f1	-0.16	FOV [deg.]	88.4

《第六實施例》

本發明第六實施例請參閱第六 A 圖，第六實施例的像差曲線請參閱第六 B 圖。第六實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(670)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(610)，其材質為塑膠，其物側面(611)於近光軸處為凸面，其像側面(612)於近光軸處為凸面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(620)，其材質為塑膠，其物側面(621)於近光軸處為凹面，其像側面(622)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(630)，其材質為塑膠，其物側面(631)於近光軸處為凹面，其像側面(632)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(640)，其材質為塑膠，其物側面(641)於近光軸處為凸面，其像側面(642)於近光軸處為凹面，其兩面皆為非球面，且其像側面(642)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(600)，置於該第一透鏡(610)與該第二透鏡(620)間；另包含有一紅外線濾除濾光元件(650)置於該第四透鏡(640)與一成像面(660)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(670)設置於該成像面(660)上。

第六實施例詳細的光學數據如表十五所示，其非球面數據如表十六所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV定義為最大視角的一半。

表十五

(第六實施例)

f = 1.27 mm, Fno = 2.10, HFOV = 44.4 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	2.393	ASP	0.280	塑膠	1.544	55.9	3.85
2		-16.057	ASP	0.017				
3	光圈	平面		0.044				

4	第二透鏡	-30.373	ASP	0.755	塑膠	1.544	55.9	0.87
5		-0.468	ASP	0.121				
6	第三透鏡	-0.246	ASP	0.240	塑膠	1.639	23.5	-0.90
7		-0.594	ASP	0.030				
8	第四透鏡	0.639	ASP	0.522	塑膠	1.530	55.8	1.47
9		2.521	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.073				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								

表十六				
非球面係數				
表面 #	1	2	4	5
k =	1.7241E+00	-8.9754E+01	-9.0000E+01	-7.5923E-01
A4 =	2.1410E-01	1.4516E+00	1.5168E-01	-5.4982E-01
A6 =	-2.3810E-01	-1.0826E+01	4.8929E+00	2.0791E+00
A8 =	2.3555E+01	1.9495E+02	-3.2116E+01	8.2787E-01
A10 =	-2.5034E+02	-5.1780E+02	-2.6801E+03	-1.4893E+02
A12 =	1.4357E+03	-5.7593E+04	4.6579E+04	1.0534E+03
A14 =	-4.2381E+03	9.2351E+05	-3.3256E+05	-3.0936E+03
A16 =	4.9589E+03	-4.2045E+06	9.0327E+05	3.3098E+03
表面 #	6	7	8	9
k =	-9.9704E-01	-3.7851E+00	-7.3474E-01	-2.0751E+00
A4 =	2.9255E+00	-1.3600E+00	-1.2133E+00	1.8260E+00
A6 =	-2.4852E+00	5.5927E+00	3.0817E+00	-5.9653E+00
A8 =	-5.7718E+01	-1.8755E+01	-1.0034E+01	9.6816E+00
A10 =	6.7135E+02	7.3016E+01	1.9498E+01	-9.2466E+00
A12 =	-3.0733E+03	-1.6937E+02	-2.1549E+01	5.1894E+00
A14 =	6.6780E+03	1.9522E+02	1.2590E+01	-1.5760E+00
A16 =	-5.6393E+03	-8.6932E+01	-3.0510E+00	1.9769E-01

第六實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表十七中所列。

表十七			
第六實施例			
f [mm]	1.27	f2/f3	-0.97
Fno	2.10	|f/f4|	0.86
HFOV [deg.]	44.4	f/f3	-1.41

V1	55.9	Td [mm]	2.009
CT2/(CT1+CT3+CT4)	0.72	ΣCT/Td	0.89
(R3+R4)/(R3-R4)	1.03	Td/tan(HFOV) [mm]	2.05
f/f1	0.33	FOV [deg.]	88.8

《第七實施例》

本發明第七實施例請參閱第七 A 圖，第一實施例的像差曲線請參閱第七 B 圖。第七實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(770)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(710)，其材質為塑膠，其物側面(711)於近光軸處為凸面，其像側面(712)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(720)，其材質為塑膠，其物側面(721)於近光軸處為凹面，其像側面(722)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(730)，其材質為塑膠，其物側面(731)於近光軸處為凹面，其像側面(732)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(740)，其材質為塑膠，其物側面(741)於近光軸處為凸面，其像側面(742)於近光軸處為凹面，其兩面皆為非球面，且其像側面(742)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(700)，置於一被攝物與該第一透鏡(710)間；另包含有一紅外線濾除濾光元件(750)置於該第四透鏡(740)與一成像面(760)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(770)設置於該成像面(760)上。

第七實施例詳細的光學數據如表十八所示，其非球面數據如表十九所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表十八								
(第七實施例)								
f = 1.57 mm, Fno = 2.05, HFOV = 48.5 deg.								
表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	光圈	平面		-0.052				
2	第一透鏡	1.142	ASP	0.279	塑膠	1.544	55.9	2.84
3		4.008	ASP	0.159				
4	第二透鏡	-4.075	ASP	0.614	塑膠	1.544	55.9	1.24
5		-0.608	ASP	0.142				
6	第三透鏡	-0.255	ASP	0.230	塑膠	1.634	23.8	-1.37
7		-0.487	ASP	0.030				
8	第四透鏡	0.636	ASP	0.414	塑膠	1.535	55.7	2.35
9		0.998	ASP	0.500				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.141				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								

表十九				
非球面係數				
表面 #	2	3	4	5
k =	-5.4318E-01	6.9324E+01	6.0179E+01	-4.8138E-01
A4 =	1.1275E-01	-3.4138E-01	-6.6571E-01	-8.5384E-02
A6 =	-1.4350E+00	-2.7321E+00	4.9846E-01	-6.6518E-01
A8 =	6.0529E+00	2.0740E+01	-4.5807E+00	-2.1554E-01
A10 =	4.7148E+01	-7.0776E+01	-1.7027E+02	-7.9977E+00
A12 =	-1.4571E+02	-1.4998E+03	1.2130E+03	2.5638E+01
A14 =	-3.8164E+03	1.2389E+04	-4.4615E+03	-4.3167E+01
A16 =	1.5882E+04	-2.9058E+04	6.2425E+03	7.2938E+01
表面 #	6	7	8	9
k =	-1.1103E+00	-3.0258E+00	-9.3042E-01	-5.1455E+00
A4 =	5.4423E+00	4.5345E-01	-7.7223E-01	7.0200E-01
A6 =	-3.5666E+01	-4.9768E+00	9.4468E-01	-1.5850E+00
A8 =	1.3446E+02	1.9752E+01	-1.3669E+00	1.7028E+00
A10 =	-2.5131E+02	-4.2912E+01	1.1409E+00	-1.1082E+00
A12 =	-7.3665E+01	5.3544E+01	-5.2307E-01	4.3302E-01
A14 =	1.1117E+03	-3.5702E+01	1.2365E-01	-9.2838E-02
A16 =	-1.2600E+03	1.0063E+01	-1.1645E-02	8.3092E-03

第七實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十中所列。

表二十

第七實施例			
f [mm]	1.57	f2/f3	-0.91
Fno	2.05	|f/f4|	0.67
HFOV [deg.]	48.5	f/f3	-1.15
V1	55.9	Td [mm]	1.868
CT2/(CT1+CT3+CT4)	0.67	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	1.35	Td/tan(HFOV) [mm]	1.65
f/f1	0.55	FOV [deg.]	97.0

《第八實施例》

本發明第八實施例請參閱第八A圖，第八實施例的像差曲線請參閱第八B圖。第八實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(870)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(810)，其材質為塑膠，其物側面(811)於近光軸處為凸面，其像側面(812)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(820)，其材質為塑膠，其物側面(821)於近光軸處為凹面，其像側面(822)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(830)，其材質為塑膠，其物側面(831)於近光軸處為凹面，其像側面(832)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(840)，其材質為塑膠，其物側面(841)於近光軸處為凸面，其像側面(842)於近光軸處為凹面，其兩面皆為非球面，且其像側面(842)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(800)，置於該第一透鏡(810)與該第二透鏡(820)間；另包含有一紅外線濾除濾光元件(850)置於該第四透鏡(840)與一成像面(860)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(870)設置於該成像面(860)上。

第八實施例詳細的光學數據如表二十一所示，其非球面數據如表二十二所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表二十一

(第八實施例)

f = 1.68 mm, Fno = 2.10, HFOV = 46.0 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	1.787	ASP	0.278	塑膠	1.544	55.9	3.81
2		12.133	ASP	0.022				
3	光圈	平面		0.145				
4	第二透鏡	-3.839	ASP	0.668	塑膠	1.544	55.9	1.38
5		-0.668	ASP	0.194				
6	第三透鏡	-0.273	ASP	0.230	塑膠	1.639	23.5	-1.18
7		-0.569	ASP	0.030				
8	第四透鏡	0.784	ASP	0.496	塑膠	1.530	55.8	1.65
9		5.992	ASP	0.400				
10	紅外線濾除	平面		0.175	玻璃	1.517	64.2	-
11	濾光片	平面		0.472				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表二十二

非球面係數

表面 #	1	2	4	5
k =	-1.3232E+00	5.3151E+01	5.1693E+01	-5.9308E-01
A4 =	1.6281E-02	-1.2122E-02	-2.5602E-01	-1.1508E-01
A6 =	1.5823E-01	-1.1940E+00	-1.0332E+00	-6.8787E-01
A8 =	5.9941E-01	1.2093E+01	1.0464E+01	-9.7964E-02
A10 =	-1.3812E+01	-2.0003E+01	-1.9940E+02	-6.2734E+00
A12 =	4.5317E+01	-1.4998E+03	1.2130E+03	2.8529E+01

A14 =	-4.4460E+01	1.2389E+04	-4.4615E+03	-4.4589E+01
A16 =	-4.7734E+01	-2.9058E+04	6.2425E+03	2.7908E+01
表面 #	6	7	8	9
k =	-1.0578E+00	-3.0032E+00	-8.6121E-01	5.6610E+00
A4 =	4.0391E+00	9.4553E-02	-6.6716E-01	7.7788E-01
A6 =	-2.6571E+01	-4.4170E+00	1.1395E+00	-1.2944E+00
A8 =	1.2417E+02	1.9085E+01	-1.7698E+00	1.0967E+00
A10 =	-3.9394E+02	-4.1568E+01	1.6239E+00	-5.7605E-01
A12 =	8.2748E+02	5.5376E+01	-8.6944E-01	1.8609E-01
A14 =	-9.7331E+02	-4.1902E+01	2.5418E-01	-3.3617E-02
A16 =	4.7213E+02	1.3653E+01	-3.1838E-02	2.5144E-03

第八實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十三中所列。

表二十三

第八實施例

f [mm]	1.68	f2/f3	-1.17
Fno	2.10	|f/f4|	1.02
HFOV [deg.]	46.0	f/f3	-1.42
V1	55.9	Td [mm]	2.063
CT2/(CT1+CT3+CT4)	0.67	ΣCT/Td	0.81
(R3+R4)/(R3-R4)	1.42	Td/tan(HFOV) [mm]	1.99
f/f1	0.44	FOV [deg.]	92.0

《第九實施例》

本發明第九實施例請參閱第九 A 圖，第九實施例的像差曲線請參閱第九 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡組與一電子感光元件(970)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(910)，其材質為塑膠，其物側面(911)於近光軸處為凸面，其像側面(912)於近光軸處為凸面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(920)，其材質為塑膠，其物側面(921)於近光軸處為凸面，其像側面(922)於近光軸處為凸面，且

其兩面皆為非球面；

一具負屈折力的第三透鏡(930)，其材質為塑膠，其物側面(931)於近光軸處為凹面，其像側面(932)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(940)，其材質為塑膠，其物側面(941)於近光軸處為凸面，其像側面(942)於近光軸處為凹面，其兩面皆為非球面，且其像側面(942)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(900)，置於該第一透鏡(910)與該第二透鏡(920)間；另包含有一紅外線濾除濾光元件(950)置於該第四透鏡(940)與一成像面(960)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(970)設置於該成像面(960)上。

第九實施例詳細的光學數據如表二十四所示，其非球面數據如表二十五所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表二十四

(第九實施例)

f = 0.92 mm, Fno = 2.45, HFOV = 43.9 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	第一透鏡	100.000	ASP	0.205	塑膠	1.633	23.4	13.12
2		-9.046	ASP	0.017				
3	光圈	平面		0.024				
4	第二透鏡	1.695	ASP	0.475	塑膠	1.544	55.9	0.54
5		-0.319	ASP	0.100				
6	第三透鏡	-0.148	ASP	0.160	塑膠	1.634	23.8	-0.65
7		-0.329	ASP	0.030				
8	第四透鏡	0.595	ASP	0.239	塑膠	1.530	55.8	1.28
9		4.109	ASP	0.300				
10	紅外線濾除	平面		0.145	玻璃	1.517	64.2	-
11	濾光片	平面		0.151				
12	成像面	平面		-				

註：參考波長為 d-line 587.6 nm

表二十五				
非球面係數				
表面 #	1	2	4	5
k =	-9.0000E+01	9.0000E+01	3.3243E+01	-6.6437E-01
A4 =	2.5656E-01	2.4894E+00	-1.9077E+00	-1.5093E+00
A6 =	-1.0613E+00	-9.5530E+01	-1.3506E+01	4.3096E+00
A8 =	1.6769E+02	3.0126E+03	1.0928E+01	1.6065E+02
A10 =	-3.7307E+03	-2.3016E+04	-4.4021E+04	-2.9203E+03
A12 =	3.9786E+04	-1.5960E+06	1.2908E+06	2.9181E+04
A14 =	-2.1485E+05	4.6819E+07	-1.6860E+07	-1.5683E+05
A16 =	4.5990E+05	-3.8994E+08	8.3772E+07	3.0696E+05
表面 #	6	7	8	9
k =	-1.0921E+00	-2.4247E+00	-6.0015E-01	3.3921E+01
A4 =	8.8579E+00	-1.7457E+00	-1.8642E+00	3.4965E+00
A6 =	-9.7201E+00	2.7059E+01	4.2816E+00	-1.7965E+01
A8 =	-4.6210E+02	-1.6609E+02	-3.6842E+01	3.3243E+01
A10 =	1.0079E+04	1.0699E+03	9.4802E+01	-3.1178E+01
A12 =	-8.5169E+04	-4.7330E+03	-1.9140E+02	1.8452E+01
A14 =	3.3855E+05	1.0605E+04	3.6755E+02	-3.7397E+01
A16 =	-5.2300E+05	-7.7191E+03	-9.3365E+02	3.7762E+01

第九實施例非球面曲線方程式的表示如同第一實施例的形式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十六中所列。

表二十六			
第九實施例			
f [mm]	0.92	f2/f3	-0.83
Fno	2.45	|f/f4|	0.72
HFOV [deg.]	43.9	f/f3	-1.42
V1	23.4	Td [mm]	1.250
CT2/(CT1+CT3+CT4)	0.79	ΣCT/Td	0.86
(R3+R4)/(R3-R4)	0.68	Td/tan(HFOV) [mm]	1.30
f/f1	0.07	FOV [deg.]	87.8

《第十實施例》

本發明第十實施例請參閱第十 A 圖，第十實施例的像差曲線請參閱第十 B 圖。第一實施例的取像裝置包含影像拾取系統透鏡

組與一電子感光元件(1070)，該影像拾取系統透鏡組主要由四片具屈折力的透鏡構成，由物側至像側依序包含：

一具正屈折力的第一透鏡(1010)，其材質為塑膠，其物側面(1011)於近光軸處為凸面，其像側面(1012)於近光軸處為凹面，且其兩面皆為非球面；

一具正屈折力的第二透鏡(1020)，其材質為塑膠，其物側面(1021)於近光軸處為凹面，其像側面(1022)於近光軸處為凸面，且其兩面皆為非球面；

一具負屈折力的第三透鏡(1030)，其材質為塑膠，其物側面(1031)於近光軸處為凹面，其像側面(1032)於近光軸處為凸面，且其兩面皆為非球面；及

一具正屈折力的第四透鏡(1040)，其材質為塑膠，其物側面(1041)於近光軸處為凸面，其像側面(1042)於近光軸處為凹面，其兩面皆為非球面，且其像側面(1042)於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組另設置有一光圈(1000)，置於一被攝物與該第一透鏡(1010)間；另包含有一紅外線濾除濾光元件(1050)置於該第四透鏡(1040)與一成像面(1060)間，其材質為玻璃且不影響焦距。

其中，該電子感光元件(1070)設置於該成像面(1060)上。

第十實施例詳細的光學數據如表二十七所示，其非球面數據如表二十八所示，其中曲率半徑、厚度及焦距的單位為毫米，HFOV 定義為最大視角的一半。

表二十七

(第十實施例)

f = 1.80 mm, Fno = 2.12, HFOV = 47.2 deg.

表面 #		曲率半徑		厚度	材質	折射率	色散係數	焦距
0	被攝物	平面		無限				
1	光圈	平面		-0.060				
2	第一透鏡	1.246	ASP	0.289	塑膠	1.544	55.9	2.97
3		5.018	ASP	0.191				

4	第二透鏡	-3.749	ASP	0.593	塑膠	1.544	55.9	1.57
5		-0.733	ASP	0.156				
6	第三透鏡	-0.288	ASP	0.248	塑膠	1.634	23.8	-1.33
7		-0.584	ASP	0.030				
8	第四透鏡	0.704	ASP	0.601	塑膠	1.535	55.7	2.05
9		1.382	ASP	0.500				
10	紅外線濾除	平面		0.210	玻璃	1.517	64.2	-
11	濾光片	平面		0.198				
12	成像面	平面		-				
註：參考波長為 d-line 587.6 nm								
第 9 面有效半徑為 1.676 mm								

表二十八

非球面係數

表面 #	2	3	4	5
k =	-5.0585E-01	9.0000E+01	3.6143E+01	-3.9805E-01
A4 =	8.6099E-02	-2.2970E-01	-4.8540E-01	-1.5034E-01
A6 =	-9.1382E-01	-1.8900E+00	2.7508E-01	-5.1276E-01
A8 =	1.9706E+00	1.1233E+01	-2.0152E+00	-1.5742E-01
A10 =	1.9492E+01	-3.0654E+01	-6.3534E+01	-3.0117E+00
A12 =	-3.5519E+01	-4.4967E+02	3.6120E+02	7.3424E+00
A14 =	-8.0910E+02	2.9681E+03	-1.0702E+03	-1.0241E+01
A16 =	2.4600E+03	-5.5960E+03	1.2022E+03	1.7746E+01
表面 #	6	7	8	9
k =	-1.1070E+00	-2.9894E+00	-9.3316E-01	-5.2865E+00
A3 =			-1.4739E-01	5.0831E-01
A4 =	4.3809E+00	4.3352E-01	-3.5412E+00	2.6512E+00
A5 =			2.4672E-02	1.3099E-01
A6 =	-2.6437E+01	-3.7903E+00	1.0303E+01	-3.1255E+01
A7 =			3.7082E-02	2.0652E-01
A8 =	9.1296E+01	1.0965E+01	-3.1616E+01	1.1148E+02
A9 =			-2.2687E-03	-9.0797E-01
A10 =	-1.5853E+02	-1.4675E+01	6.3626E+01	-2.2327E+02
A11 =			-2.3794E-03	3.6058E-01
A12 =	8.3141E+00	7.7310E+00	-7.5604E+01	2.6201E+02
A13 =			8.0966E-03	1.7201E-01
A14 =	3.8963E+02	1.2159E+00	4.7652E+01	-1.7041E+02
A15 =			-5.5857E-02	1.0396E-01
A16 =	-3.9976E+02	-1.8447E+00	-1.2153E+01	4.7523E+01

第十實施例非球面曲線方程式的表示如同第一實施例的形

式。此外，各個關係式的參數係如同第一實施例所闡釋，惟各個關係式的數值係如表二十六中所列。

表二十九

第十實施例

f [mm]	1.80	f2/f3	-1.18
Fno	2.12	|f/f4|	0.88
HFOV [deg.]	47.2	f/f3	-1.35
V1	55.9	Td [mm]	2.108
CT2/(CT1+CT3+CT4)	0.52	ΣCT/Td	0.82
(R3+R4)/(R3-R4)	1.49	Td/tan(HFOV) [mm]	1.95
f/f1	0.61	FOV [deg.]	94.4

表一至表二十九所示為本發明的影像拾取系統透鏡組實施例的不同數值變化表，然本發明各個實施例的數值變化皆屬實驗所得，即使使用不同數值，相同結構的產品仍應屬於本發明的保護範疇，故以上的說明所描述的及圖式僅做為例示性，非用以限制本發明的申請專利範圍。

【符號說明】

光圈　100、200、300、400、500、600、700、800、900、1000

第一透鏡　110、210、310、410、510、610、710、810、910、1010

物側面　111、211、311、411、511、611、711、811、911、1011

像側面　112、212、312、412、512、612、712、812、912、1012

第二透鏡　120、220、320、420、520、620、720、820、920、1020

物側面　121、221、321、421、521、621、721、821、921、

1021

像側面　122、222、322、422、522、622、722、822、922、1022

第三透鏡　130、230、330、430、530、630、730、830、930、1030

物側面　131、231、331、431、531、631、731、831、931、1031

像側面　132、322、332、432、532、632、732、832、932、1032

第四透鏡　140、240、340、440、540、640、740、840、940、1040

物側面　141、241、341、441、541、641、741、841、941、1041

像側面　142、422、342、442、542、642、742、842、942、1042

紅外線濾除濾光元件　150、250、350、450、550、650、750、850、950、1050

成像面　160、260、360、460、560、660、760、860、960、1060

電子感光元件　170、270、370、470、570、670、770、870、970、1070

取像裝置　1101

智慧型手機　1110

平板電腦　1120

可穿戴式設備　1130

影像拾取系統透鏡組的焦距為 f

第一透鏡的焦距為 f1

第二透鏡的焦距為 f2

第三透鏡的焦距為 f3

第四透鏡的焦距為 f4

第一透鏡的色散係數為 V1

第一透鏡物側面至第四透鏡像側面於光軸上的距離為 Td

第一透鏡於光軸上的厚度為 CT1

第二透鏡於光軸上的厚度為 CT2

第三透鏡於光軸上的厚度為 CT3

第四透鏡於光軸上的厚度為 CT4

第一透鏡、第二透鏡、第三透鏡、及第四透鏡於光軸上的厚度的總和為∑CT

第二透鏡物側面的曲率半徑為 R3

第二透鏡像側面的曲率半徑為 R4

影像拾取系統透鏡組的光圈值為 Fno

影像拾取系統透鏡組的最大視角為 FOV

影像拾取系統透鏡組中最大視角的一半為 HFOV

【生物材料寄存】

國內寄存資訊【請依寄存機構、日期、號碼順序註記】

無

國外寄存資訊【請依寄存國家、機構、日期、號碼順序註記】

無

申請專利範圍

1. 一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該第二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，係滿足下列關係式：

$0.5\ mm < Td < 3.2\ mm$；

$1.0\ mm < Td / \tan(HFOV) < 3.75\ mm$；

$|f / f4| < 1.20$；及

$f2 / f3 < -0.65$。

2. 如申請專利範圍第 1 項所述的影像拾取系統透鏡組，其中該第四透鏡的物側面於近光軸處為凸面。

3. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f，該第一透鏡的焦距為 f1，係滿足下列關係式：

$-0.25 < f / f1 < 0.75$。

4. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，係滿足下列關係式：

$0.8\ mm < Td < 2.5\ mm$。

申請案號：102139029

5. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的光圈值為 Fno，係滿足下列關係式：

$1.4 < Fno \leq 2.25$。

6. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，該第二透鏡物側面的曲率半徑為 R3，該第二透鏡像側面的曲率半徑為 R4，係滿足下列關係式：

$0.5 < (R3+R4) / (R3-R4) < 2.5$。

7. 如申請專利範圍第 2 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f，係滿足下列關係式：

$0.5\ mm < f < 2.0\ mm$。

8. 如申請專利範圍第 1 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面於近光軸處為凸面。

9. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，係滿足下列關係式：

$1.2\ mm < Td / \tan(HFOV) < 2.75\ mm$。

10. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡、該第二透鏡、該第三透鏡、及該第四透鏡於光軸上之厚度的總合為∑CT，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，係滿足下列關係式：

$0.80 < \sum CT / Td < 0.95$。

11. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 V1，係滿足下列關係式：

$45 < V1$。

12. 如申請專利範圍第 8 項所述的影像拾取系統透鏡組，其中該第二透鏡於光軸上的厚度為 CT2，該第一透鏡於光軸上的厚度為 CT1，該第三透鏡於光軸上的厚度為 CT3，該第四透鏡於光軸上

