CERTIFICATE OF TRANSLATION

I, Sayuri Anderson, located in Chicago, Illinois, am fluent in the Japanese and English languages. I have been translating documents for 25 years and am competent to translate documents from Japanese into English. I hereby certify that the document identified below, translated from Japanese into English, is true and accurate, to the best of my knowledge and belief.

Japanese Patent H2001-82935 (P2001-82935A)

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my ability. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true to the best of my ability; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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I, Matthew Bramble, located at 2301 Caprock Place, Georgetown TX, am fluent in the Japanese and English languages. I have been translating documents for 25 years and am competent to translate documents from Japanese into English. I hereby certify that the document identified below, translated from Japanese into English, is true and accurate, to the best of my knowledge and belief.

Japanese Unexamined Patent Application No. 2001-82935

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(19) Japan Patent Office (JP)

(12) **Japanese Unexamined Patent Application Publication** (A)

(11) Japanese Unexamined Patent Application Publication Number

2001-82935
(P2001-82935A)

(43) Publication Date March 30, 2001

(51) Int Cl[7]	ID Symbols	F1	Theme Code (Reference)
G01B 11/24		G01B 11/24 K	2F066

Examination Claim Unexamined, Number of Claim Items 5 OL (Total 10 pages)

(21) Patent Application No. Patent Application H11-256683

(22) Application Date September 10, 1999

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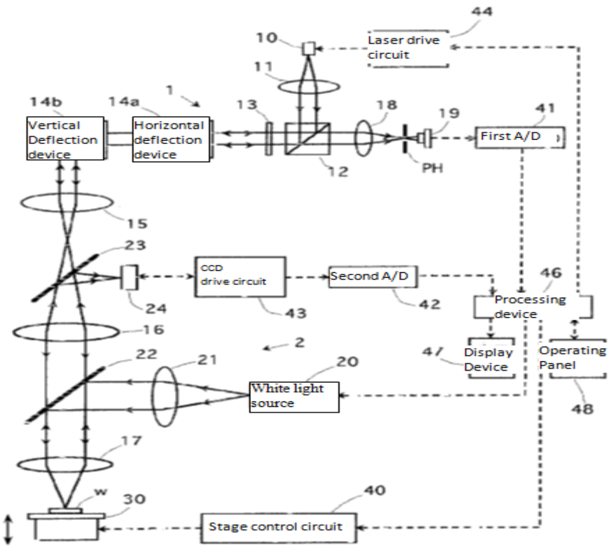
(54) [Title of Invention] 3-dimensional Measurement Device

(57) [Abstract]
[Topics] A 3-dimensional measurement device is provided that is easy to understand the corresponding relationship of the site of the actual means target object and the site of the surface shape that is displayed on the display device.
[Solution means] A confocal microcopy, which is a 3 dimensional measurement device, comprises: a photo receptor 19 which receives the light from the measurement target object w through confocal light system 1 that includes object lens 17; color CCD 24 that obtains for each pixel the color information of measurement target object w; Z direction displacement mechanism 30 that enables the change of the relative position of measurement target object w with respect to focal point of object lens 17 at optical axis direction; scanning mechanisms 14a, 14b that scan the measurement target object w by the light from light source 10 in XY direction that is vertical to optical axis direction; processing device 46 that seeks and stores for each pixel the height information and color information that correspond to the relative position in the optical axis direction of the measurement target object w when the light reception amount is maximized; and display device 47 that uses height information and color information for each pixel and engages in color 3 dimensional display of the surface shape of the measurement target object w.



[Scope of Patent Claim]
[Claim 1] A 3-dimensional measurement device that receives lights from the measurement target object using photo receptor, and obtains 3-dimensional surface shape that includes the height information of the aforementioned measurement target object based on the light reception information and displays 3 dimensionally the aforementioned surface shape on the display device,
The 3-dimensional measurement device wherein the device comprises color filming means that obtains color images of the aforementioned measurement target object
and using the color information for each pixel that is obtained from the aforementioned color filming means, colors the 3-dimensional display of the aforementioned surface shape

[Claim 2] The 3-dimensional measurement device according to claim 1 wherein the device is furthermore provided with means that seeks the