的厚度為 CT4，係滿足下列關係式：

$0.65 < CT2 / (CT1+CT3+CT4) < 2.0$。

13.一種取像裝置，包含如申請專利範圍第 1 項所述的影像拾取系統透鏡組及一電子感光元件。

14.一種可攜裝置，包含如申請專利範圍第 13 項所述的取像裝置。

15.一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該第三透鏡的焦距為 f3，係滿足下列關係式：

$0.5 \text{ mm} < Td < 3.2 \text{ mm}$；

$1.0 \text{ mm} < Td / \tan(HFOV) < 3.75 \text{ mm}$；

$|f / f4| < 1.20$；及

$-2.0 < f / f3 < -0.95$。

16.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 V1，係滿足下列關係式：

$45 < V1$。

17.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的焦距為 f，該第一透鏡的焦距為 f1，係滿足下列關係式：

$-0.25 < f / f1 < 0.75$。

18.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的最大視角為 FOV，係滿足下列關係式：

80 度 < FOV < 110 度。

19.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，係滿足下列關係式：

0.8 mm < Td < 2.5 mm。

20.如申請專利範圍第 15 項所述的影像拾取系統透鏡組，其中該第二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，係滿足下列關係式：

f2 / f3 < -0.75。

21.一種影像拾取系統透鏡組，由物側至像側依序包含：

一具屈折力的第一透鏡；

一具正屈折力的第二透鏡，其像側面於近光軸處為凸面；

一具負屈折力的第三透鏡，其物側面於近光軸處為凹面，其像側面於近光軸處為凸面；及

一具屈折力的第四透鏡，其像側面於近光軸處為凹面，其物側面及像側面皆為非球面，且其像側面於離軸處具有至少一凸面；

其中，該影像拾取系統透鏡組中具有屈折力的透鏡為四片；

其中，該第一透鏡物側面至該第四透鏡像側面於光軸上的距離為 Td，該影像拾取系統透鏡組中最大視角的一半為 HFOV，該影像拾取系統透鏡組的焦距為 f，該第四透鏡的焦距為 f4，該影像拾取系統透鏡組的光圈值為 Fno，係滿足下列關係式：

0.5 mm < Td < 3.2 mm；

1.0 mm < Td / tan(HFOV) < 3.75 mm；

|f / f4| < 1.20；及

1.40 < Fno ≤ 2.25。

22.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第

二透鏡的焦距為 f2，該第三透鏡的焦距為 f3，係滿足下列關係式：

$$f2 / f3 < -0.65。$$

23.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第一透鏡的色散係數為 V1，係滿足下列關係式：

$$45 < V1。$$

24.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第一透鏡具正屈折力，該影像拾取系統透鏡組的焦距為 f，該第一透鏡的焦距為 f1，係滿足下列關係式：

$$0.25 < f / f1 < 0.75。$$

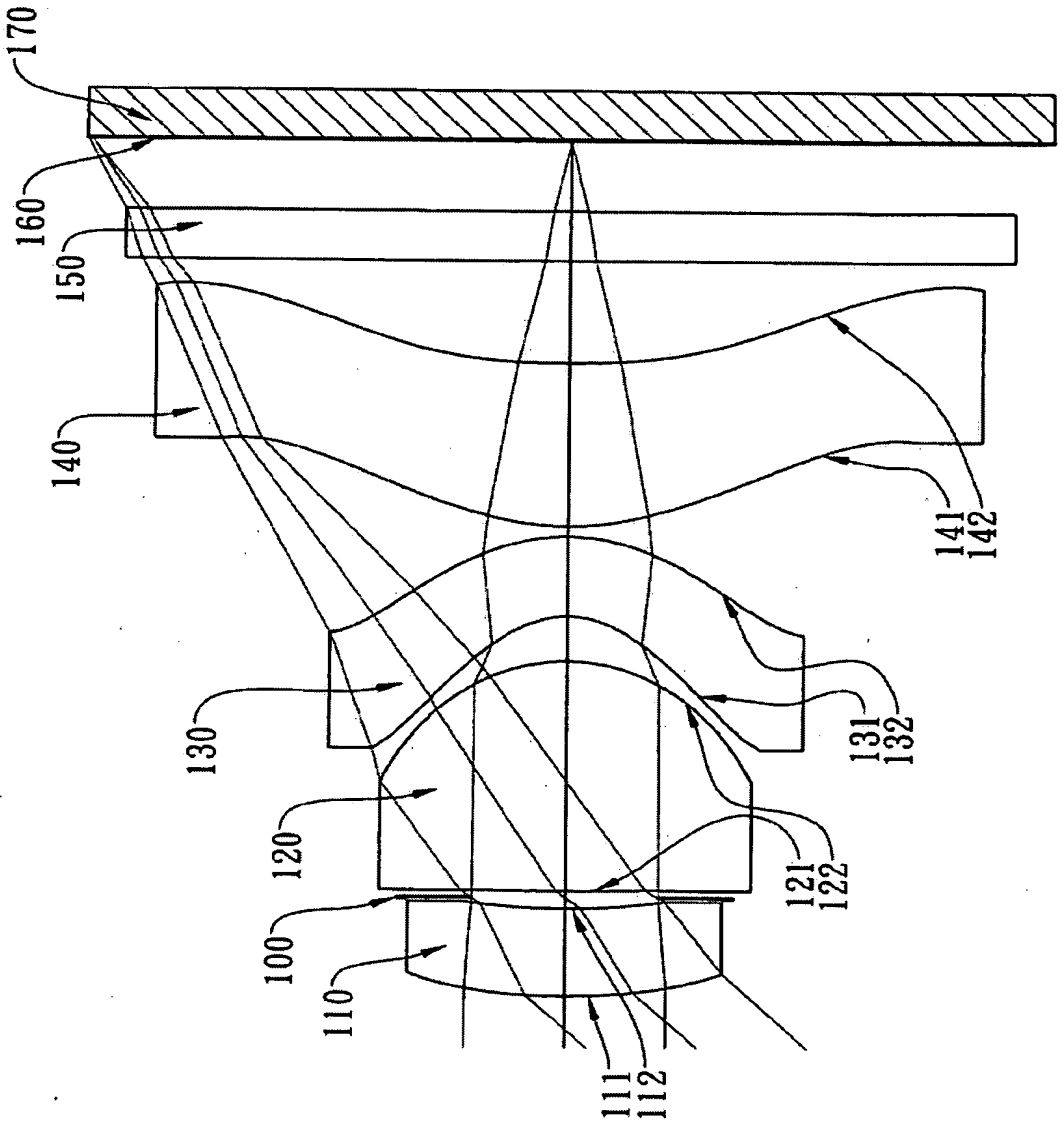
25.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該影像拾取系統透鏡組的最大視角為 FOV，係滿足下列關係式：

$$80 度 < FOV < 110 度。$$

26.如申請專利範圍第 21 項所述的影像拾取系統透鏡組，其中該第二透鏡於光軸上的厚度為 CT2，該第一透鏡於光軸上的厚度為 CT1，該第三透鏡於光軸上的厚度為 CT3，該第四透鏡於光軸上的厚度為 CT4，係滿足下列關係式：

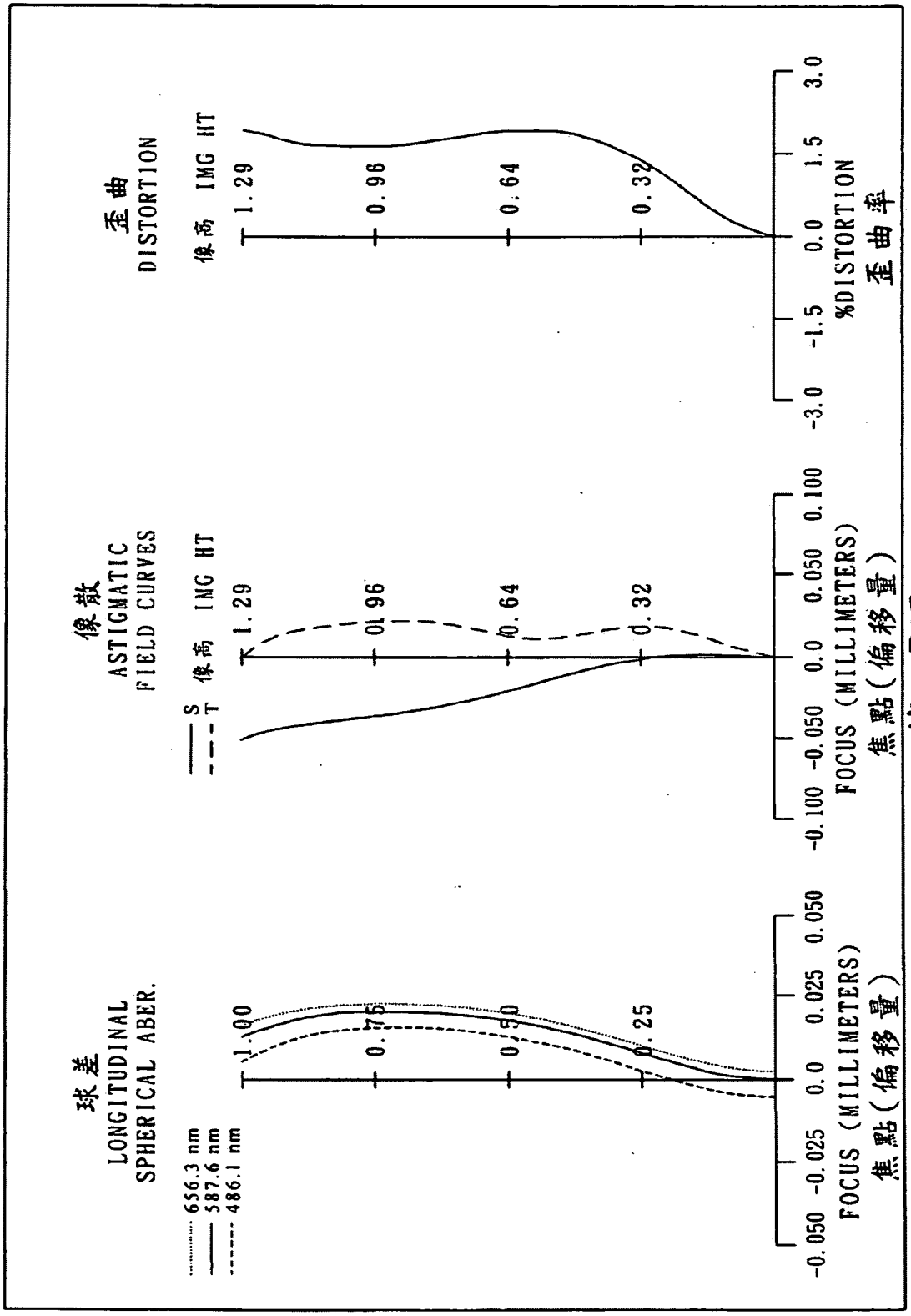
$$0.65 < CT2 / (CT1+CT3+CT4) < 2.0。$$

圖式



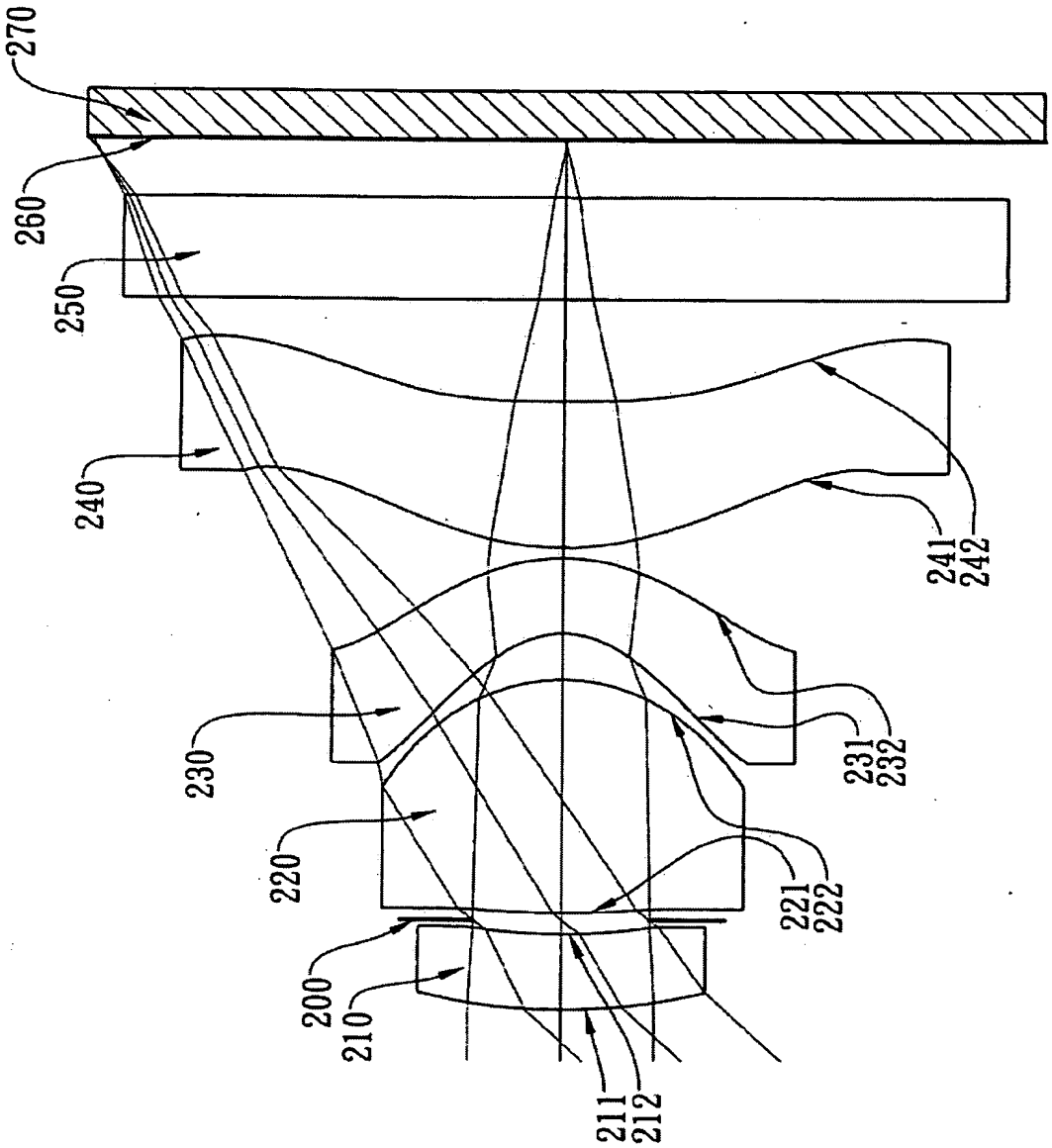
第一A圖

申請案號：102139029

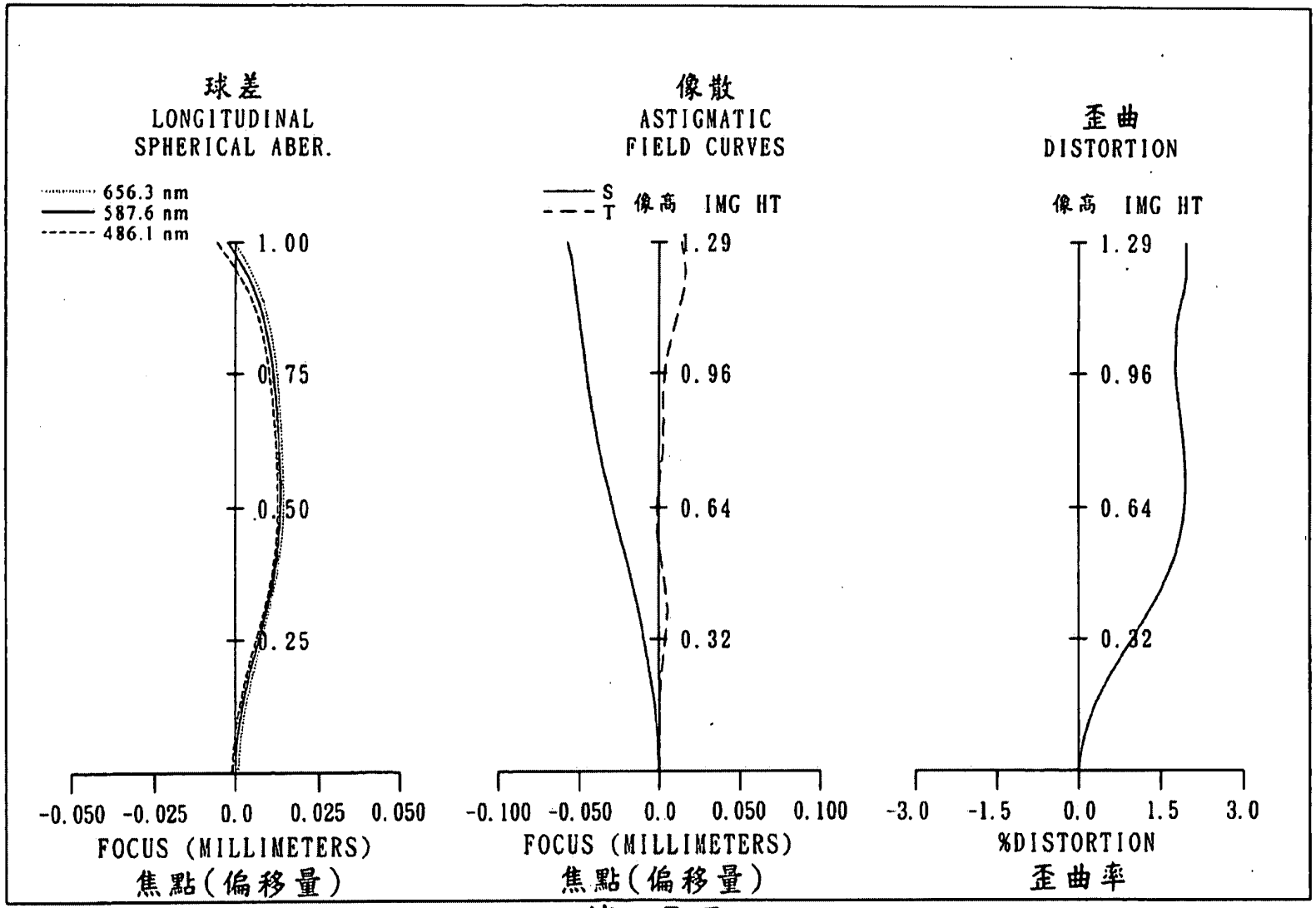


第一B圖

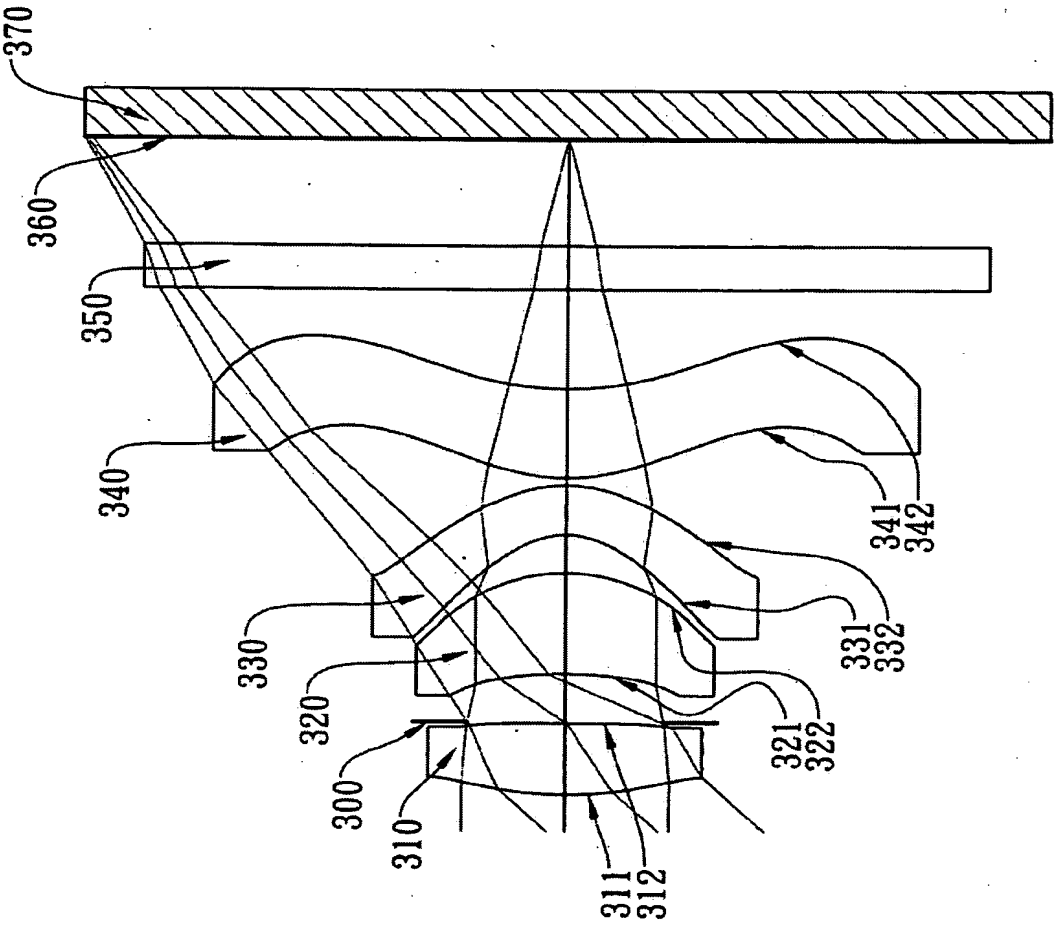
申請案號：102139029



第二A圖

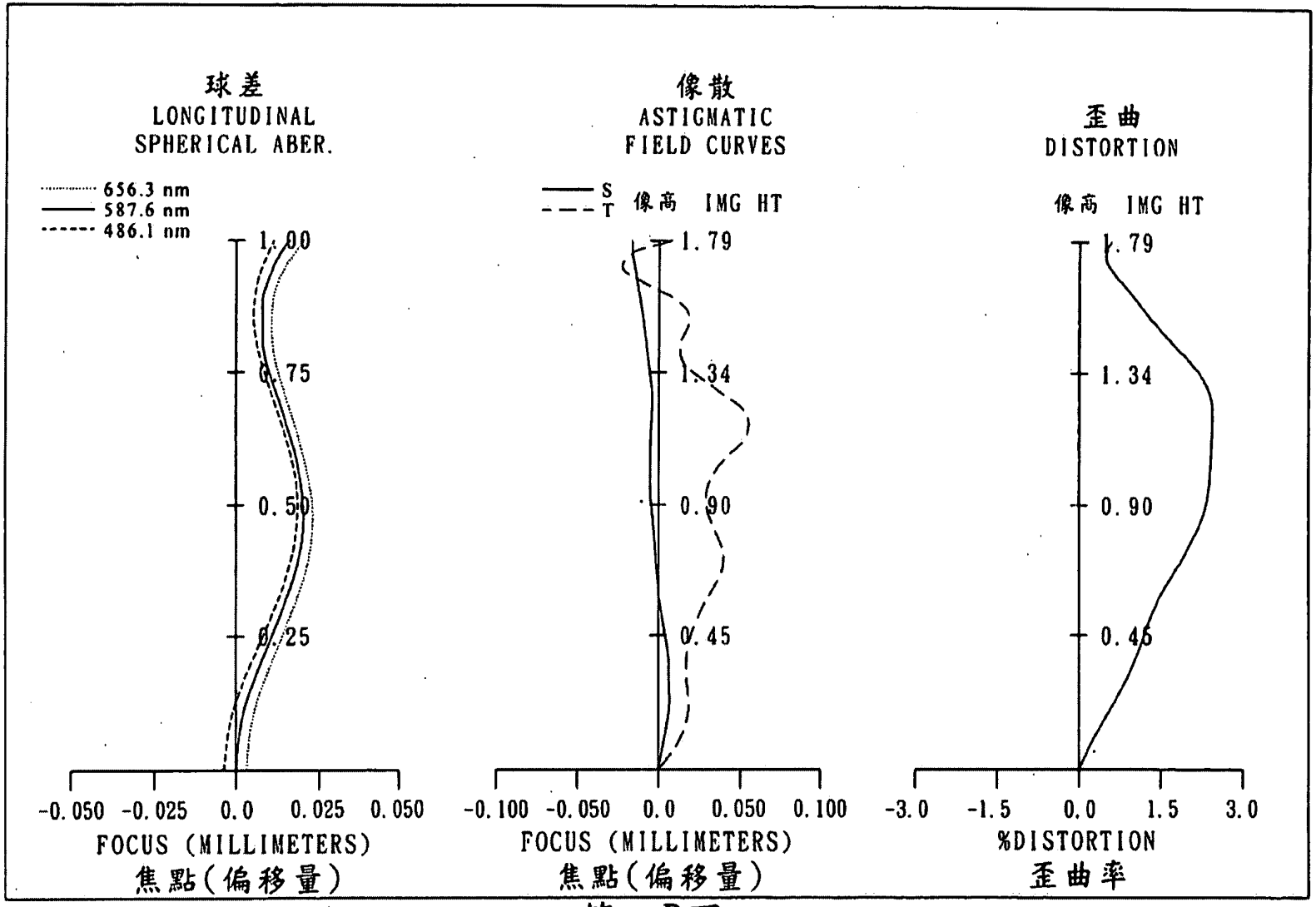

球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
1.29
0.96
0.64
0.32
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
1.29
0.96
0.64
0.32
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第二B圖

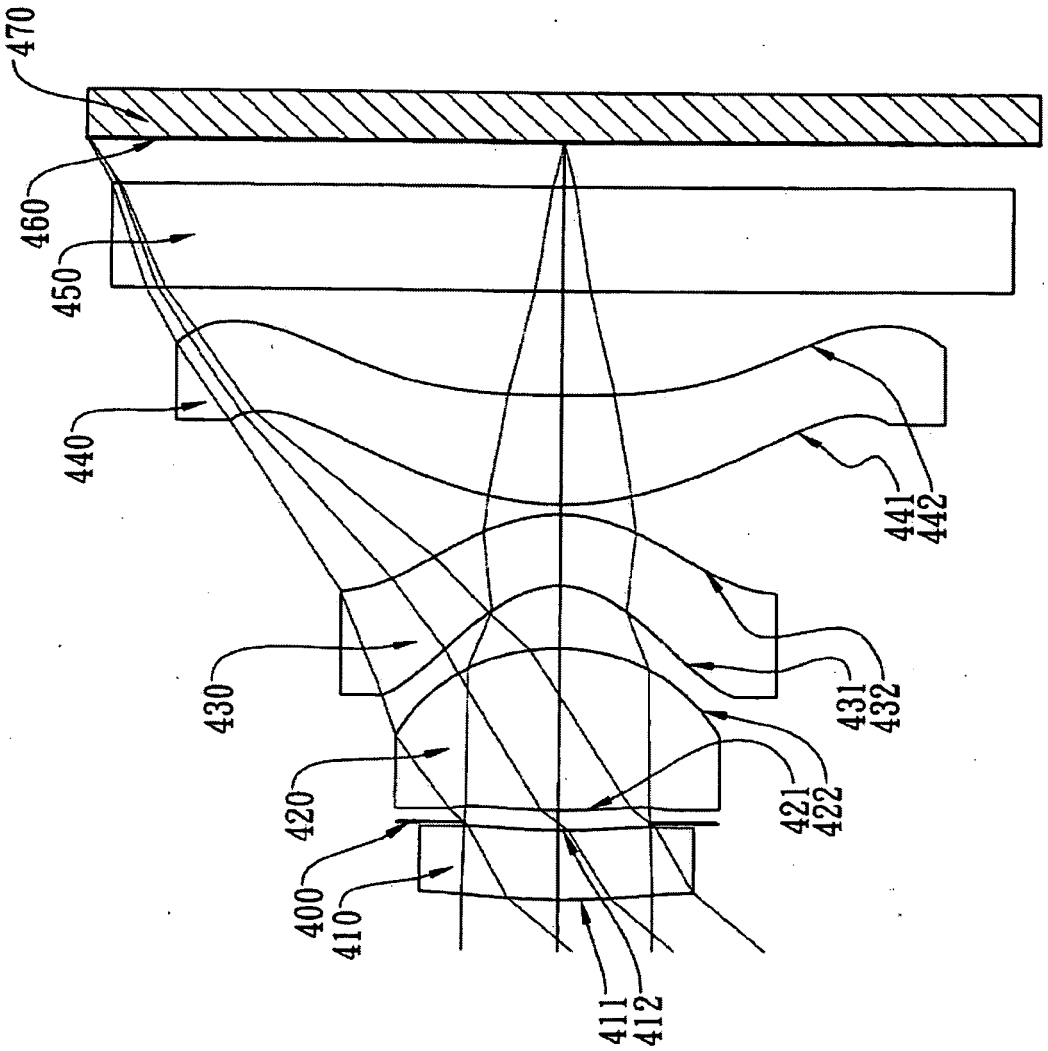


第三A圖

申請案號：102139029

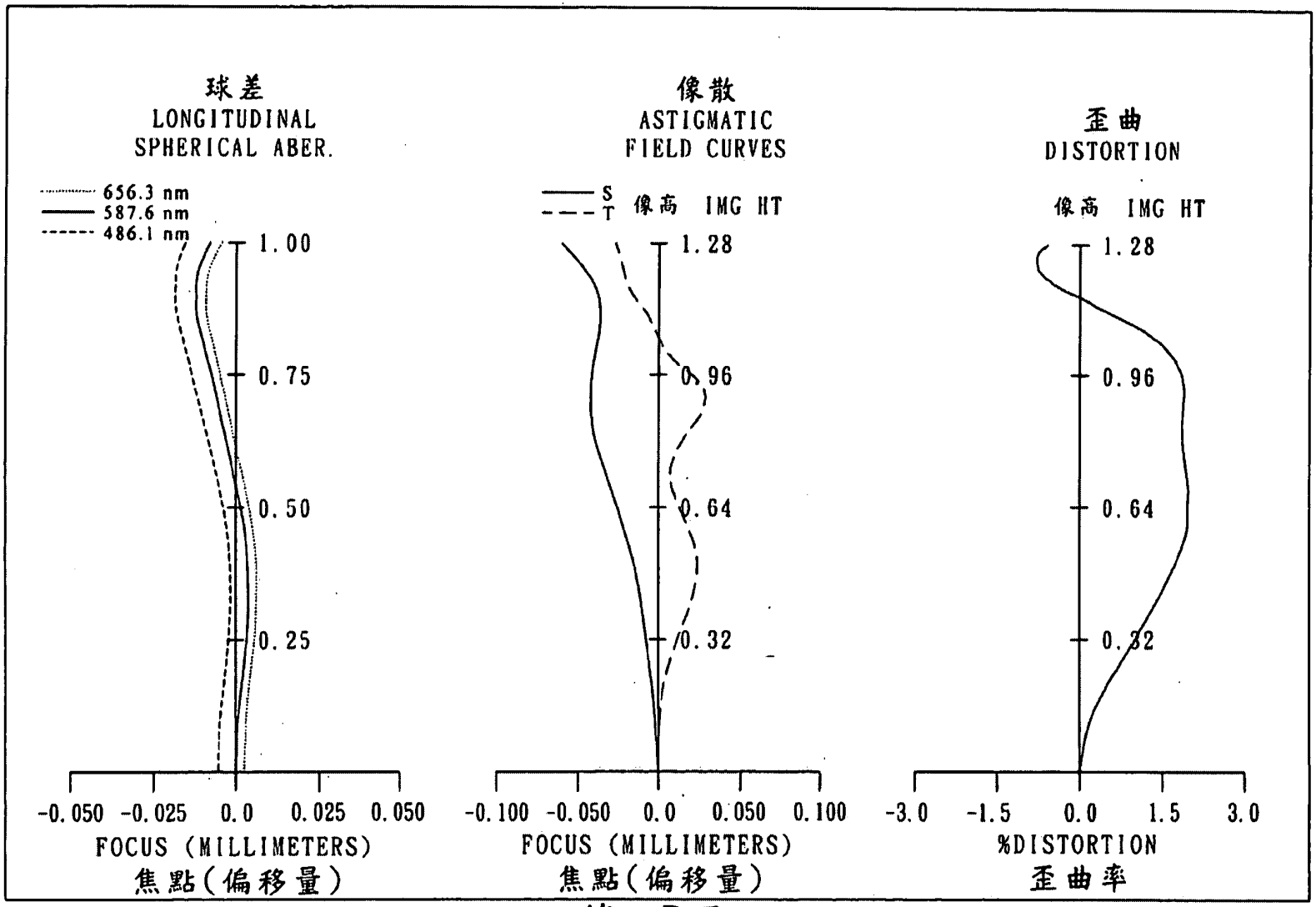

球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
1.79
1.34
0.90
0.45
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
1.79
1.34
0.90
0.45
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第三B圖

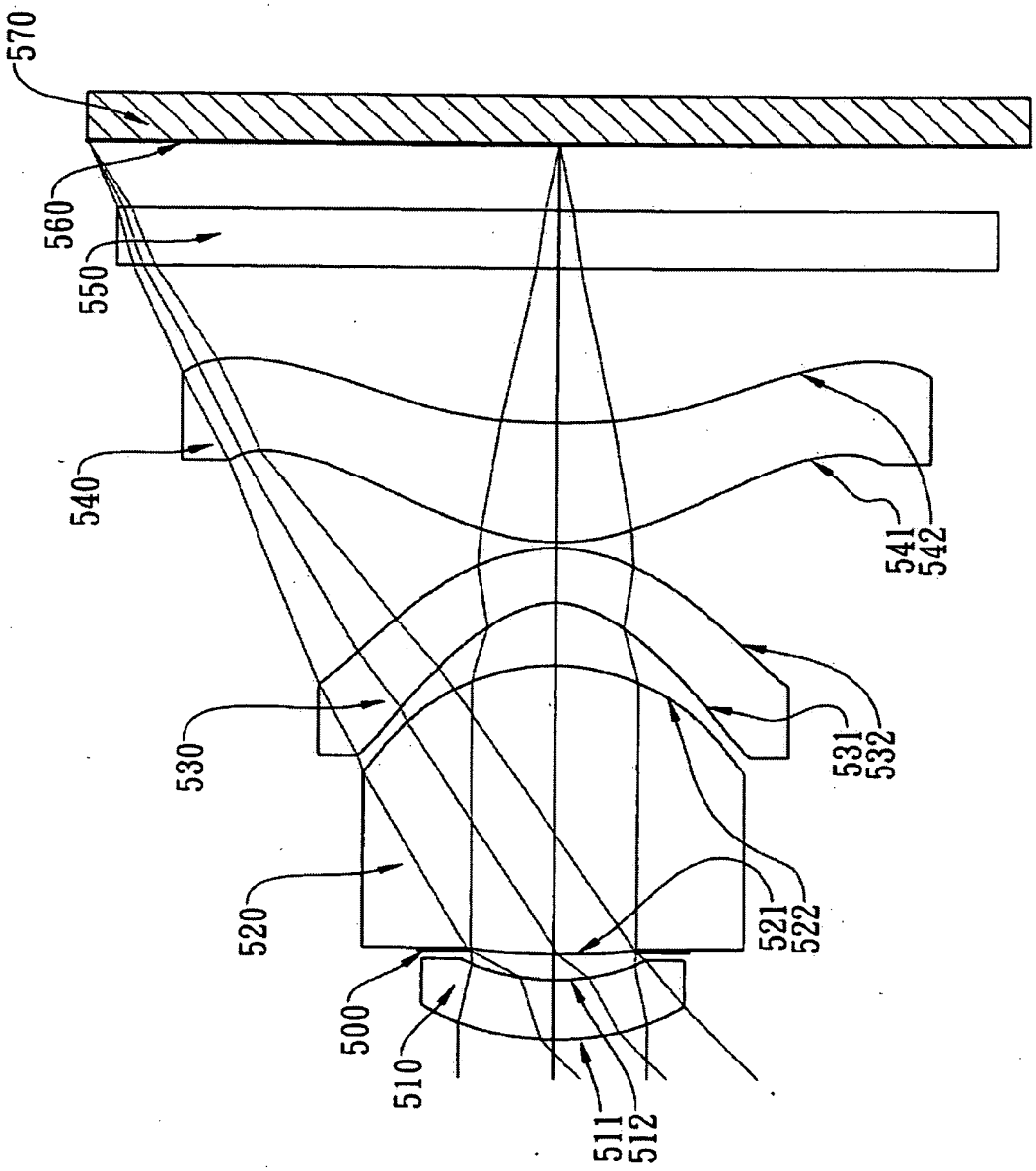


第四A圖

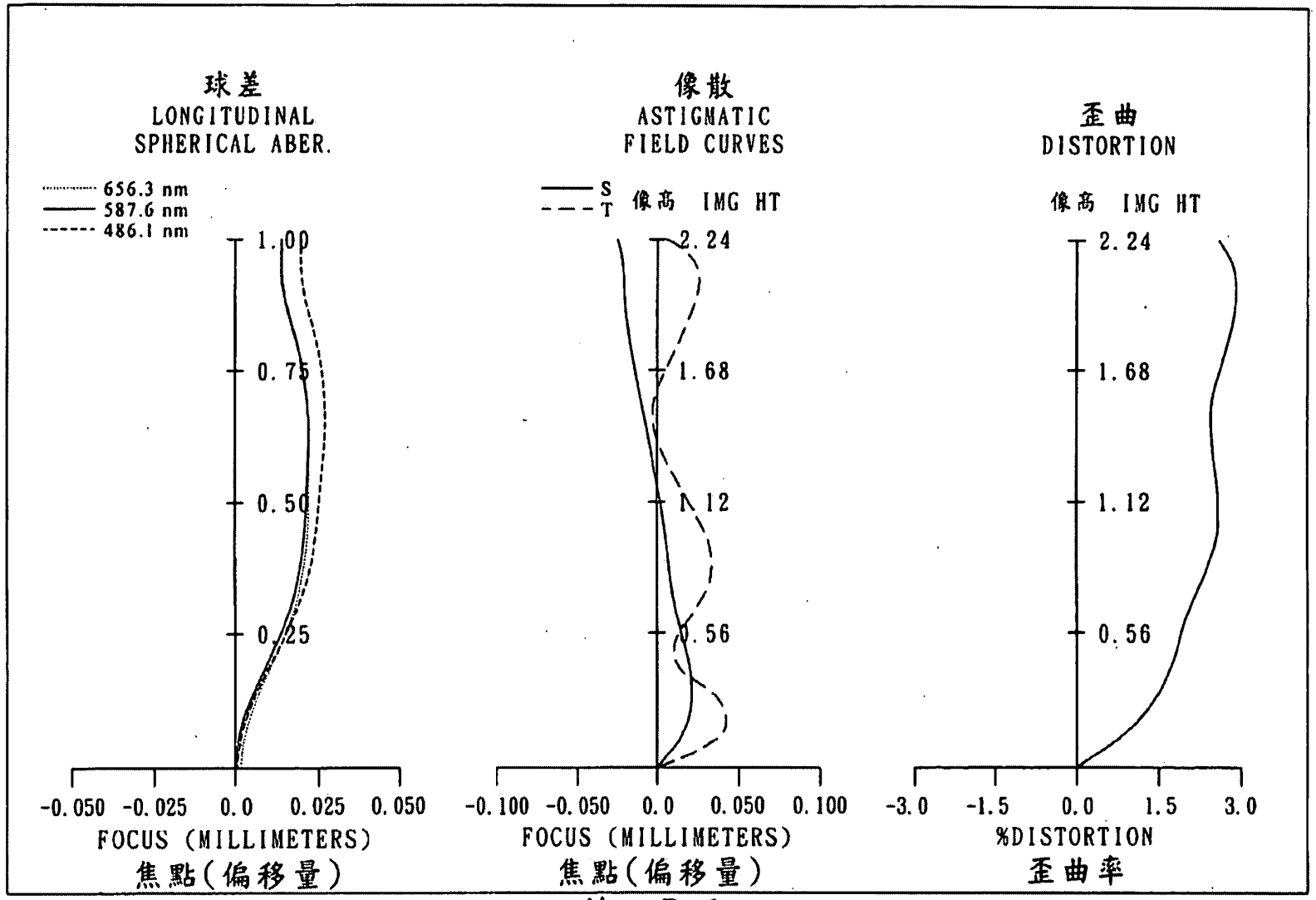
申請案號：102139029


球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
1.28
0.96
0.64
0.32
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
1.28
0.96
0.64
0.32
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

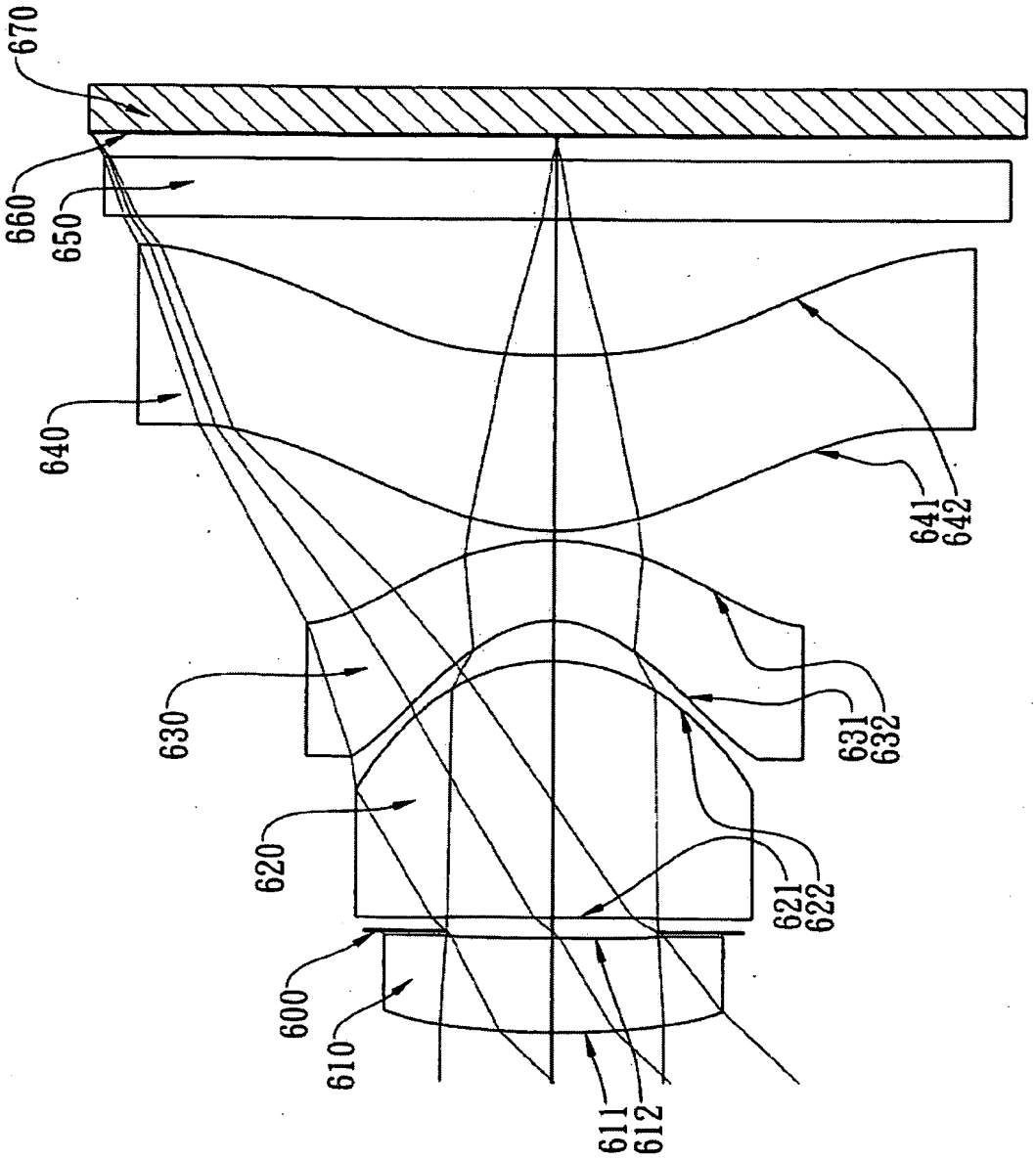
第四B圖



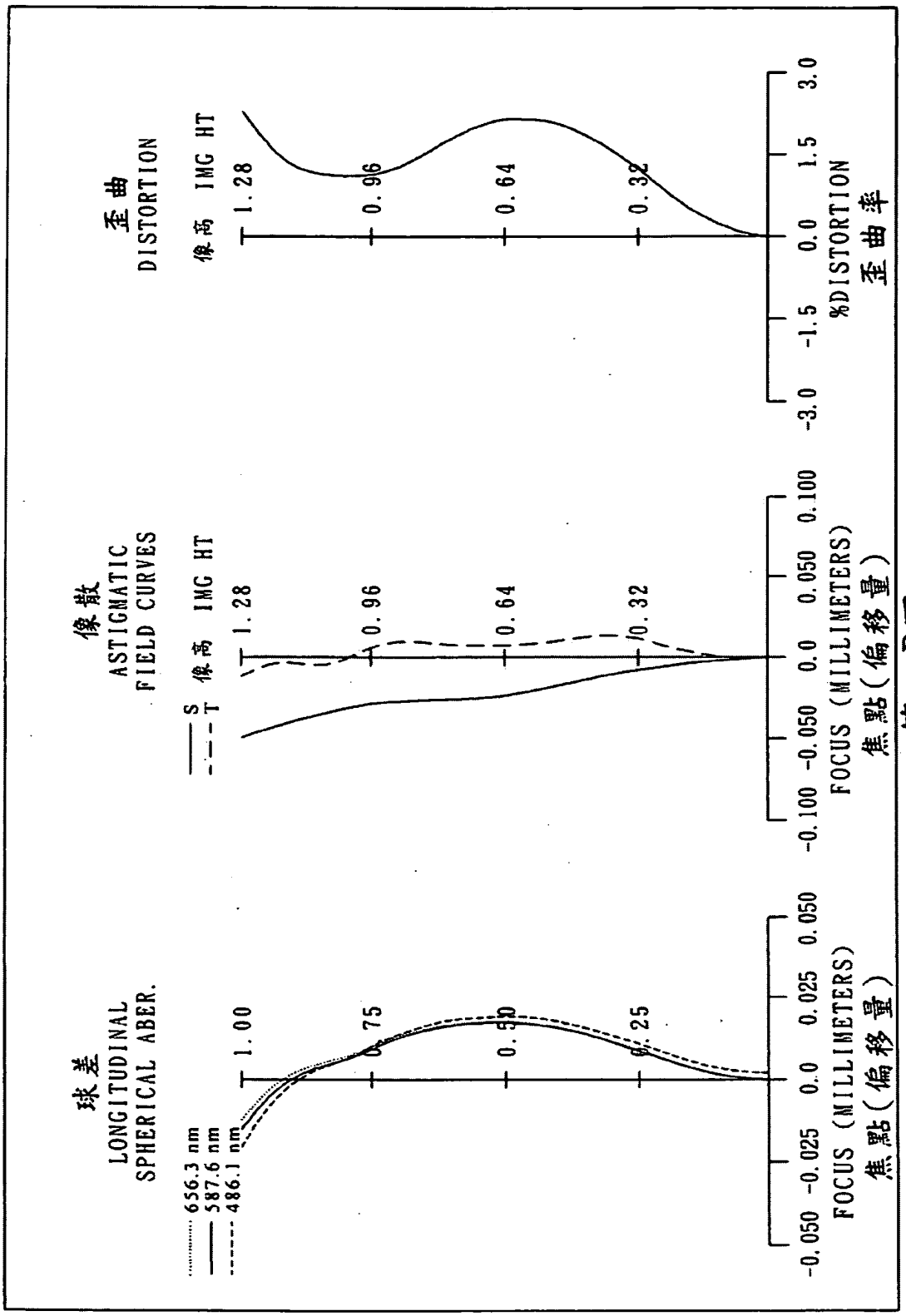
第五A圖


球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
2.24
1.68
1.12
0.56
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
2.24
1.68
1.12
0.56
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第五B圖

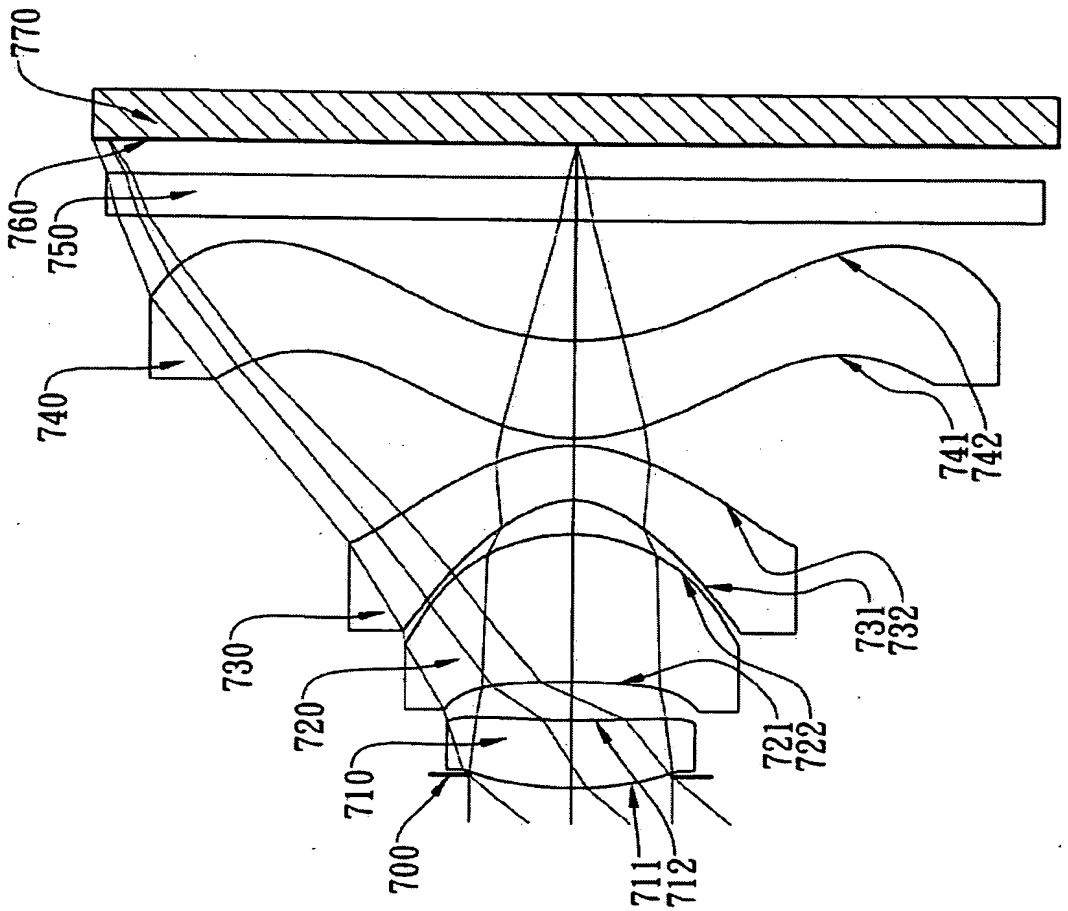


第六A圖



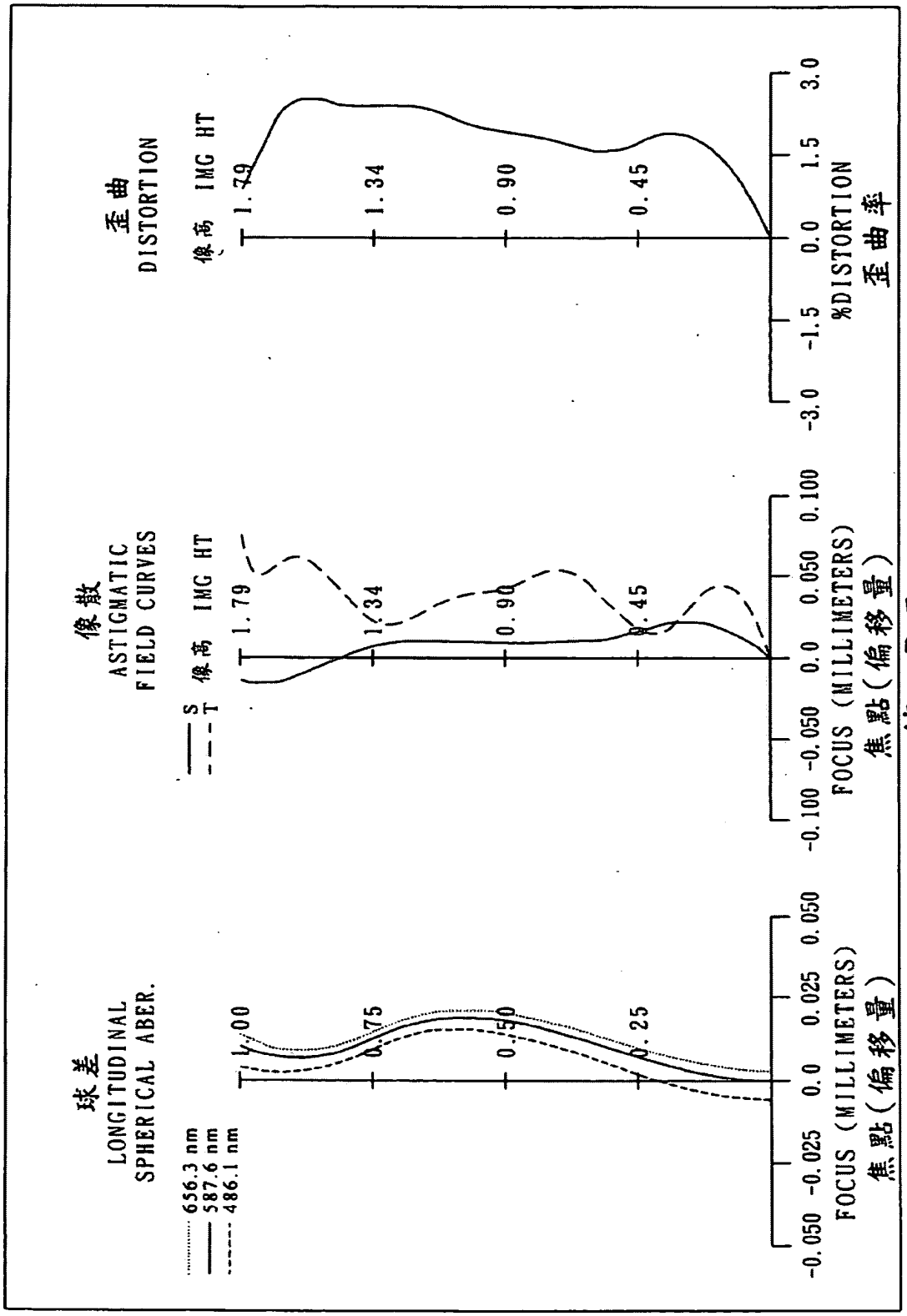
第六B圖

申請案號：102139029

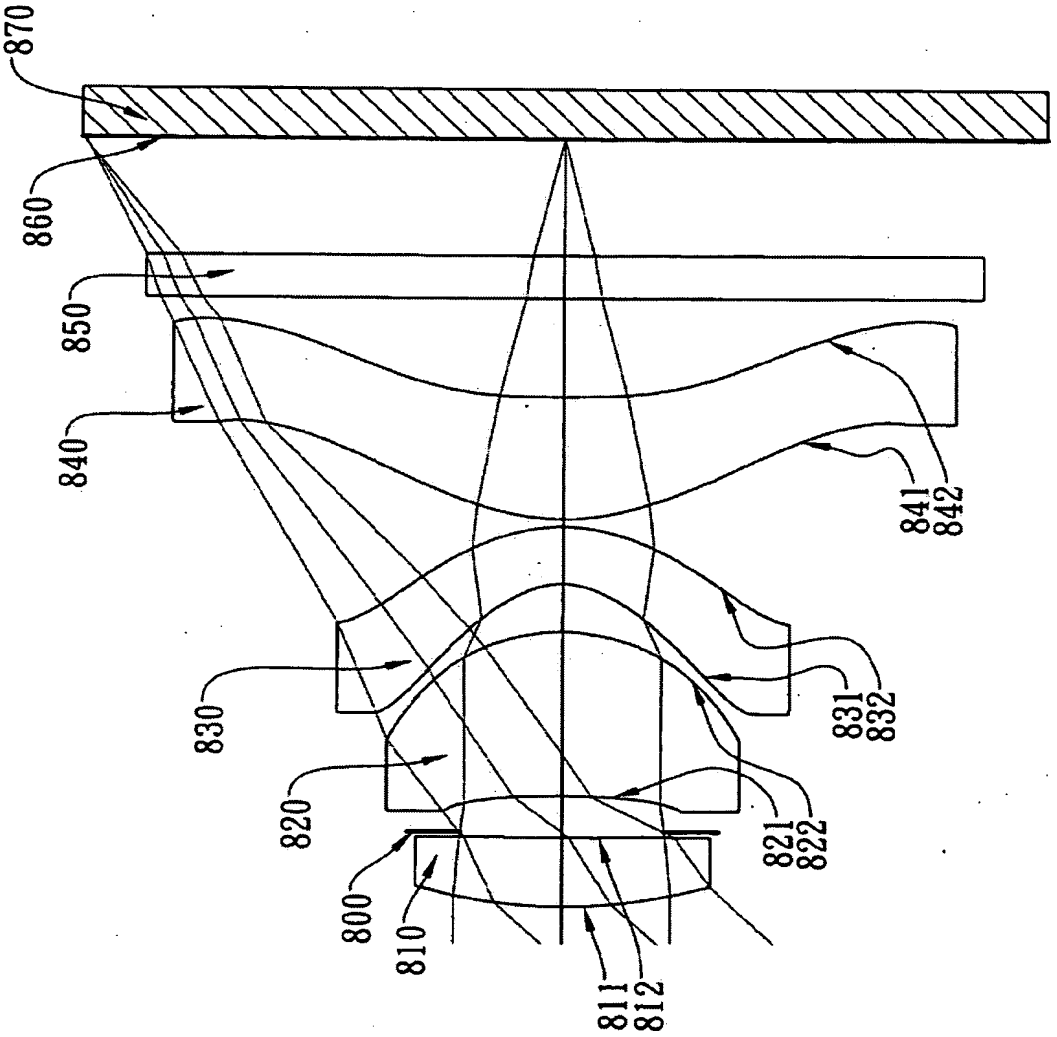


第七A圖

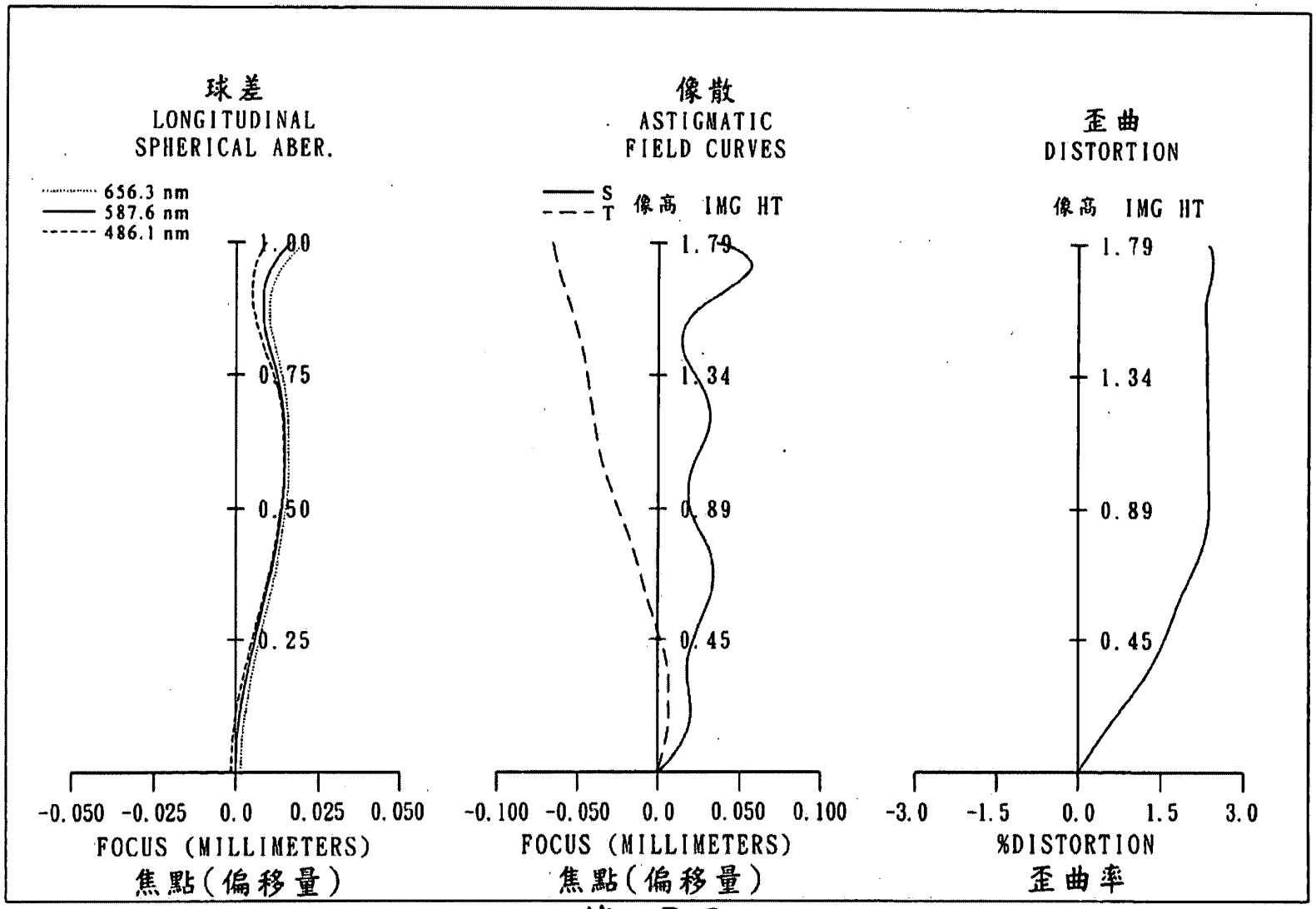
申請案號：102139029


球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
1.79
1.34
0.90
0.45
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
1.79
1.34
0.90
0.45
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

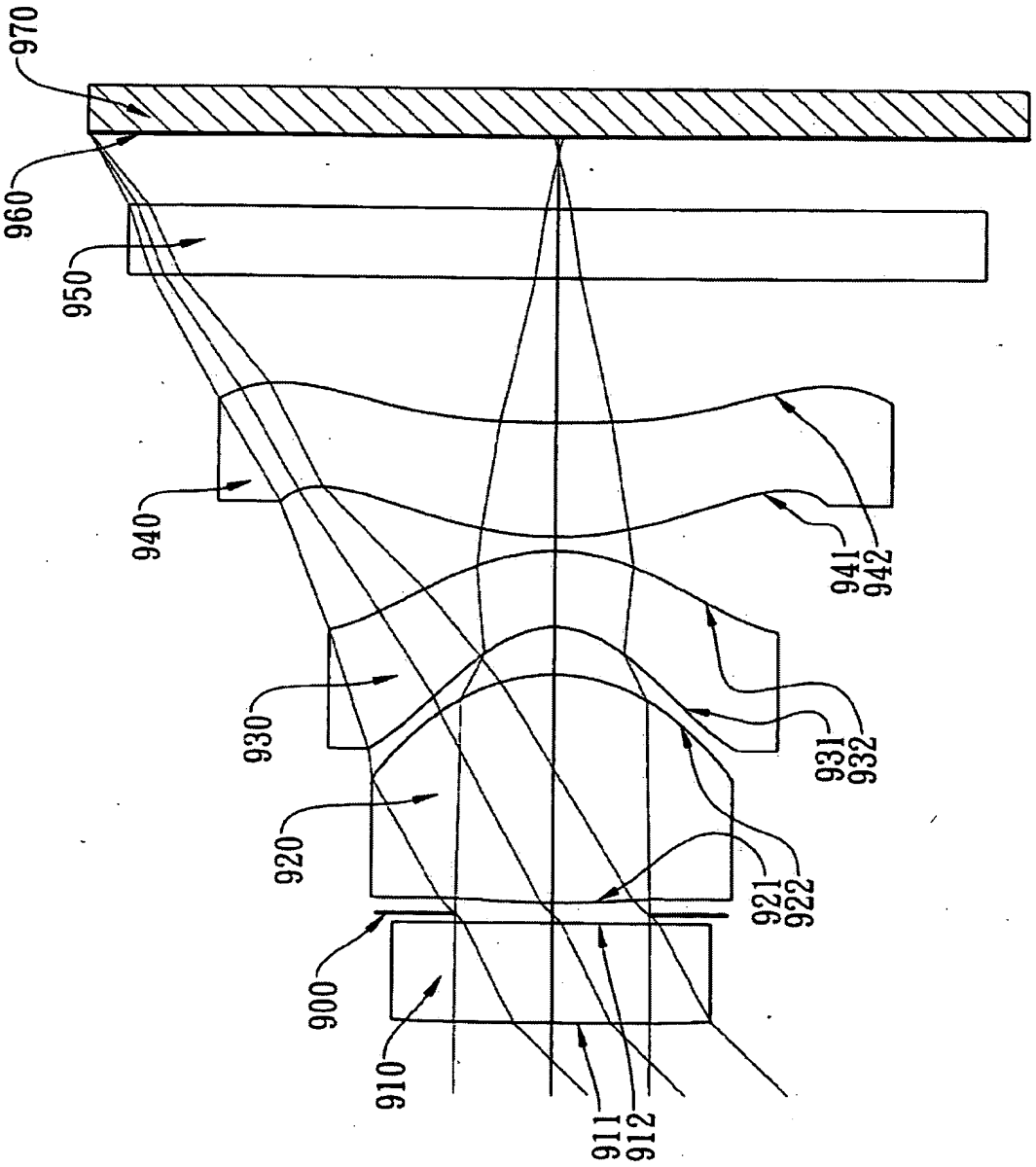
第七B圖



第八A圖

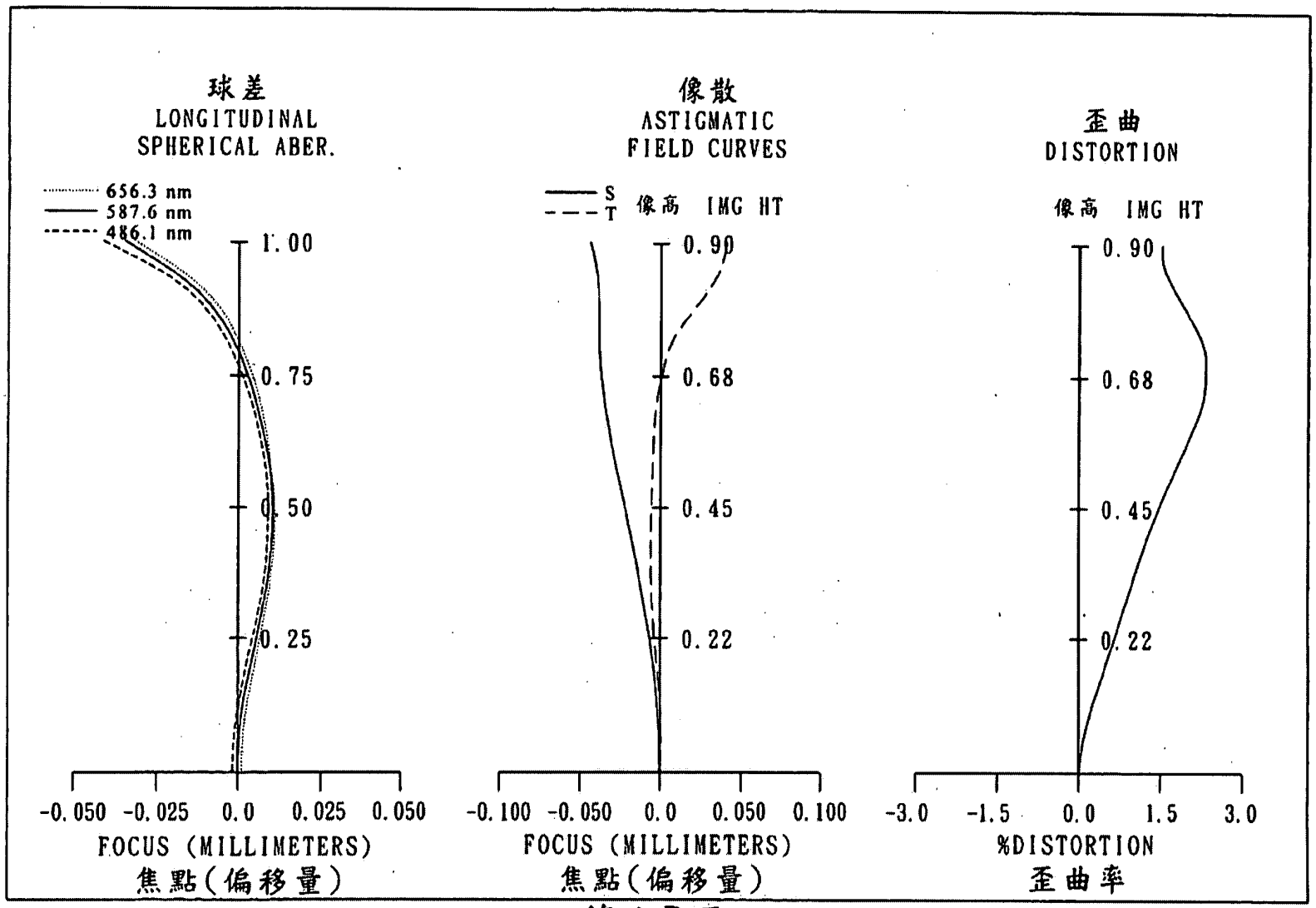

球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
1.79
1.34
0.89
0.45
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
1.79
1.34
0.89
0.45
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第八B圖

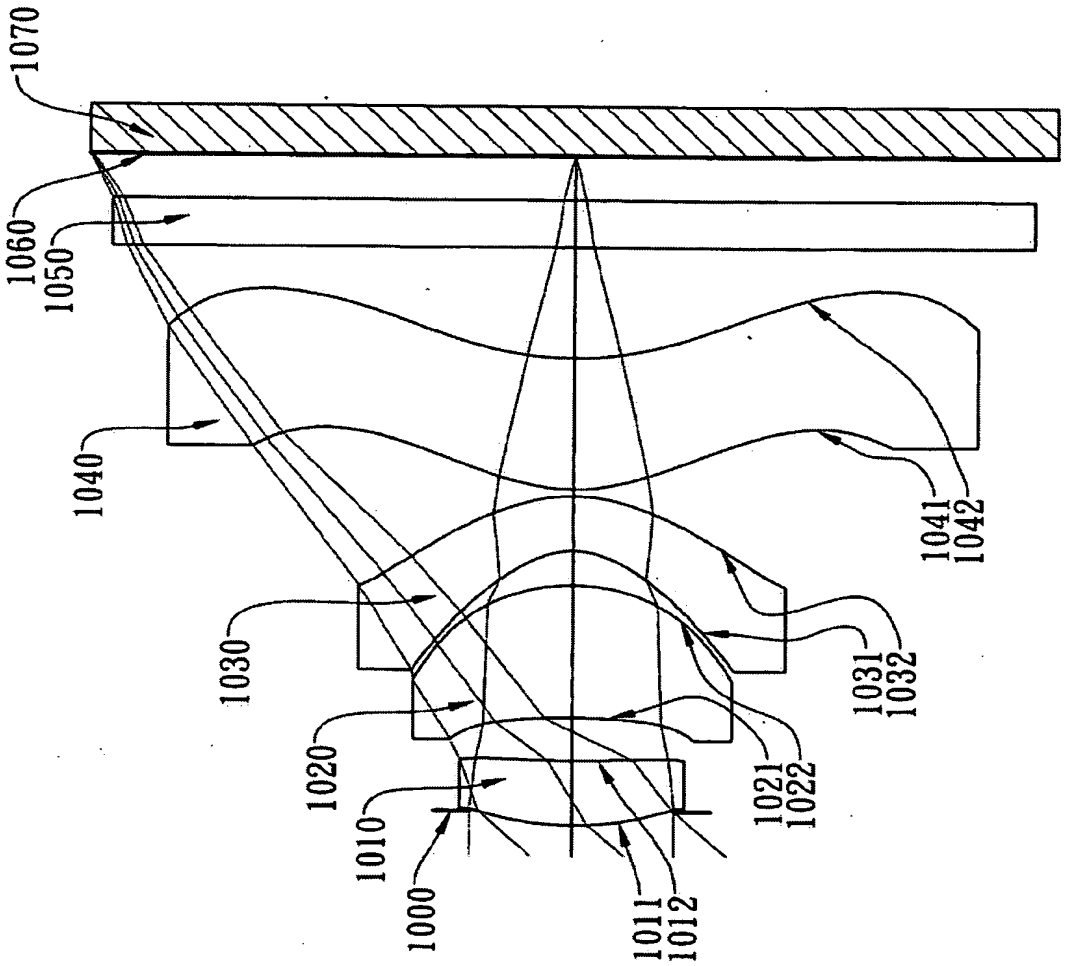


第九A圖

申請案號：102139029

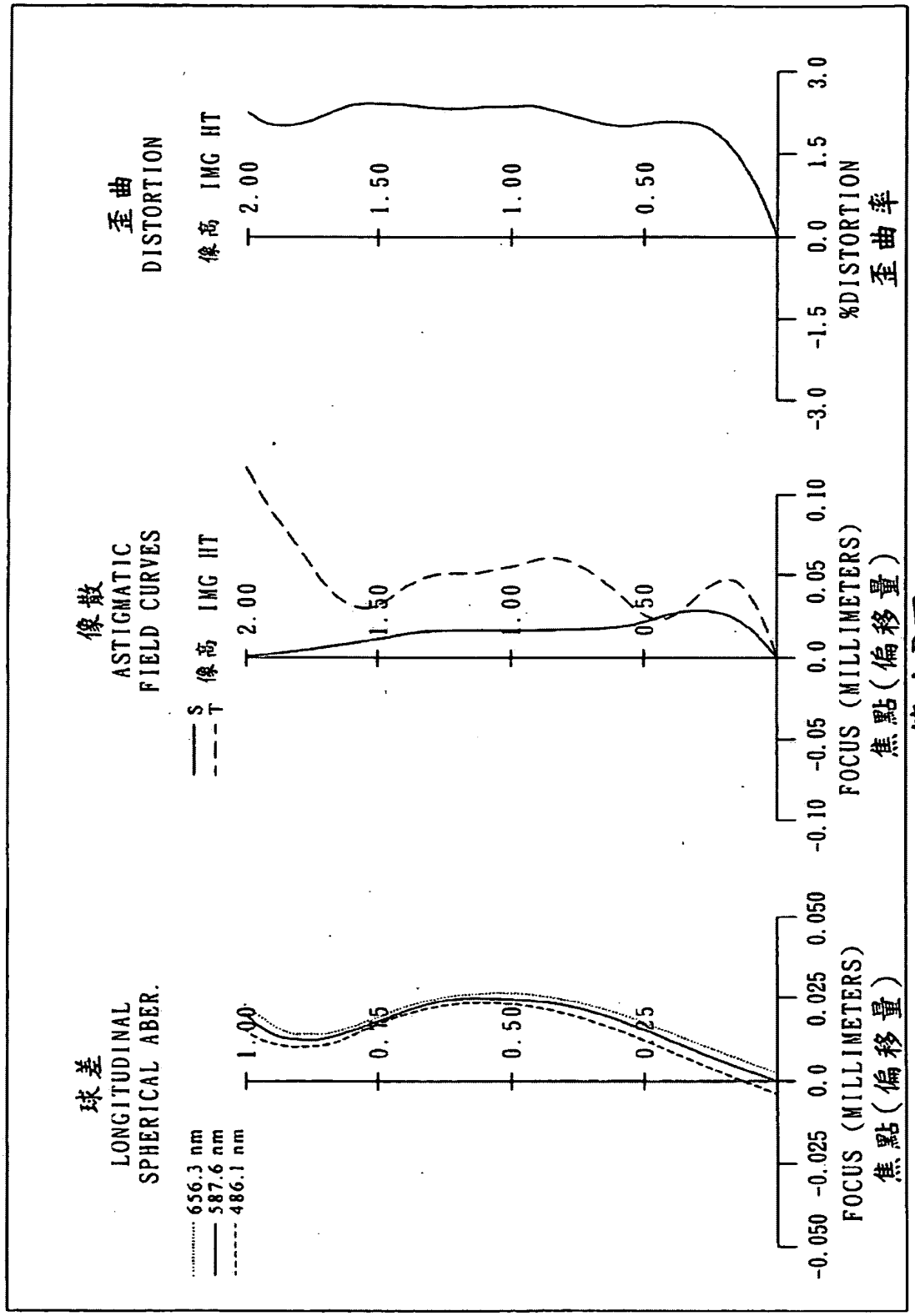

球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
0.90
0.68
0.45
0.22
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
0.90
0.68
0.45
0.22
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第九B圖

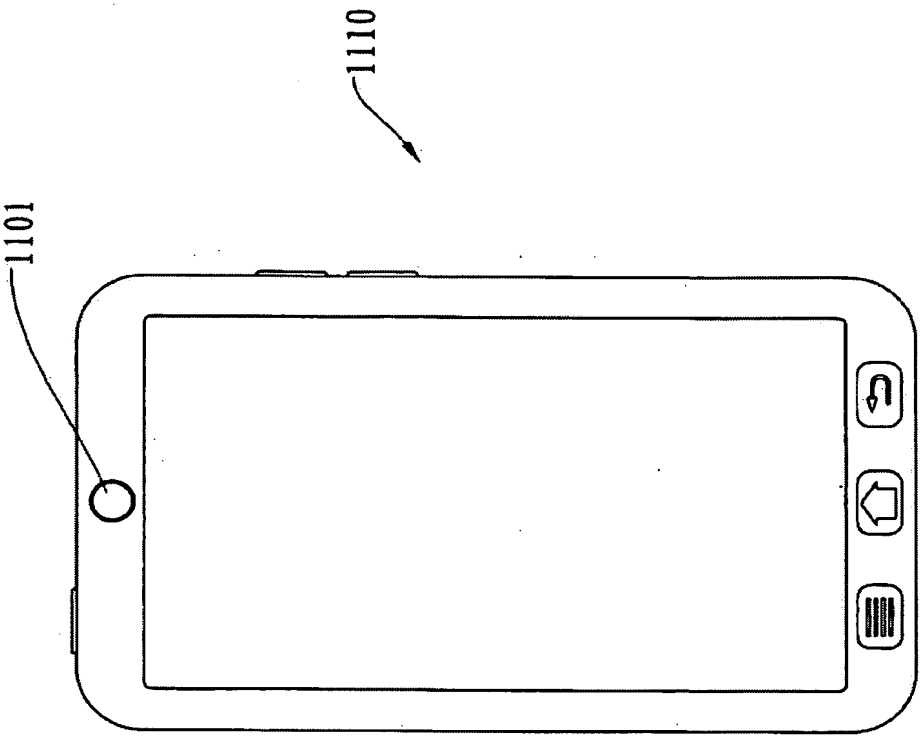


第十A圖

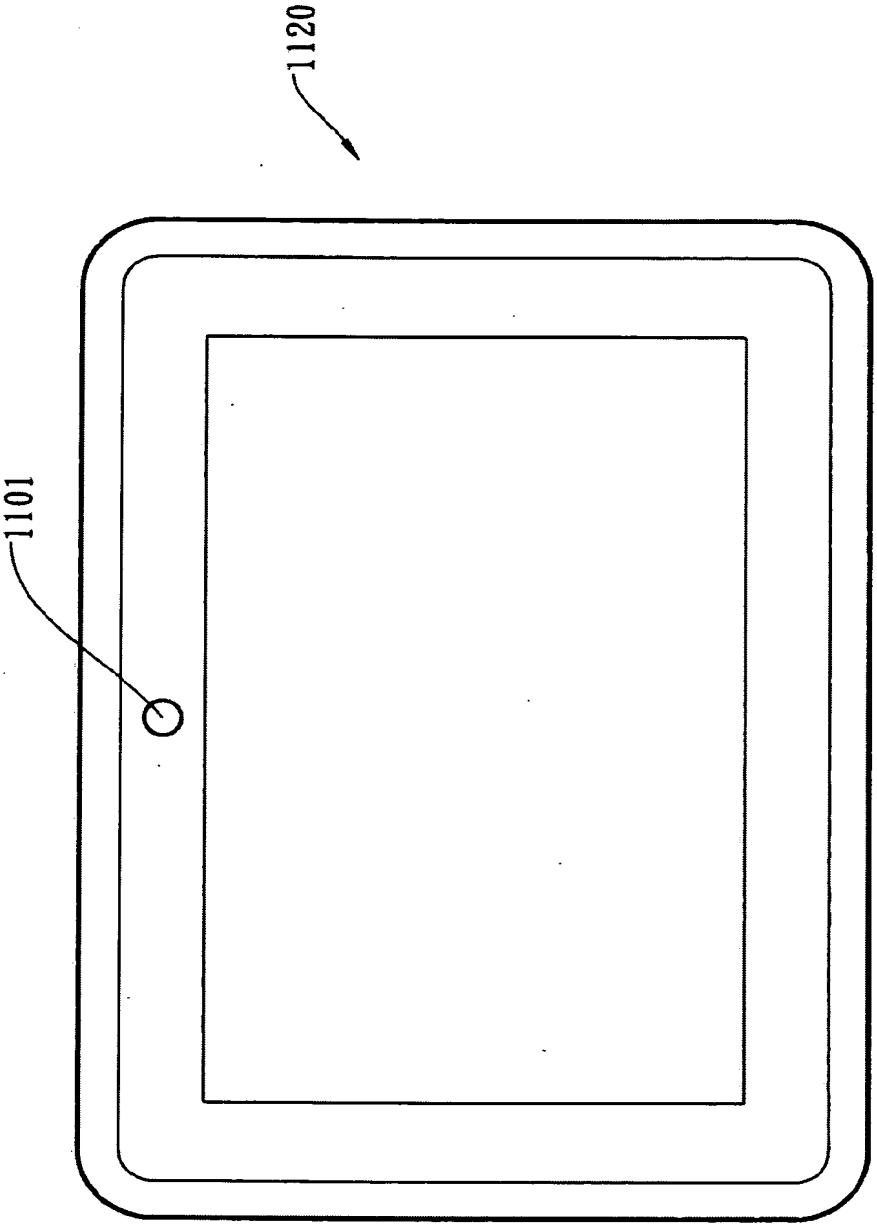
申請案號：102139029


球差
LONGITUDINAL
SPHERICAL ABER.
656.3 nm
587.6 nm
486.1 nm
1.00
0.75
0.50
0.25
-0.050 -0.025 0.0 0.025 0.050
FOCUS (MILLIMETERS)
焦點(偏移量)
像散
ASTIGMATIC
FIELD CURVES
S
T
像高 IMG HT
2.00
1.50
1.00
0.50
-0.10 -0.05 0.0 0.05 0.10
FOCUS (MILLIMETERS)
焦點(偏移量)
歪曲
DISTORTION
像高 IMG HT
2.00
1.50
1.00
0.50
-3.0 -1.5 0.0 1.5 3.0
%DISTORTION
歪曲率

第十B圖

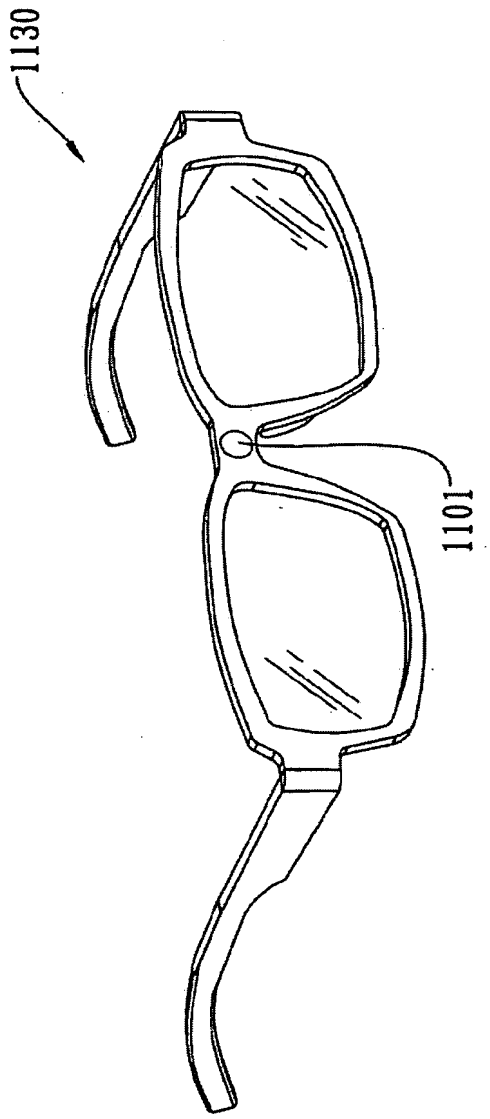


第十一A圖



第十一B圖

申請案號：102139029



第十一C圖

申請案號：102139029

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Wei-Yu Chen	Examiner:	Unassigned
Serial No.:	14/105,811	Group Art Unit:	Unassigned
Filed:	December 13, 2013	Docket No.:	14970-94702
Title:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL		

CERTIFICATE UNDER 37 CFR 1.8:
I hereby certify that this correspondence is being deposited on January 6, 2014 with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

By: _____
Name: Tim Tingkang Xia

TRANSMITTAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

January 6, 2014

Customer No. 24728

Sir:

We are transmitting herewith the attached:

☒ Transmittal Sheet containing Certificate of Mailing (1 page)
☒ Submission of Priority Document (1 page)
☒ Certified Copy of Priority Document Taiwan Patent Application 102139029, filed October 29, 2013 (66 pages)
☒ Return Postcard

MORRIS, MANNING & MARTIN, LLP
1600 Atlanta Financial Center
3343 Peachtree Road NE
Atlanta, Georgia 30326
404.495.3678
Customer No. 24728

By: _____
Name: Tim Tingkang Xia
Reg. No.: 45,242
TTX

S/N: 14/105,811

PATENT
Confirmation No. 5836

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Wei-Yu Chen	Examiner:	Unassigned
Serial No.:	14/105,811	Group Art Unit:	Unassigned
Filed:	December 13, 2013	Docket No.:	14970-94702
Title:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMIAL		

CERTIFICATE UNDER 37 CFR 1.8:
I hereby certify that this correspondence is being deposited on January 6, 2014 with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

By: _____
Name: Tim Tingkang Xia

SUBMISSION OF PRIORITY DOCUMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

January 6, 2014

CUSTOMER NO. 24728

Dear Sir:

The certified copy of Taiwan Patent Application No. 102139029, from which this application claims priority is hereby submitted as the priority document.

If there are any questions regarding this matter, please call the undersigned at 404-495-3678.

Respectfully submitted,

MORRIS, MANNING & MARTIN, LLP

January 6, 2014

Tim Tingkang Xia
Reg. No. 45,242
Attorney for the Assignee and Applicants on Record

MORRIS, MANNING & MARTIN, L.L.P.
1600 Atlanta Financial Center
3343 Peachtree Road, N.E.
Atlanta, Georgia 30326
404-495-3678 Direct
Customer No. 24728

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
14/105,811		2872	

OC000000068949500

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 24728 on 06/10/2014

- **Correspondence Address**
- **Maintenance Fee Address**

The address of record for Customer Number 24728 is:

24728
MORRIS MANNING MARTIN LLP
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	14105811
Filing Date	2013-12-13
First Named Inventor	WEI-YU CHEN
Art Unit	2872
Examiner Name	
Attorney Docket Number	14970-94702

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8842379	B2	2014-09-23	Largan Precision Co., Ltd.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100165485	A1	2010-07-01	Milestone Co., Ltd.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2014-178623	JP		2014-09-25	Hitachi Maxell, Ltd.		☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	14105811
	Filing Date	2013-12-13
	First Named Inventor	WEI-YU CHEN
	Art Unit	2872
	Examiner Name	
	Attorney Docket Number	14970-94702

	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	14105811
	Filing Date	2013-12-13
	First Named Inventor	WEI-YU CHEN
	Art Unit	2872
	Examiner Name	
	Attorney Docket Number	14970-94702

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Tim Tingkang Xia/	Date (YYYY-MM-DD)	2014-12-01
Name/Print	Tim Tingkang Xia	Registration Number	45242

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

English Translation of Abstract of JP2014-178623

This invention provides a wide-angle lens system 10 from an object-side to an image-side in order including a first lens element 11 with negative refractive power, a second lens element 12 with positive refractive power, a third lens element 13 with negative refractive power and a fourth lens element 14 with positive refractive power. The first lens element 11 has negative refractive power and a concave surface and the second lens element 12 has positive refractive power and convex surfaces such that a total track length of the lens system with more than 65-degree view of angle is controlled within about 5mm. An image surface 14b of the fourth lens element 14 is provided with inflection points so as to control a direction of the light coming from the wide-angle lens system 10.

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2014-178623
(P2014-178623A)
(43)公開日　平成26年9月25日(2014.9.25)

(51)Int.Cl.		F I		テーマコード（参考）
G02B 13/00	(2006.01)	G02B	13/00	2H087
G02B 13/18	(2006.01)	G02B	13/18	

審査請求 未請求　請求項の数 7　OL　（全 31 頁）

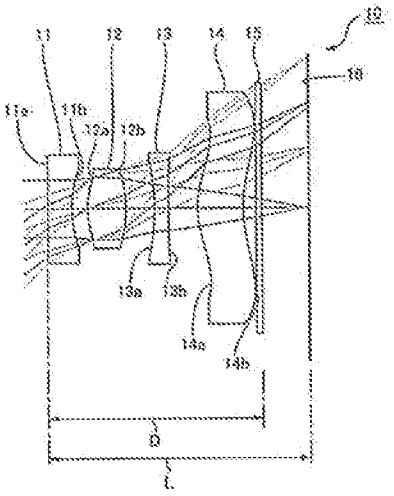
(21)出願番号　特願2013-53990(P2013-53990)
(22)出願日　平成25年3月15日(2013.3.15)

(71)出願人　000005810
日立マクセル株式会社
大阪府茨木市丑寅一丁目１番８８号
(74)代理人　100090170
弁理士　横沢　志郎
(74)代理人　100142619
弁理士　河合　徹
(74)代理人　100163316
弁理士　河口　伸子
(72)発明者　杉山　隆
大阪府茨木市丑寅一丁目１番８８号　日立マクセル株式会社内
(72)発明者　上岡原　隆
大阪府茨木市丑寅一丁目１番８８号　日立マクセル株式会社内

最終頁に続く

(54)【発明の名称】広角レンズおよび撮像装置

(57)【要約】
【課題】レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制できる広角レンズを提供すること。
【解決手段】広角レンズ１０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ１１、正のパワーを有する第２レンズ１２、負のパワーを有する第３レンズ１３、および正のパワーを有する第４レンズ１４からなる。第１レンズ１１に凹形状を備える負のパワーのレンズを配置し、第２レンズ１２に凸形状を備える正のパワーを有するレンズを配置したので、６５°以上の画角を備えるレンズ系の全長を５ｍｍ程度に抑えることができる。第４レンズ１４の像側レンズ面１４ｂは、変曲点を有しているので、広角レンズ１０からの射出光線の方向を制御できる。
【選択図】図１



【特許請求の範囲】
【請求項１】
物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ、正のパワーを有する第２レンズ、負のパワーを有する第３レンズおよび正のパワーを有する第４レンズからなり、
前記第１レンズの像側レンズ面は、凹形状を備え、
前記第２レンズの物体側レンズ面は、凸形状を備え、
前記第４レンズの像側レンズ面は、変曲点を備える非球面であり、光軸を含む中央部分が凹形状をしており、
前記第４レンズの像側レンズ面を含む少なくとも２つのレンズ面が非球面とされていることを特徴とする広角レンズ。
【請求項２】
請求項１において、
レンズ系全体の焦点距離をｆ、前記第２レンズの焦点距離をｆ２としたときに、以下の条件式（１）を満たすことを特徴とする広角レンズ。
０．４　≦　ｆ２／ｆ　≦　０．７　・・（１）
【請求項３】
請求項１または２において、
前記第３レンズの焦点距離をｆ３としたときに、以下の条件式（２）を満たすことを特徴とする広角レンズ。
－１　≦　ｆ２／ｆ３　≦　－０．２５　・・（２）
【請求項４】
請求項１ないし３のうちのいずれかの項において、
前記第１レンズの物体側レンズ面の物体側の端から第４レンズの像側レンズ面の像側の端までの距離をＤとしたときに、以下の条件式（３）を満たすことを特徴とする広角レンズ。
１．０　≦　Ｄ／ｆ　≦２．０　・・（３）
【請求項５】
請求項１ないし４のうちのいずれかの項において、
前記第１レンズの焦点距離をｆ１としたときに、以下の条件式（４）を満たすことを特徴とする広角レンズ。
－３０　≦　ｆ１／ｆ　≦　－０．５　・・（４）
【請求項６】
請求項１ないし５のうちのいずれかの項において、
画角が６５°以上であることを特徴とする広角レンズ。
【請求項７】
請求項１ないし６のうちのいずれかの項に記載の広角レンズと、
前記広角レンズの焦点位置に配置された撮像素子と、を有することを特徴とする撮像装置。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、４枚のレンズからなる小型の広角レンズおよび当該広角レンズを搭載する撮像装置に関する。
【背景技術】
【０００２】
携帯電話などの情報端末や小型のデジタルカメラに搭載される撮像レンズは特許文献１に記載されている。同文献の撮影レンズは物体側から像側に向かって順に配置された、正のパワーを備える第１レンズ、負のパワーを備える第２レンズ、正のパワーを備える第３レンズ、像側が凸のメニスカス形状の第４レンズ、および、像側レンズ面が変曲点を備え

る非球面形状とされた第５レンズを備えている。同文献の撮像レンズの最大画角は６０°である。

【先行技術文献】

【特許文献】

【０００３】

【特許文献１】特開２００９－１４９４７号公報

【発明の概要】

【発明が解決しようとする課題】

【０００４】

情報端末や小型のデジタルカメラなどの機器に搭載される撮像レンズにおいては、使い勝手を考慮して画角を広くする場合がある。すなわち、これらの小型の機器においては、標準画角の撮像レンズを、６０°以上の画角の広角レンズに置き換えることが要求される場合がある。

【０００５】

ここで、標準レンズを広角レンズに置き換えるためには、広角レンズのレンズ系の全長（第１レンズの物体側レンズ面の物体側の端から結像面までの距離）を短く抑え、広角レンズを標準レンズの配置スペースに設置可能としなければならない。また、これらの機器において、撮像レンズの焦点位置に配置される撮像素子には、そのセンサ面に斜めから入射する光に対して感度が低下する特性を有するものがあるので、センサ面（撮像レンズの結像面）に対する主光線入射角度を小さく抑制して、画質の劣化を抑制しなければならない。

【０００６】

さらに、情報端末や小型のデジタルカメラなどの機器に搭載される撮像レンズには、軽量化や製造コストの抑制が求められている。かかる要求に対応するためには、撮像レンズを構成しているレンズの枚数を減少させることが望ましい。

【０００７】

このような点に鑑みて、本発明の課題は、レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制できる４枚のレンズから構成された広角レンズを提供することにある。また、このような広角レンズを搭載する撮像装置を提供することにある。

【課題を解決するための手段】

【０００８】

上記課題を解決するために、本発明の広角レンズは、

物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ、正のパワーを有する第２レンズ、負のパワーを有する第３レンズおよび正のパワーを有する第４レンズからなり、

前記第１レンズの像側レンズ面は、凹形状を備え、

前記第２レンズの物体側レンズ面は、凸形状を備え、

前記第４レンズの像側レンズ面は、変曲点を備える非球面であり、光軸を含む中央部分が凹形状をしており、

前記第４レンズの像側レンズ面を含む少なくとも２つのレンズ面が非球面とされていることを特徴とする。

【０００９】

本発明によれば、第１レンズに凹形状を備える負のパワーのレンズを配置し、第２レンズに凸形状を備える正のパワーを有するレンズを配置したので、レンズ系の全長を抑えた広角レンズを構成できる。また、第４レンズの像側レンズ面を、変曲点を備える非球面としたので、広角レンズからの射出光線の方向を制御することが容易となり、結像面に入射する主光線入射角度を小さく抑制することができる。さらに、第４レンズの像側レンズ面を含む少なくとも２つのレンズ面が非球面とされているので、広角レンズを明るく構成することが容易である。これに加えて、４枚のレンズから広角レンズを構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容

易である。なお、広角レンズとは、一般的に、画角が６０°以上の撮像レンズをいう。主光線入射角度とは、結像面へ入射する光線と光軸が交差する角度である。

【００１０】

本発明において、レンズ系全体の焦点距離をｆ、前記第２レンズの焦点距離をｆ２としたときに、以下の条件式（１）を満たすことが望ましい。

０．４ ≦ ｆ２／ｆ ≦ ０．７ ・・（１）

【００１１】

条件式（１）はレンズ系の全長の抑制を容易にするものであり、条件式（１）の上限値を上回ると、レンズ系の全長の増大を招く。条件式（１）の下限値を下回ると、バックフォーカスを確保することが困難となる。

【００１２】

本発明において、前記第３レンズの焦点距離をｆ３としたときに、以下の条件式（２）を満たすことが望ましい。

－１ ≦ ｆ２／ｆ３ ≦ －０．２５ ・・（２）

【００１３】

条件式（２）は軸上の色収差を抑制するものである。すなわち、軸上の色収差は隣接配置した正のパワーを有する第２レンズ１２、負のパワーを有する第３レンズ１３によって抑制することが可能であるが、第２レンズのパワーと第３レンズのパワーのバランスによって、条件式（２）の上限値を上回ると色収差の補正が不足となり、条件式（２）の下限値を下回ると色収差に過剰補正が生じる。

【００１４】

本発明において、前記第１レンズの物体側レンズ面の物体側の端から第４レンズの像側レンズ面の像側の端までの距離（レンズ系のレンズ厚）をＤとしたときに、以下の条件式（３）を満たすことが望ましい。

１．０ ≦ Ｄ／ｆ ≦２．０ ・・（３）

【００１５】

条件式（３）はバックフォーカスを確保しながらレンズ系の全長を抑制することを容易にするものである。条件式（３）の上限値を上回るとバックフォーカスを確保することが困難となる。条件式（３）の下限値を下回ると、各レンズの間の距離が短くなり、各レンズの配置に無理が生じやすい。すなわち、各レンズの中心厚やコバ厚によって、各レンズの配置が困難となる場合が発生する。

【００１６】

本発明において、前記第１レンズの焦点距離をｆ１としたときに、以下の条件式（４）を満たすことが望ましい。

－３０ ≦ ｆ１／ｆ ≦ －０．５ ・・（４）

【００１７】

条件式（４）は画角の確保を容易にするものである。条件式（４）の上限値を上回ると第１レンズのパワーがレンズ系の中で大きくなりすぎて、全長の増大を招く。また、第１レンズのパワーがレンズ系の中で大きくなりすぎて、像面湾曲の補正が困難となる。条件式（２）の下限値を下回ると、第１レンズのパワーの低下により画角の確保が難しくなる。

【００１８】

本発明において、画角は６５°以上とすることができる。すなわち、標準レンズよりも広い画角を備えるものとすることができる。

【００１９】

次に、本発明の撮像装置は、上記の広角レンズと、前記広角レンズの焦点位置に配置された撮像素子とを有することを特徴とする。

【００２０】

本発明によれば、広角レンズのレンズ系の全長が短く抑えられている。従って、撮像装置を小さく構成できる。また、広角レンズが明るく、結像面に対する主光線入射角度が小

さく抑制されている。従って、撮像レンズの焦点位置に配置される撮像素子がそのセンサ面に斜めから入射する光に対して感度が低下する特性を有するものであっても、画質の劣化を抑制することができる。さらに、４枚のレンズから広角レンズを構成したので、５枚以上のレンズを備える撮像レンズを搭載する場合と比較して、撮像装置の軽量化や製造コストの抑制を図ることが容易である。

【発明の効果】

【００２１】

本発明によれば、レンズ系の全長を短く抑え、結像面に対する主光線入射角度を小さく抑制した明るい広角レンズを４枚のレンズから構成できる。

【図面の簡単な説明】

【００２２】

【図１】本発明を適用した実施例１の広角レンズの構成図である。

【図２】図１の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図３】本発明を適用した実施例２の広角レンズの構成図である。

【図４】図３の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図５】本発明を適用した実施例３の広角レンズの構成図である。

【図６】図５の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図７】本発明を適用した実施例４の広角レンズの構成図である。

【図８】図７の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図９】本発明を適用した実施例５の広角レンズの構成図である。

【図１０】図９の広角レンズの縦収差図、横収差図、像面湾曲図、歪曲収差図である。

【図１１】広角レンズを搭載する撮像装置の説明図である。

【発明を実施するための形態】

【００２３】

以下に図面を参照して、本発明を適用した広角レンズを説明する。

【００２４】

（実施例１）

図１は実施例１の広角レンズの光線図である。図１に示すように、広角レンズ１０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ１１、正のパワーを有する第２レンズ１２、負のパワーを有する第３レンズ１３、および正のパワーを有する第４レンズ１４からなる。第１レンズ１１と第２レンズ１２の間には絞り（不図示）が配置されている。第４レンズ１４の像側にはカバーガラス１５が配置されている。結像面１６はカバーガラス１５と間隔を開けた位置にある。

【００２５】

第１レンズ１１は、物体側レンズ面１１ａおよび像側レンズ面１１ｂのそれぞれが非球面とされている。物体側レンズ面１１ａは凸形状を備えており、像側レンズ面１１ｂは凹形状を備えている。物体側レンズ面１１ａは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【００２６】

第２レンズ１２は、物体側レンズ面１２ａおよび像側レンズ面１２ｂのそれぞれが非球面とされている。物体側レンズ面１２ａおよび像側レンズ面１２ｂは、それぞれ凸形状を備えている。

【００２７】

第３レンズ１３は、物体側レンズ面１３ａおよび像側レンズ面１３ｂのそれぞれが非球面とされている。物体側レンズ面１３ａおよび像側レンズ面１３ｂは、それぞれ凹形状を備えている。

【００２８】

第４レンズ１４は、物体側レンズ面１４ａおよび像側レンズ面１４ｂのそれぞれが非球面とされている。物体側レンズ面１４ａは光軸を含む中央部分に凸形状を備えている。像側レンズ面１４ｂは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。

従って、像側レンズ面１４ｂは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【００２９】

広角レンズ１０の開口数をＦｎｏ．、半画角をω、および、レンズ系の全長（第１レンズ１１の物体側レンズ面１１ａの物体側の端から結像面１６までの距離）をＬ、レンズ系のレンズ厚（第１レンズ１１の物体側レンズ面１１ａの物体側の端から第４レンズ１４の像側レンズ面１４ｂの像側の端までの距離）をＤとすると、これらの値は以下のとおりである。

Ｆｎｏ．＝２．８

ω＝８５．８°

Ｌ＝４．２８１ｍｍ

Ｄ＝３．２１２ｍｍ

【００３０】

また、全レンズ系の焦点距離をｆ、第１レンズ１１の焦点距離をｆ１、第２レンズ１２の焦点距離をｆ２、第３レンズ１３の焦点距離をｆ３、第４レンズ１４の焦点距離をｆ４とすると、これらの値は以下のとおりである。

ｆ＝２．５６４

ｆ１＝－３．３９０

ｆ２＝１．４９０

ｆ３＝－３．２４１

ｆ４＝４．５６１

【００３１】

ここで、本例の広角レンズ１０は、以下の条件式（１）～（４）を満たす。

０．４　≦　ｆ２／ｆ　≦　０．７　・・（１）

－１　≦　ｆ２／ｆ３＝　≦　－０．２５　・・（２）

１．０　≦　Ｄ／ｆ　≦２．０　・・（３）

－３０　≦　ｆ１／ｆ　≦　－０．５　・・（４）

【００３２】

すなわち、ｆ２／ｆ＝０．５８１であり、ｆ２／ｆ３＝－０．４６０であり、Ｄ／ｆ＝１．２５３であり、ｆ１／ｆ＝－１．３２２である。

【００３３】

広角レンズ１０は条件式（１）を満たすので、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。すなわち、条件式（１）の上限値を上回ると、全長の増大を招く。条件式（１）の下限値を下回ると、バックフォーカスを確保することが困難となる。

【００３４】

広角レンズ１０は条件式（２）を満たすので、軸上の色収差が抑制される。すなわち、軸上の色収差は隣接配置した正のパワーを有する第２レンズ１２、負のパワーを有する第３レンズ１３によって抑制することが可能となっているが、第２レンズ１２のパワーと第３レンズ１３のパワーのバランスによって、条件式（２）の上限値を上回ると色収差の補正が不足となり、条件式（２）の下限値を下回ると色収差に過剰補正が生じる。

【００３５】

広角レンズ１０は条件式（３）を満たすので、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。すなわち、条件式（３）の上限値を上回るとバックフォーカスを確保することが困難となる。条件式（３）の下限値を下回ると、各レンズの間の距離が短くなるので、各レンズの中心厚やコバ厚によって、各レンズの配置が困難となる場合が発生する。

【００３６】

広角レンズ１０は条件式（４）を満たすので、画角の確保が容易である。すなわち、条件式（４）の上限値を上回ると第１レンズ１１のパワーがレンズ系の中で大きくなりすぎ

て、レンズ系の全長の増大を招く。また、条件式（４）の上限値を上回ると第１レンズ１１のパワーがレンズ系の中で大きくなりすぎて、像面湾曲の補正が困難となる。一方、条件式（２）の下限値を下回ると、第１レンズ１１のパワーの低下により画角の確保が難しくなる。

【００３７】

また、広角レンズ１０は、以下の条件式（５）、（６）を満たす。

－１．４ ≦ ｆ３／ｆ ≦－０．６ ・・（５）

１．３ ≦ Ｌ／ｆ ≦２．５ ・・（６）

【００３８】

すなわち、ｆ３／ｆ＝－１．２６４であり、Ｌ／ｆ＝１．６７０である。

【００３９】

広角レンズ１０は条件式（５）を満たすので、色収差を良好に補正できる。すなわち、条件式（５）の上限値を上回ると色収差の補正が過剰となり、下限値を下回ると色収差の補正に不足が生じる。

【００４０】

さらに、広角レンズ１０は条件式（６）を満たすので、バックフォーカスを確保しながらレンズ系の全長を抑制することがより容易となる。すなわち、条件式（６）の上限値を上回るとバックフォーカスを確保することが困難となる。条件式（６）の下限値を下回ると、各レンズの間の距離が短くなるので、各レンズの中心厚やコバ厚によって、各レンズの配置が困難となる場合が発生する。

【００４１】

以下の表１Ａは広角レンズ１０の各レンズ面のレンズデータを示す。表１Ａでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、９面および１０面はカバーガラス１５のガラス面であり、１１面は結像面１６である。曲率半径および間隔の単位はミリメートルである。

【００４２】

【表１Ａ】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	18.988	0.400	1.53116	56.0	樹脂
2	1.639	0.259			
3	1.306	0.627	1.53116	56.0	樹脂
4	-1.693	0.477			
5	-2.153	0.226	1.63494	24.0	樹脂
6	61.884	0.479			
7	1.220	0.744	1.53116	56.0	樹脂
8	1.929	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.781			
11	infinity	-0.022			

【００４３】

次に、表１Ｂ、表１Ｃは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表１Ｂ、表１Ｃにおいても物体側から数えた順番で各レンズ面を特定している。

【表１８】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	1.96845E+00	-3.24341E+00	0.00000E+00	-4.91958E+01	3.84487E+03
A4	-6.70903E-02	-1.23090E-01	1.05137E-01	2.08266E-01	-4.45527E-02	2.10240E-02
A6	1.43040E-02	1.93268E-01	2.60961E-01	-7.07806E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-5.44654E-01	1.00543E+00	-1.05324E-01	5.55869E-02
A10	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表１Ｃ】

	第7面	第8面
K	-5.35406E+00	0.00000E+00
A4	-6.29015E-02	-1.28252E-01
A6	-2.28756E-03	3.60116E-02
A8	-6.15992E-03	-3.97193E-02
A10	3.30573E-04	3.02394E-02
A12	7.78451E-03	-1.38145E-02
A14	-4.09359E-03	3.33327E-03
A16	4.32061E-04	-3.35E-04

【００４４】

なお、レンズ面に採用する非球面形状は、Ｙをサグ量、ｃを曲率半径の逆数、Ｋを円錐係数、ｈを光線高さ、４次、６次、８次、１０次、１２次、１４次、１６次の非球面係数をそれぞれＡ４、Ａ６、Ａ８、Ａ１０、Ａ１２、Ａ１４、Ａ１６とすると、次式により表わされる。

【００４５】

【数１】

$$Y(h)=\frac{ch^2}{1+\sqrt{1-(K+1)c^2h^2}}+A_4h^4+A_6h^6+A_8h^8+A_{10}h^{10}+A_{12}h^{12}+A_{14}h^{14}+A_{16}h^{16}$$

【００４６】

（作用効果）

図２（ａ）～（ｄ）は広角レンズ１０の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図２（ａ）の縦収差図では、横軸は光線が光軸Ｌと交わる位置を示し、縦軸は光線がレンズ系に入射する高さを示している。図２（ｂ）の横収差図では横軸は入射瞳座標を示し、縦軸は収差量を示す。図２（ａ）、（ｂ）では、波長の異なる複数の可視光線についてのシミュレーション結果を示してある。図２（ｃ）の像面湾曲図では横軸は光軸方向の距離を示し、縦軸は像の高さを示す。図２（ｃ）において、Ｓはサジタル面における像面湾曲収差を示し、Ｔはタンジェンシャル面における像面湾曲収差を示す。図２（ｄ）の歪曲収差図では横軸は像の歪み量を示し、縦軸は像の高さを示す。

【００４７】

図２（ａ）に示すように、広角レンズ１０によれば、軸上の色収差が良好に補正されている。また、図２（ｂ）に示すように、色の滲みが抑制される。さらに、図２（ｃ）、（ｄ）に示すように、像面湾曲が良好に補正されている。従って、広角レンズ１０が高解像度となる。

【００４８】

また、広角レンズ１０では、第１レンズ１１に凹形状を備える負のパワーのレンズを配置し、第２レンズ１２に凸形状を備える正のパワーを有するレンズを配置したので、６５°以上の画角を備えるレンズ系の全長を４．３ｍｍ以下に抑えることができる。さらに、第４レンズ１４の像側レンズ面１４ｂを、変曲点を備える非球面としたので、広角レンズ

１０からの射出光線の方向を制御することが容易となり、結像面１６に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ１０が明るく構成される。さらに、４枚のレンズから広角レンズ１０を構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【００４９】

（実施例２）

図３は実施例２の広角レンズの光線図である。図３に示すように、広角レンズ２０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ２１、正のパワーを有する第２レンズ２２、負のパワーを有する第３レンズ２３、および正のパワーを有する第４レンズ２４からなる。第１レンズ２１と第２レンズ２２の間には絞り（不図示）が配置されている。第４レンズ２４の像側にはカバーガラス２５が配置されている。結像面２６はカバーガラス２５と間隔を開けた位置にある。

【００５０】

第１レンズ２１は、物体側レンズ面２１ａおよび像側レンズ面２１ｂのそれぞれが非球面とされている。物体側レンズ面２１ａは凸形状を備えており、像側レンズ面２１ｂは凹形状を備えている。物体側レンズ面２１ａは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【００５１】

第２レンズ２２は、物体側レンズ面２２ａおよび像側レンズ面２２ｂのそれぞれが非球面とされている。物体側レンズ面２２ａおよび像側レンズ面２２ｂは、それぞれ凸形状を備えている。

【００５２】

第３レンズ２３は、物体側レンズ面２３ａおよび像側レンズ面２３ｂのそれぞれが非球面とされている。物体側レンズ面２３ａおよび像側レンズ面２３ｂは、それぞれ凹形状を備えている。

【００５３】

第４レンズ２４は、物体側レンズ面２４ａおよび像側レンズ面２４ｂのそれぞれが非球面とされている。物体側レンズ面２４ａは光軸を含む中央部分に凸形状を備えている。像側レンズ面２４ｂは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面２４ｂは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【００５４】

広角レンズ２０の開口数をＦｎｏ、、半画角をω、および、レンズ系の全長（第１レンズ２１の物体側レンズ面２１ａの物体側の端から結像面２６までの距離）をＬ、レンズ系のレンズ厚（第１レンズ２１の物体側レンズ面２１ａの物体側の端から第４レンズ２４の像側レンズ面２４ｂの像側の端までの距離）をＤとすると、これらの値は以下のとおりである。

Ｆｎｏ．＝２．８

ω＝８５．８°

Ｌ＝４．９８３ｍｍ

Ｄ＝３．９３５ｍｍ

【００５５】

また、全レンズ系の焦点距離をｆ、第１レンズ２１の焦点距離をｆ１、第２レンズ２２の焦点距離をｆ２、第３レンズ２３の焦点距離をｆ３、第４レンズ２４の焦点距離をｆ４とすると、これらの値は以下のとおりである。

ｆ＝２．５６３

ｆ１＝－６．９７２

ｆ２＝１．５２９

ｆ３＝－２．４７９

ｆ４＝７．８９０

【００５６】

ここで、本例の広角レンズ２０は、以下の条件式（１）～（４）を満たす。

０．４≦　ｆ２／ｆ＝０．５９６　≦０．７　・・（１）

－１≦　ｆ２／ｆ３＝－０．６１７　≦－０．２５　・・（２）

１．０≦　Ｄ／ｆ＝１．５３５　≦２．０　・・（３）

－３０≦　ｆ１／ｆ＝－２．７２０　≦－０．５　・・（４）

【００５７】

広角レンズ２０は、条件式（１）～（４）を満たすので、６５°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【００５８】

また、広角レンズ２０は、以下の条件式（５）、（６）を満たす。

－１．４≦　ｆ３／ｆ＝－０．９６７　≦－０．６　・・（５）

１．３≦　Ｌ／ｆ＝１．９４４　≦２．５　・・（６）

【００５９】

広角レンズ２０は条件式（５）、（６）を満たすので、色収差を良好に補正できる。また、結像面２６に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。

【００６０】

以下の表２Ａは広角レンズ２０の各レンズ面のレンズデータを示す。表２Ａでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、９面および１０面はカバーガラス２５のガラス面であり、１１面は結像面２６である。曲率半径および間隔の単位はミリメートルである。

【００６１】

【表２Ａ】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	18.988	0.400	1.53116	56.0	樹脂
2	3.087	1.067			
3	1.218	0.529	1.53116	56.0	樹脂
4	-2.093	0.215			
5	-2.030	0.383	1.63494	24.0	樹脂
6	7.868	0.601			
7	1.498	0.739	1.53116	56.0	樹脂
8	1.928	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.762			
11	infinity	-0.024			

【００６２】

次に、表２Ｂ、表２Ｃは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表２Ｂ、表２Ｃにおいても物体側から数えた順番で各レンズ面を特定している。

【表２Ｂ】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	3.85318E+00	-2.99208E+00	2.54698E+00	-4.46502E+01	0.00000E+00
A4	5.78055E-03	5.21124E-03	7.81867E-02	1.02266E-01	-7.96020E-02	2.09047E-01
A6	-1.09778E-02	-4.44309E-02	3.32598E-02	-5.30663E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-7.00411E-01	6.21259E-01	-2.22084E-01	8.71866E-02
A10	0.00000E+00	0.00000E+00	-3.91407E-01	-1.87758E+00	-3.06686E-01	-8.16509E-02
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表２Ｃ】

	第7面	第8面
K	-5.38920E+00	0.00000E+00
A4	-1.11271E-01	-1.63845E-01
A6	3.08045E-02	4.93248E-02
A8	-3.76929E-03	-3.99351E-02
A10	-3.21886E-03	3.00214E-02
A12	5.97323E-03	-1.39517E-02
A14	-4.16558E-03	3.30562E-03
A16	9.01603E-04	-3.20E-04

【００６３】

（作用効果）

図４（ａ）～（ｄ）は広角レンズ２０の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図４（ａ）に示すように、広角レンズ２０によれば、軸上の色収差が良好に補正されている。また、図４（ｂ）に示すように、色の滲みが抑制される。さらに、図４（ｃ）、（ｄ）に示すように、像面湾曲が良好に補正されている。従って、広角レンズ２０が高解像度となる。

【００６４】

また、広角レンズ２０では、第１レンズ２１に凹形状を備える負のパワーのレンズを配置し、第２レンズ２２に凸形状を備える正のパワーを有するレンズを配置したので、６５°以上の画角を備えるレンズ系の全長を５ｍｍ以下に抑えることができる。さらに、第４レンズ２４の像側レンズ面２４ｂを、変曲点を備える非球面としたので、広角レンズ２０からの射出光線の方向を制御することが容易となり、結像面２６に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ２０が明るく構成される。さらに、４枚のレンズから広角レンズを構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【００６５】

（実施例３）

図５は実施例３の広角レンズの光線図である。図５に示すように、広角レンズ３０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ３１、正のパワーを有する第２レンズ３２、負のパワーを有する第３レンズ３３、および正のパワーを有する第４レンズ３４からなる。第１レンズ３１と第２レンズ３２の間には絞り（不図示）が配置されている。第４レンズ３４の像側にはカバーガラス３５が配置されている。結像面３６はカバーガラス３５と間隔を開けた位置にある。

【００６６】

第１レンズ３１は、物体側レンズ面３１ａおよび像側レンズ面３１ｂのそれぞれが非球面とされている。物体側レンズ面３１ａは凸形状を備えており、像側レンズ面３１ｂは凹形状を備えている。物体側レンズ面３１ａは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【００６７】
第２レンズ３２は、物体側レンズ面３２ａおよび像側レンズ面３２ｂのそれぞれが非球面とされている。物体側レンズ面３２ａおよび像側レンズ面３２ｂは、それぞれ凸形状を備えている。
【００６８】
第３レンズ３３は、物体側レンズ面３３ａおよび像側レンズ面３３ｂのそれぞれが非球面とされている。物体側レンズ面３３ａは凹形状を備えており、像側レンズ面３３ｂは凸形状を備えている。
【００６９】
第４レンズ３４は、物体側レンズ面３４ａおよび像側レンズ面３４ｂのそれぞれが非球面とされている。物体側レンズ面３４ａは光軸を含む中央部分に凸形状を備えている。像側レンズ面３４ｂは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面３４ｂは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。
【００７０】
広角レンズ３０の開口数をＦｎｏ．、半画角をω、および、レンズ系の全長（第１レンズ３１の物体側レンズ面３１ａの物体側の端から結像面３６までの距離）をＬ、レンズ系のレンズ厚（第１レンズ３１の物体側レンズ面３１ａの物体側の端から第４レンズ３４の像側レンズ面３４ｂの像側の端までの距離）をＤとすると、これらの値は以下のとおりである。
Ｆｎｏ．＝２．８
ω＝８５．８°
Ｌ＝３．８３８ｍｍ
Ｄ＝２．７８３ｍｍ
【００７１】
また、全レンズ系の焦点距離をｆ、第１レンズ３１の焦点距離をｆ１、第２レンズ３２の焦点距離をｆ２、第３レンズ３３の焦点距離をｆ３、第４レンズ３４の焦点距離をｆ４とすると、これらの値は以下のとおりである。
ｆ＝２．５６３
ｆ１＝－４．８２４
ｆ２＝１．３４０
ｆ３＝－２．２５９
ｆ４＝４．１９０
【００７２】
ここで、本例の広角レンズ３０は、以下の条件式（１）～（４）を満たす。
０．４≦　ｆ２／ｆ＝０．５２３　≦０．７　・・（１）
－１≦　ｆ２／ｆ３＝－０．５９３　≦－０．２５　・・（２）
１．０≦　Ｄ／ｆ＝１．０８６　≦２．０　・・（３）
－３０≦　ｆ１／ｆ＝－１．８８２　≦－０．５　・・（４）
【００７３】
広角レンズ３０は、条件式（１）～（４）を満たすので、６５°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。
【００７４】
また、広角レンズ３０は、以下の条件式（５）、（６）を満たす。
－１．４≦　ｆ３／ｆ＝－０．８８１　≦－０．６　・・（５）
１．３≦　Ｌ／ｆ＝１．４９８　≦２．５　・・（６）
【００７５】
広角レンズ３０は条件式（５），（６）を満たすので，色収差を良好に補正できる。また、結像面３６に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを

確保しながらレンズ系の全長を抑制することが容易である。

【００７６】

以下の表３Ａは広角レンズ３０の各レンズ面のレンズデータを示す。表３Ａでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、９面および１０面はカバーガラス３５のガラス面であり、１１面は結像面３６である。曲率半径および間隔の単位はミリメートルである。

【００７７】

【表３Ａ】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	2.527	0.068			
3	0.974	0.479	1.53116	56.0	樹脂
4	-2.225	0.289			
5	-0.678	0.322	1.63494	24.0	樹脂
6	-1.512	0.301			
7	1.218	0.923	1.53116	56.0	樹脂
8	1.971	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.773			
11	infinity	-0.028			

【００７８】

次に、表３Ｂ、表３Ｃは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表３Ｂ、表３Ｃにおいても物体側から数えた順番で各レンズ面を特定している。

【表３Ｂ】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	3.50577E+00	-3.83881E+00	5.33536E+00	-4.54098E+00	0.00000E+00
A4	-1.74521E-02	-3.32642E-01	5.90588E-02	8.27775E-02	-4.37925E-01	1.43565E-01
A6	-1.70578E-01	-1.70011E-01	8.54668E-02	-2.36439E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	0.00000E+00	-5.37071E-01	-1.38356E+00	1.01642E+00	6.87456E-01
A10	0.00000E+00	0.00000E+00	-3.10124E+00	9.66727E-01	1.18549E+00	-1.66451E-01
A12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表３Ｃ】

	第7面	第8面
K	-7.24393E+00	0.00000E+00
A4	-1.40591E-01	-1.60657E-01
A6	4.71227E-02	6.52796E-02
A8	-5.32562E-03	-4.48510E-02
A10	-5.36876E-03	2.97256E-02
A12	5.96681E-03	-1.34959E-02
A14	-4.45794E-03	3.25636E-03
A16	1.08896E-03	-3.23E-04

【００７９】

（作用効果）

図６（ａ）～（ｄ）は広角レンズ３０の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図６（ａ）に示すように、広角レンズ３０によれば、軸上の色収差が良好に補正されている。また、図６（ｂ）に示すように、色の滲みが抑制される。さらに、図６（ｃ）、（ｄ）に示すように、像面湾曲が良好に補正されている。従って、広角レンズ３０が

高解像度となる。

【００８０】

また、広角レンズ３０では、第１レンズ３１に凹形状を備える負のパワーのレンズを配置し、第２レンズ３２に凸形状を備える正のパワーを有するレンズを配置したので、８５°以上の画角を備えるレンズ系の全長を４ｍｍ以下に抑えることができる。さらに、第４レンズ３４の像側レンズ面３４ｂを、変曲点を備える非球面としたので、広角レンズ３０からの射出光線の方向を制御することが容易となり、結像面３６に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ３０が明るく構成される。さらに、４枚のレンズから広角レンズ１０を構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【００８１】

（実施例４）

図７は実施例４の広角レンズの光線図である。図７に示すように、広角レンズ４０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ４１、正のパワーを有する第２レンズ４２、負のパワーを有する第３レンズ４３、および正のパワーを有する第４レンズ４４からなる。第１レンズ４１と第２レンズ４２の間には絞り（不図示）が配置されている。第４レンズ４４の像側にはカバーガラス４５が配置されている。結像面４６はカバーガラス４５と間隔を開けた位置にある。

【００８２】

第１レンズ４１は、物体側レンズ面４１ａおよび像側レンズ面４１ｂのそれぞれが非球面とされている。物体側レンズ面４１ａは凸形状を備えており、像側レンズ面４１ｂは凹形状を備えている。物体側レンズ面４１ａは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【００８３】

第２レンズ４２は、物体側レンズ面４２ａおよび像側レンズ面４２ｂのそれぞれが非球面とされている。物体側レンズ面４２ａおよび像側レンズ面４２ｂは、それぞれ凸形状を備えている。

【００８４】

第３レンズ４３は、物体側レンズ面４３ａおよび像側レンズ面４３ｂのそれぞれが非球面とされている。物体側レンズ面４３ａは凹形状を備えており、像側レンズ面４３ｂは凸形状を備えている。

【００８５】

第４レンズ４４は、物体側レンズ面４４ａおよび像側レンズ面４４ｂのそれぞれが非球面とされている。物体側レンズ面４４ａは光軸を含む中央部分に凸形状を備えている。像側レンズ面４４ｂは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面４４ｂは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。

【００８６】

広角レンズ４０の開口数をＦｎｏ．、半画角をω、および、レンズ系の全長（第１レンズ４１の物体側レンズ面４１ａの物体側の端から結像面４６までの距離）をＬ、レンズ系のレンズ厚（第１レンズ４１の物体側レンズ面４１ａの物体側の端から第４レンズ４４の像側レンズ面４４ｂの像側の端までの距離）をＤとすると、これらの値は以下のとおりである。

Ｆｎｏ．＝２．８

ω＝８５．８°

Ｌ＝３．９３２ｍｍ

Ｄ＝２．８９５ｍｍ

【００８７】

また、全レンズ系の焦点距離をｆ、第１レンズ４１の焦点距離をｆ１、第２レンズ４２

の焦点距離をｆ２、第３レンズ４３の焦点距離をｆ３、第４レンズ４４の焦点距離をｆ４とすると、これらの値は以下のとおりである。

ｆ＝２．５６３
ｆ１＝－１４．４５６
ｆ２＝１．５９５
ｆ３＝－２．０３２
ｆ４＝３．６０７

【００８８】

ここで、本例の広角レンズ４０は、以下の条件式（１）～（４）を満たす。

０．４≦　ｆ２／ｆ＝０．６２２　≦０．７　・・（１）
－１≦　ｆ２／ｆ３＝－０．７８５　≦－０．２５　・・（２）
１．０≦　Ｄ／ｆ＝１．１２９　≦２．０　・・（３）
－３０≦　ｆ１／ｆ＝－５．６４０　≦－０．５　・・（４）

【００８９】

広角レンズ４０は、条件式（１）～（４）を満たすので、６５°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。

【００９０】

また、広角レンズ４０は、以下の条件式（５）、（６）を満たす。

－１．４≦　ｆ３／ｆ＝－０．７９３　≦－０．６　・・（５）
１．３≦　Ｌ／ｆ＝１．５３４　≦２．５　・・（６）

【００９１】

広角レンズ４０は条件式（５）、（６）を満たすので、色収差を良好に補正できる。また、結像面４６に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを確保しながらレンズ系の全長を抑制することが容易である。

【００９２】

以下の表４Ａは広角レンズ４０の各レンズ面のレンズデータを示す。表４Ａでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、９面および１０面はカバーガラス４５のガラス面であり、１１面は結像面４６である。曲率半径および間隔の単位はミリメートルである。

【００９３】

【表４Ａ】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	7.327	0.099			
3	1.413	0.556	1.53116	56.0	樹脂
4	-1.846	0.338			
5	-0.578	0.361	1.63494	24.0	樹脂
6	-1.285	0.146			
7	1.147	0.995	1.53116	56.0	樹脂
8	1.985	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.753			
11	infinity	-0.026			

【００９４】

次に、表４Ｂ、表４Ｃは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表４Ｂ、表４Ｃにおいても物体側から数えた順番で各レンズ面を特定している。

【表４Ｂ】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	9.96692E+01	-4.55267E+00	5.20287E+00	-3.51020E+00	0.00000E+00
A4	-2.50523E-03	-3.83857E-02	3.83770E-02	-1.33640E-01	-5.16180E-01	1.22505E-01
A6	-8.07761E-02	-6.22535E-02	-1.17843E-01	7.52591E-02	0.00000E+00	0.00000E+00
A8	0.00000E+00	-3.63324E-01	-7.96090E-01	-1.60850E+00	8.70251E-01	6.90508E-01
A10	0.00000E+00	0.00000E+00	-4.16550E+00	5.85779E-01	8.59858E-01	-3.11595E-01
A12	0.00000E+00	0.00000E+00	8.20707E+00	1.85436E+00	-3.35126E-01	-4.39279E-02
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表４Ｃ】

	第7面	第8面
K	-8.11925E+00	0.00000E+00
A4	-1.95885E-01	-1.93101E-01
A6	1.03146E-01	7.12000E-02
A8	-3.61144E-02	-4.41820E-02
A10	2.64718E-03	2.85423E-02
A12	6.32241E-03	-1.35319E-02
A14	-6.95948E-03	3.43603E-03
A16	1.89193E-03	-3.56E-04

【００９５】

（作用効果）

図８（ａ）～（ｄ）は広角レンズ４０の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図８（ａ）に示すように、広角レンズ４０によれば、軸上の色収差が良好に補正されている。また、図８（ｂ）に示すように、色の滲みが抑制される。さらに、図８（ｃ）、（ｄ）に示すように、像面湾曲が良好に補正されている。従って、広角レンズ４０が高解像度となる。

【００９６】

また、広角レンズ４０では、第１レンズ４１に凹形状を備える負のパワーのレンズを配置し、第２レンズ４２に凸形状を備える正のパワーを有するレンズを配置したので、６５°以上の画角を備えるレンズ系の全長を４．０ｍｍ以下に抑えることができる。さらに、第４レンズ４４の像側レンズ面４４ｂを、変曲点を備える非球面としたので、広角レンズ４０からの射出光線の方向を制御することが容易となり、結像面４６に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ４０が明るく構成される。さらに、４枚のレンズから広角レンズを構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【００９７】

（実施例５）

図９は実施例５の広角レンズの光線図である。図９に示すように、広角レンズ５０は、物体側から像側に向かって順に配置された、負のパワーを有する第１レンズ５１、正のパワーを有する第２レンズ５２、負のパワーを有する第３レンズ５３、および正のパワーを有する第４レンズ５４からなる。第１レンズ５１と第２レンズ５２の間には絞り（不図示）が配置されている。第４レンズ５４の像側にはカバーガラス５５が配置されている。結像面５６はカバーガラス５５と間隔を開けた位置にある。

【００９８】

第１レンズ５１は、物体側レンズ面５１ａおよび像側レンズ面５１ｂのそれぞれが非球面とされている。物体側レンズ面５１ａは凸形状を備えており、像側レンズ面５１ｂは凹形状を備えている。物体側レンズ面５１ａは、凸形状をしているレンズ面部分の曲率半径が大きく、平面形状に近い。

【００９９】
第２レンズ５２は、物体側レンズ面５２ａおよび像側レンズ面５２ｂのそれぞれが非球面とされている。物体側レンズ面５２ａおよび像側レンズ面５２ｂは、それぞれ凸形状を備えている。
【０１００】
第３レンズ５３は、物体側レンズ面５３ａおよび像側レンズ面５３ｂのそれぞれが非球面とされている。物体側レンズ面５３ａは凹形状を備えており、像側レンズ面５３ｂは凸形状を備えている。
【０１０１】
第４レンズ５４は、物体側レンズ面５４ａおよび像側レンズ面５４ｂのそれぞれが非球面とされている。物体側レンズ面５４ａは光軸を含む中央部分に凸形状を備えている。像側レンズ面５４ｂは、変曲点を有しており、光軸を含む中央部分に凹形状を備えている。従って、像側レンズ面５４ｂは変曲点から内周側に向かって物体側に湾曲しており、変曲点から外周側に向かって物体側に湾曲している。
【０１０２】
広角レンズ５０の開口数をＦｎｏ、、半画角をω、および、レンズ系の全長（第１レンズ５１の物体側レンズ面５１ａの物体側の端から結像面５６までの距離）をＬ、レンズ系のレンズ厚（第１レンズ５１の物体側レンズ面５１ａの物体側の端から第４レンズ５４の像側レンズ面５４ｂの像側の端までの距離）をＤとすると、これらの値は以下のとおりである。
Ｆｎｏ．＝２．８
ω＝８５．７°
Ｌ＝４．１０７ｍｍ
Ｄ＝３．０３１ｍｍ
【０１０３】
また、全レンズ系の焦点距離をｆ、第１レンズ５１の焦点距離をｆ１、第２レンズ５２の焦点距離をｆ２、第３レンズ５３の焦点距離をｆ３、第４レンズ５４の焦点距離をｆ４とすると、これらの値は以下のとおりである。
ｆ＝２．５６３
ｆ１＝－６２．５８０
ｆ２＝１．７１５
ｆ３＝－１．８３２
ｆ４＝３．０９１
【０１０４】
ここで、本例の広角レンズ５０は、以下の条件式（１）～（４）を満たす。
０．４≦　ｆ２／ｆ＝０．６６９　≦０．７　・・（１）
－１≦　ｆ２／ｆ３＝－０．９３６　≦－０．２５　・・（２）
１．０≦　Ｄ／ｆ＝１．１８２　≦２．０　・・（３）
－３０≦　ｆ１／ｆ＝－２４．４１７　≦－０．５　・・（４）
【０１０５】
広角レンズ５０は、条件式（１）～（４）を満たすので、６５°以上の画角を確保しながら、レンズ系の全長を抑制し、バックフォーカスを確保することが容易である。また、軸上の色収差を抑制することができる。
【０１０６】
また、広角レンズ５０は、以下の条件式（５）、（６）を満たす。
－１．４≦　ｆ３／ｆ＝－０．７１５　≦－０．６　・・（５）
１．３≦　Ｌ／ｆ＝１．６０２　≦２．５　・・（６）
【０１０７】
広角レンズ５０は条件式（５）、（６）を満たすので、色収差を良好に補正できる。また、結像面５６に入射する主光線入射角度を小さくできる。さらに、バックフォーカスを

確保しながらレンズ系の全長を抑制することが容易である。

【０１０８】

以下の表５Ａは広角レンズ５０の各レンズ面のレンズデータを示す。表５Ａでは物体側から数えた順番で各レンズ面を特定している。本例では、各レンズの全てのレンズ面が非球面である。なお、９面および１０面はカバーガラス５５のガラス面であり、１１面は結像面５６である。曲率半径および間隔の単位はミリメートルである。

【０１０９】

【表５Ａ】

面番	曲率半径	間隔	Nd(屈折率)	Vd(アッベ数)	材料
1	150.000	0.400	1.53116	56.0	樹脂
2	27.279	0.298			
3	1.796	0.549	1.53116	56.0	樹脂
4	-1.667	0.352			
5	-0.536	0.331	1.63494	24.0	樹脂
6	-1.225	0.109			
7	1.053	0.992	1.53116	56.0	樹脂
8	1.960	0.210			
9	infinity	0.100	1.51680	64.2	光学ガラス
10	infinity	0.791			
11	infinity	-0.025			

【０１１０】

次に、表５Ｂ、表５Ｃは非球面とされたレンズ面の非球面形状を規定するための非球面係数を示す。表５Ｂ、表５Ｃにおいても物体側から数えた順番で各レンズ面を特定している。

【表５Ｂ】

	第1面	第2面	第3面	第4面	第5面	第6面
K	0.00000E+00	1.68169E+03	-7.82206E-01	4.95063E+00	-3.52793E+00	0.00000E+00
A4	1.35856E-01	4.80109E-01	1.56539E-01	-1.62437E-01	-7.43230E-01	1.06681E-01
A6	-2.24346E-02	-6.34433E-01	-2.72463E-02	4.51584E-01	0.00000E+00	0.00000E+00
A8	0.00000E+00	1.41506E+00	-7.42170E-01	-1.63061E+00	9.47084E-01	7.11233E-01
A10	0.00000E+00	0.00000E+00	-3.96390E+00	-7.77874E-02	7.17913E-01	-3.14780E-01
A12	0.00000E+00	0.00000E+00	7.84072E+00	2.79289E+00	-3.48348E+00	-6.16063E-02
A14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
A16	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

【表５Ｃ】

	第7面	第8面
K	-6.73455E+00	0.00000E+00
A4	-1.65191E-01	-1.96948E-01
A6	9.59854E-02	7.50201E-02
A8	-3.21706E-02	-4.53006E-02
A10	2.48962E-03	2.82001E-02
A12	6.31466E-03	-1.34263E-02
A14	-7.56292E-03	3.48357E-03
A16	2.27749E-03	-3.70E-04

【０１１１】

（作用効果）

図１０（ａ）～（ｄ）は広角レンズ５０の縦収差図、横収差図、像面湾曲図、歪曲収差図である。図１０（ａ）に示すように、広角レンズ５０によれば、軸上の色収差が良好に補正されている。また、図１０（ｂ）に示すように、色の滲みが抑制される。さらに、図１０（ｃ）、（ｄ）に示すように、像面湾曲が良好に補正されている。従って、広角レン

ズ５０が高解像度となる。

【０１１２】

また、広角レンズ５０では、第１レンズ５１に凹形状を備える負のパワーのレンズを配置し、第２レンズ５２に凸形状を備える正のパワーを有するレンズを配置したので、６５°以上の画角を備えるレンズ系の全長を４．１ｍｍ程度に抑えることができる。さらに、第４レンズ５４の像側レンズ面５４ｂを、変曲点を備える非球面としたので、広角レンズ５０からの射出光線の方向を制御することが容易となり、結像面５６に入射する主光線入射角度を小さく抑制することができる。また、本例では、各レンズのレンズ面を非球面としたので、広角レンズ５０が明るく構成される。さらに、４枚のレンズから広角レンズを構成したので、５枚以上のレンズを備える撮像レンズと比較して、軽量化や製造コストの抑制を図ることが容易である。

【０１１３】

（撮像装置）

図１１は本発明の広角レンズ１０を搭載する撮像装置１００の説明図である。図１１に示すように、撮像装置１００は広角レンズ１０の結像面１６（焦点位置）にセンサ面１０１ａを配置した撮像素子１０１を備えるものである。撮像素子１０１は、ＣＣＤセンサ或いはＣＭＯＳセンサである。

【０１１４】

本例によれば、広角レンズ１０のレンズ系の全長Ｌが短いので、撮像装置１００を小型化することができる。さらに、広角レンズ１０から撮像素子１０１に入射する主光線入射角度が小さく抑えられるので、撮像装置１００における画質の劣化を抑制できる。すなわち、これらの撮像素子１０１ではセンサ面１０１ａに斜めから入射する光に対して感度が低下する特性を有するので、主光線入射角度が大きくなると画質の劣化を招いてしまうが、本例の広角レンズ１０によれば結像面に対する主光線入射角度を小さくすることができるので、センサ面への光線の入射角度に起因する画質の劣化を抑制できる。また、広角レンズ１０の解像度が高いので、撮像素子１０１として画素数の多い撮像素子１０１を採用することにより、撮像装置１００を高解像度のものとすることができる。なお、撮像装置１００には、広角レンズ２０～５０を広角レンズ１０と同様に搭載することができ、この場合にも同様の効果を得ることができる。

【０１１５】

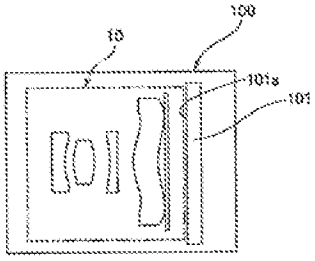
なお、上記の例では、全てのレンズ面が非球面とされているが、第４レンズの像側レンズ面を含む少なくとも２つのレンズ面を非球面とすれば、広角レンズを明るく構成することが容易となる。

【符号の説明】

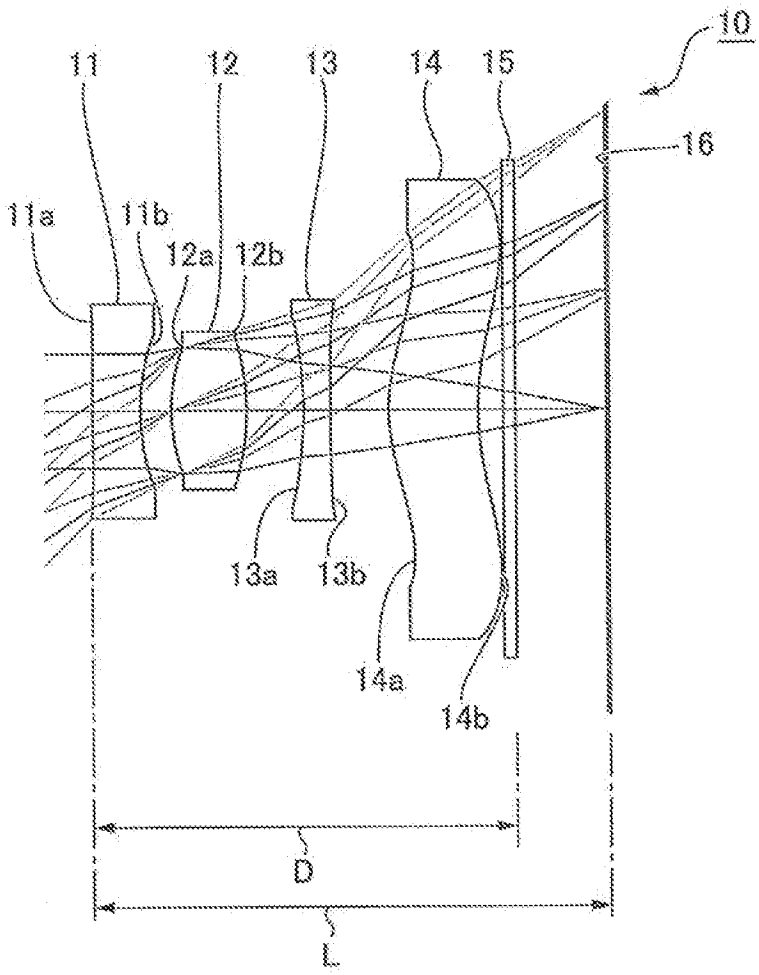
【０１１６】

１０・２０・３０・４０・５０・・・広角レンズ
１１・２１・３１・４１・５１・・・第１レンズ
１２・２２・３２・４２・５２・・・第２レンズ
１３・２３・３３・４３・５３・・・第３レンズ
１４・２４・３４・４４・５４・・・第４レンズ
１４ｂ・２４ｂ・３４ｂ・４４ｂ・５４ｂ・・・第４レンズの物体側レンズ面
１５・２５・３５・４５・５５・・・カバーガラス
１６・２６・３６・４６・５６・・・結像面
１００・・・撮像装置
１０１・・・撮像素子
１０１ａ・・・撮像素子のセンサ面
Ｄ・・・レンズ系のレンズ厚
Ｌ・・・レンズ系の全長

【図１１】

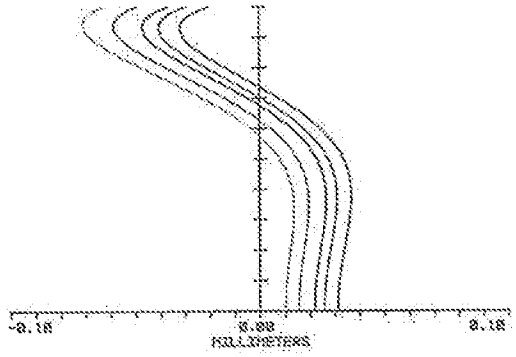


【図１】

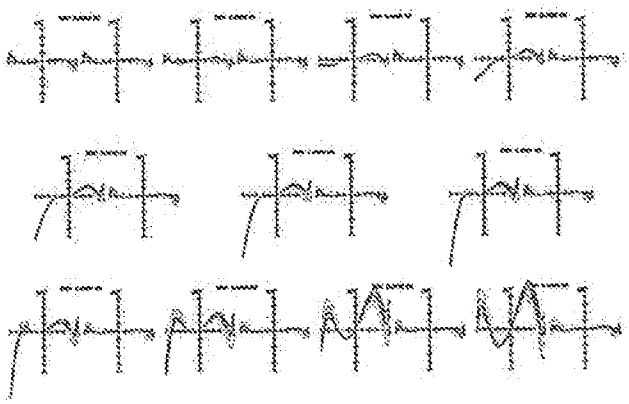


【図２】

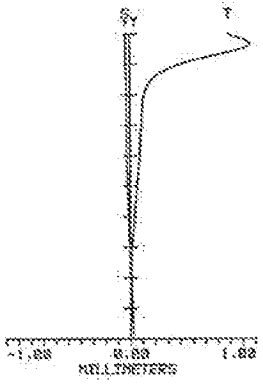
(a)



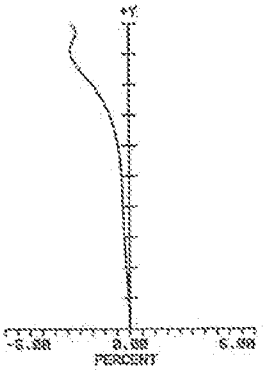
(b)



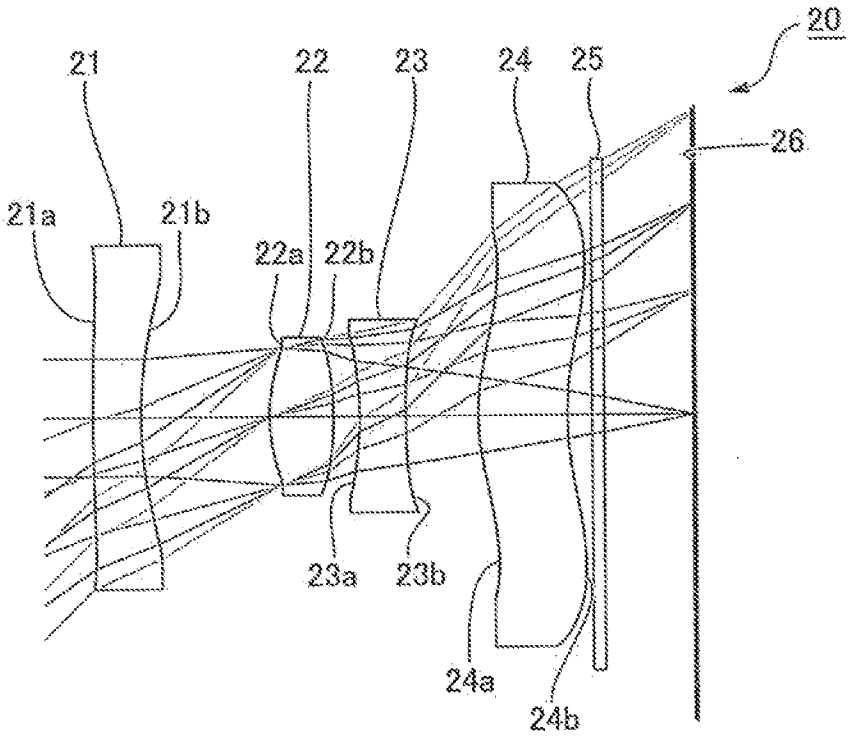
(c)



(d)

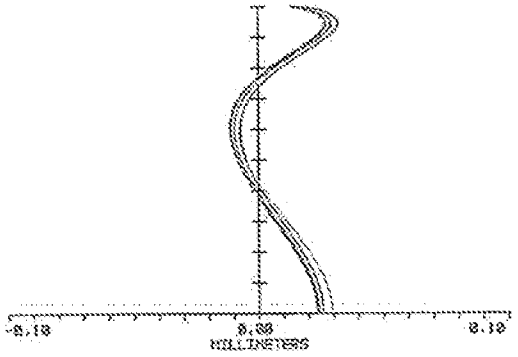


【図３】

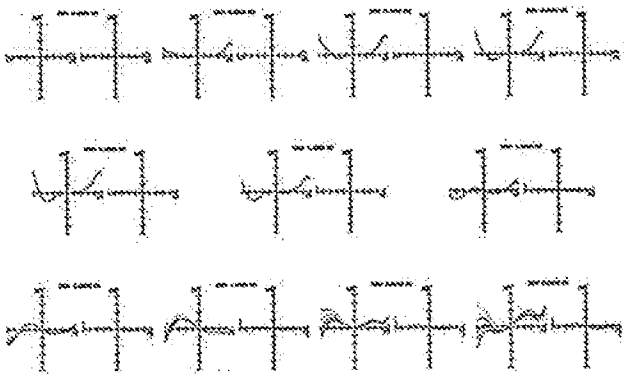


【図４】

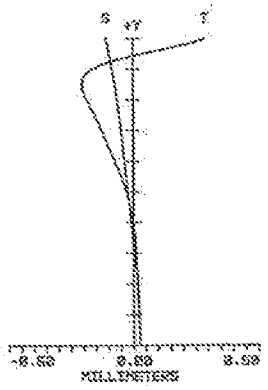
(a)


-0.10
0.00
0.10
MILLIMETERS

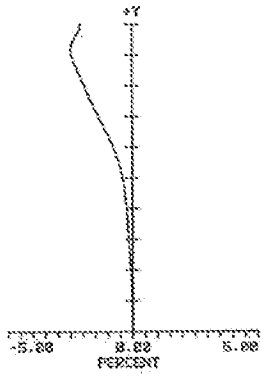
(b)



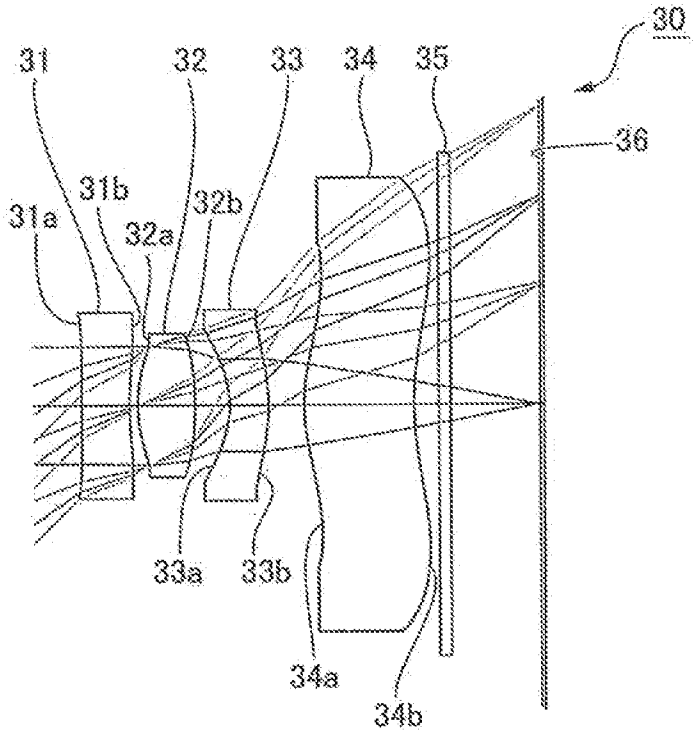
(c)


S
+Y
T
-0.50
0.00
0.50
MILLIMETERS

(d)

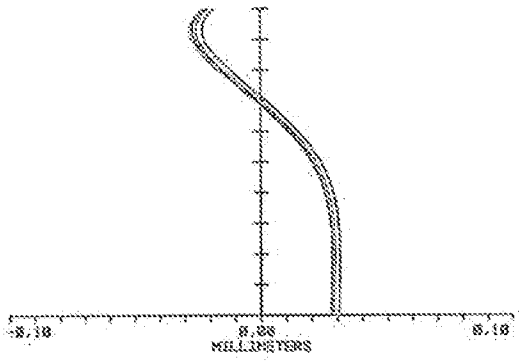

+Y
-5.00
0.00
5.00
PERCENT

【図５】

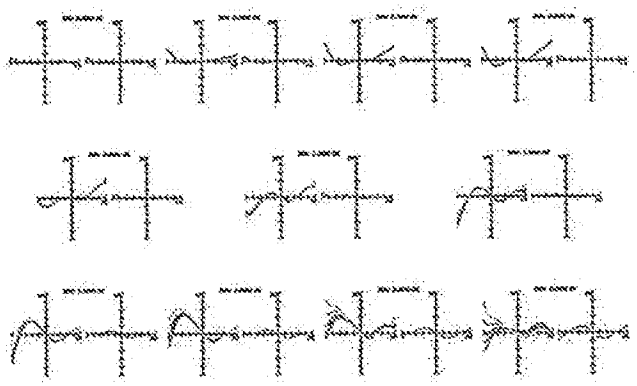


【図６】

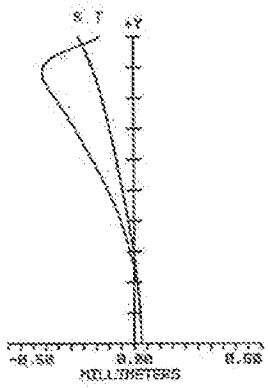
(a)


-0.10
0.00
0.10
MILLIMETERS

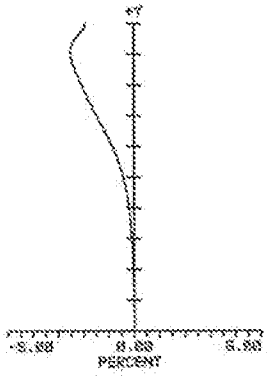
(b)



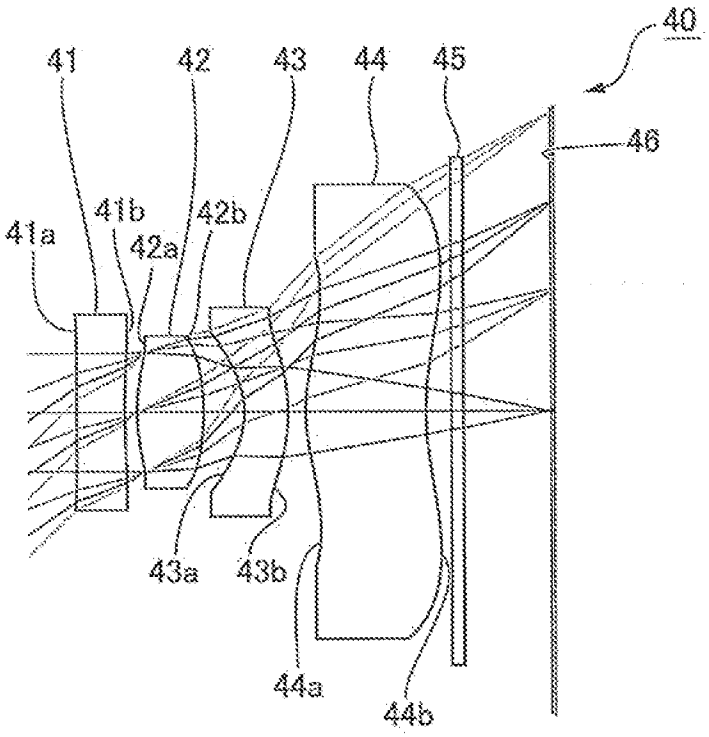
(c)


0.1
-0.50
0.00
0.50
MILLIMETERS

(d)

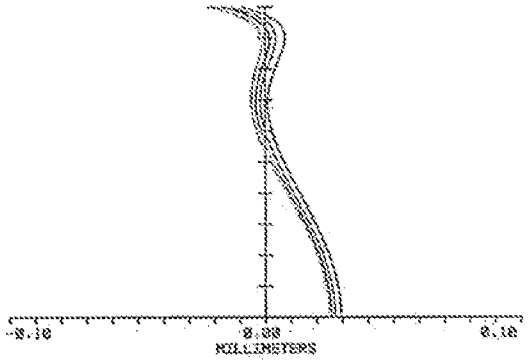

-0.00
0.00
0.00
PERCENT

【図７】

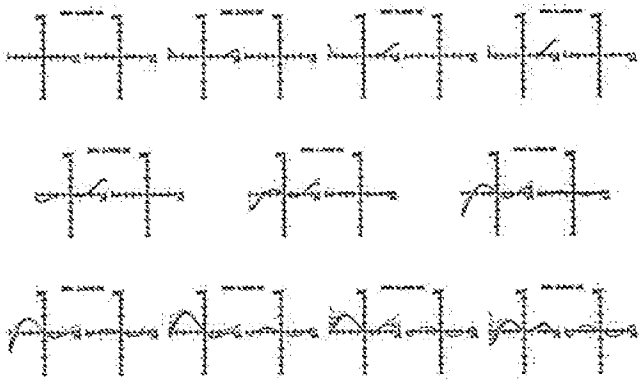


【図８】

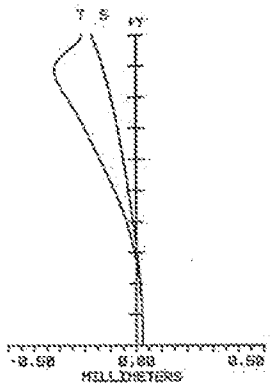
(a)


-0.10
0.00
0.10
MILLIMETERS

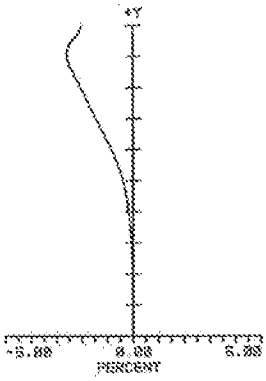
(b)



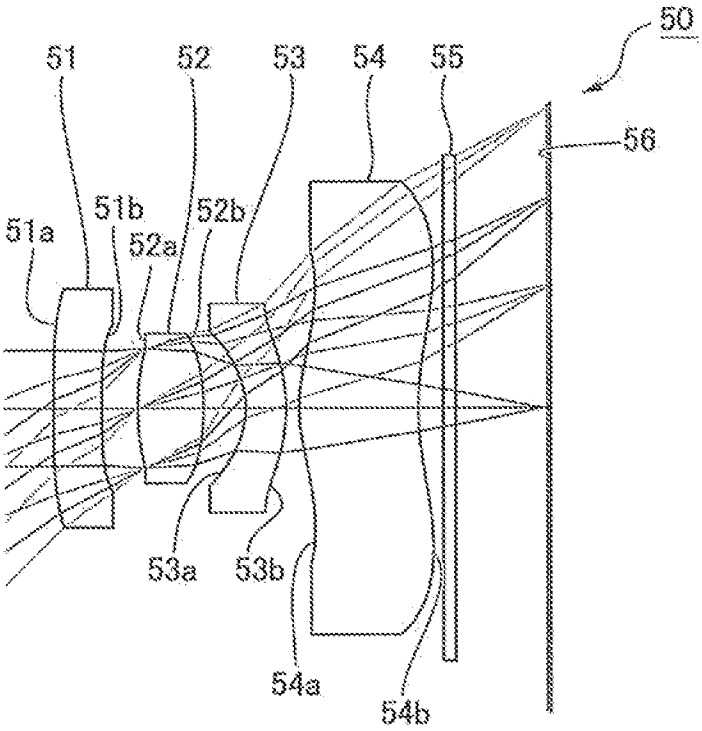
(c)


+Y
-0.50
0.00
0.50
MILLIMETERS

(d)

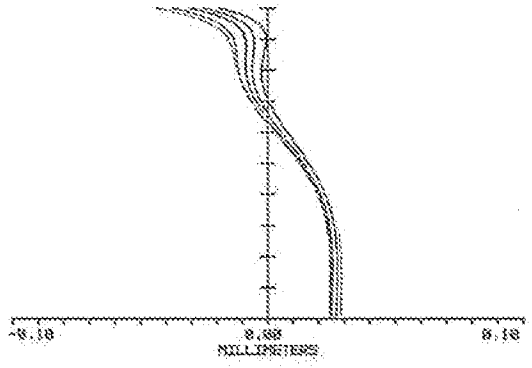

+Y
-5.00
0.00
5.00
PERCENT

【図９】

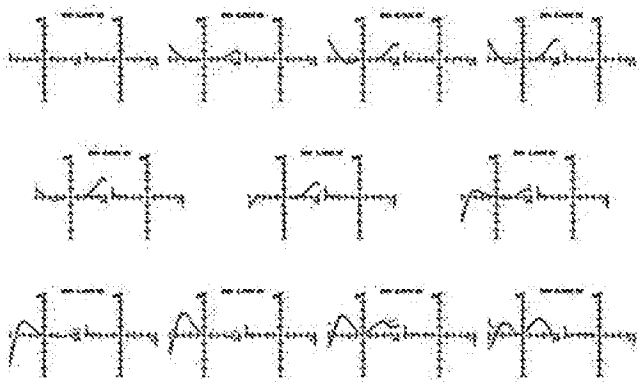


【図１０】

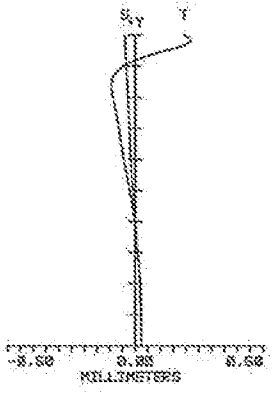
(a)


-0.10
0.000
0.10
MILLIMETERS

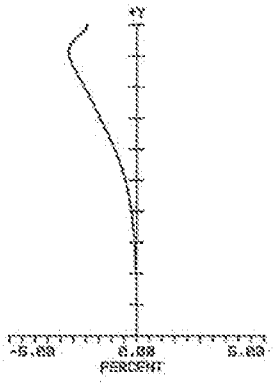
(b)



(c)


-0.50
0.00
0.50
MILLIMETERS

(d)


-0.03
0.00
0.03
PERCENT

フロントページの続き

Fターム(参考) 2H087 KA01 LA01 PA04 PA17 PB04 QA02 QA06 QA17 QA21 QA26
QA32 QA42 QA45 RA04 RA05 RA12 RA13 RA32 RA42 RA44
UA01

Electronic Acknowledgement Receipt

EFS ID:	20824379
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Chenae Byrd
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	01-DEC-2014
Filing Date:	13-DEC-2013
Time Stamp:	12:35:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	1497094702IDS.pdf	612323 63520b4aa164287e65ef6d12ce3a54d601dd4935	no	4

Warnings:	
Information:	

2	Foreign Reference	1497094702JP2014178623.pdf	4629754 f79807dce62880f452d54d28487a8dcd42f43ea4	no	32

Warnings:	
Information:	
Total Files Size (in bytes):	5242077

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

EXAMINER
DINH, JACK

ART UNIT	PAPER NUMBER
2872	

DATE MAILED: 01/27/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/27/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/27/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
DINH, JACK	2872	359-779000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

24728 7590 01/27/2015

MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

EXAMINER	
DINH, JACK	

ART UNIT	PAPER NUMBER
2872	

DATE MAILED: 01/27/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/105,811	Applicant(s) CHEN, WEI-YU	
	Examiner JACK DINH	Art Unit 2872	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the communication filed on 12/01/14*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-26*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☒ All b) ☐ Some *c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 20141201
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JACK DINH/
Primary Examiner, Art Unit 2872

REASONS FOR ALLOWANCE

1. Claims 1-26 are allowed. The following is an examiner's statement of reasons for allowance. Regarding claims 1, 15 and 21, the prior art fails to satisfy the conditions as claimed.

2. The prior art taken either singly or in combination fails to anticipate or fairly suggest the limitations of the independent claims, in such a manner that a rejection under 35 USC 102 or 103 would be improper. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Other Information/Remarks

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JACK DINH whose telephone number is (571)272-2327. The examiner can normally be reached on M-F (7:30 AM - 4:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas K. Pham can be reached on 571-272-3689. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jack Dinh/
Primary Examiner, Art Unit 2872
01/12/15

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14105811	CHEN, WEI-YU
	Examiner	Art Unit
	JACK DINH	2872

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	01/12/2015								
1	1	=								
2	2	=								
3	3	=								
4	4	=								
5	5	=								
6	6	=								
7	7	=								
8	8	=								
9	9	=								
10	10	=								
11	11	=								
12	12	=								
13	13	=								
14	14	=								
15	15	=								
16	16	=								
17	17	=								
18	18	=								
19	19	=								
20	20	=								
21	21	=								
22	22	=								
23	23	=								
24	24	=								
25	25	=								
26	26	=								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	"14105811"	US-PGPUB; USPAT	OR	OFF	2015/01/12 06:50
L2	1	("8842379").PN.	USPAT; USOCR	OR	OFF	2015/01/12 07:09
L3	2	"20100165485"	US-PGPUB; USPAT	OR	OFF	2015/01/12 07:12
L4	10323	lens$2 same (first) same (second near6 positive) same (third near6 negative) same (fourth)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L5	396	(359/771).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L6	308	(359/772).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L7	186	(359/779).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L8	284	(359/781).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:15
L9	1059	(359/771,772,779,781).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:16
L10	265	L9 and L4	US-PGPUB; USPAT;	OR	OFF	2015/01/12 07:16

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L11	636	lens$2 same (first) same ((second near6 positive) with convex with image) same ((third near6 negative) with concave with object with convex with image) same (fourth with concave with image)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L12	889	(359/715).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L13	1714	(359/715,771,772,779,781).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18
L14	86	L11 and L13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/01/12 07:18

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L15	128	(lens$2 and (first) and ((second near6 positive) with convex with image) and ((third near6 negative) with concave with object with convex with image) and (fourth with concave with image)).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/12 07:30
L16	0	(lens$2 and (first) and ((second near6 positive) with convex with image) and ((third near6 negative) with concave with object with convex with image) and (fourth with concave with image) and Td and HFOV).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2015/01/12 07:30

1/ 12/ 2015 7:31:07 AM
C:\ Users\ jdinh\ Documents\ EAST\ Workspaces\ Case 14105811.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14105811	CHEN, WEI-YU
	Examiner	Art Unit
	JACK DINH	2872

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
359	771,772,779,781,715	01/12/15	JD

SEARCH NOTES		
Search Notes	Date	Examiner
Search EAST and NPL.	01/12/15	JD

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
See search history.		01/12/15	JD

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 5836

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/105,811	12/13/2013	359	2872	14970-94702

APPLICANTS

LARGAN PRECISION CO., LTD., Taichung, TAIWAN, Assignee (with 37 CFR 1.172 Interest);

INVENTORS

WEI-YU CHEN, Taichung, TAIWAN;

**** CONTINUING DATA ***************************

**** FOREIGN APPLICATIONS ***************************

TAIWAN 102139029 10/29/2013

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

01/02/2014

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☑ Yes ☐ No	☑ Yes ☐ No	/JACK DINH/ Examiner's Signature	☐ Initials	TAIWAN	23	26	3

ADDRESS

MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326
UNITED STATES

TITLE

IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

FILING FEE RECEIVED		
2080	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14105811	CHEN, WEI-YU
	Examiner	**Art Unit**
	JACK DINH	2872

CPC						
Symbol					**Type**	**Version**
G02B		13	/	004	F	2013-01-01
G02B		9	/	34	I	2013-01-01
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	26	
/JACK DINH/ Primary Examiner.Art Unit 2872	01/12/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1A

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14105811	CHEN, WEI-YU
	Examiner	**Art Unit**
	JACK DINH	2872

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
359	779	G 0 2 B 9 / 34 (2006.0)	
CROSS REFERENCE(S)		G 0 2 B 3 / 02 (2006.01.01)	

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
359	781	715			

NONE	Total Claims Allowed:
(Assistant Examiner) (Date)	26
/JACK DINH/ Primary Examiner.Art Unit 2872 01/12/2015	O.G. Print Claim(s): 1 — O.G. Print Figure: 1A
(Primary Examiner) (Date)	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14105811	CHEN, WEI-YU
	Examiner	**Art Unit**
	JACK DINH	2872

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3	19	19												
4	4	20	20												
5	5	21	21												
6	6	22	22												
7	7	23	23												
8	8	24	24												
9	9	25	25												
10	10	26	26												
11	11														
12	12														
13	13														
14	14														
15	15														
16	16														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 26	
/JACK DINH/ Primary Examiner.Art Unit 2872 (Primary Examiner)	01/12/2015 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1A

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	14105811
Filing Date	2013-12-13
First Named Inventor	WEI-YU CHEN
Art Unit	2872
Examiner Name	
Attorney Docket Number	14970-94702

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8842379	B2	2014-09-23	Largan Precision Co., Ltd.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100165485	A1	2010-07-01	Milestone Co., Ltd.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2014-178623	JP		2014-09-25	Hitachi Maxell, Ltd.		☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

ALL REFERENCES CONSIDERED EXCEPT WHERE LI HP, THROUGH. /J.D./

Receipt date: 12/01/2014	Application Number	14105811 14105811 - GAU: 2872
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2013-12-13
	First Named Inventor	WEI-YU CHEN
	Art Unit	2872
	Examiner Name	
	Attorney Docket Number	14970-94702

	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button **Add**

EXAMINER SIGNATURE

Examiner Signature	/Jack Dinh/	Date Considered	01/12/2015

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

 ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

Receipt date: 12/01/2014	Application Number	14105811 14105811 - GAU: 2872
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2013-12-13
	First Named Inventor	WEI-YU CHEN
	Art Unit	2872
	Examiner Name	
	Attorney Docket Number	14970-94702

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Tim Tingkang Xia/	Date (YYYY-MM-DD)	2014-12-01
Name/Print	Tim Tingkang Xia	Registration Number	45242

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24728 7590 01/27/2015
MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	12/13/2013	WEI-YU CHEN	14970-94702	5836

TITLE OF INVENTION: IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/27/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
DINH, JACK	2872	359-779000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 MORRIS MANNING & MARTIN LLP
2 TIM TINGKANG XIA, ESQ.
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
LARGAN PRECISION CO., LTD.	TAICHUNG, TW

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 503537 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Tim Tingkang Xia/ Date FEBRUARY 5, 2015

Typed or printed name TIM TINGKANG XIA Registration No. 45242

Electronic Patent Application Fee Transmittal

Application Number:	14105811
Filing Date:	13-Dec-2013
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Filer:	Tim Tingkang Xia/Michelle Ellis
Attorney Docket Number:	14970-94702

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	21413714
Application Number:	14105811
International Application Number:	
Confirmation Number:	5836
Title of Invention:	IMAGE CAPTURING LENS SYSTEM, IMAGING DEVICE AND MOBILE TERMINAL
First Named Inventor/Applicant Name:	WEI-YU CHEN
Customer Number:	24728
Filer:	Tim Tingkang Xia/Michelle Ellis
Filer Authorized By:	Tim Tingkang Xia
Attorney Docket Number:	14970-94702
Receipt Date:	05-FEB-2015
Filing Date:	13-DEC-2013
Time Stamp:	16:13:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	2937
Deposit Account	503537
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	1497094702IFTrans.pdf	1099156 e9bd3b49fe968014aae0f6c3ba7a6e23a5b10b97	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30962 a3a145258b1acecbb216b5689e7580bb1e1c8a5b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1130118		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	14105811
Filing Date	2013-12-13
First Named Inventor	WEI-YU CHEN
Art Unit	2872
Examiner Name	
Attorney Docket Number	14970-94702

Change(s) applied to document,
/M.I.G./
2/10/2015

U.S.PATENTS

Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8842379	B2	2014-09-23	Largan Precision Co., Ltd.	Hsu, et al.

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS

Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100165485	A1	2010-07-01	Milestone Co., Ltd.	Do; Satoshi

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS

Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2014-178623	JP		2014-09-25	Hitachi Maxell, Ltd.		☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS

Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/105,811	03/24/2015	8988796	14970-94702	5836

24728 7590 03/04/2015

MORRIS MANNING MARTIN LLP
IP Department
3343 PEACHTREE ROAD, NE
1600 ATLANTA FINANCIAL CENTER
ATLANTA, GA 30326

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

LARGAN PRECISION CO., LTD., Taichung, TAIWAN, Assignee (with 37 CFR 1.172 Interest);
WEI-YU CHEN, Taichung, TAIWAN;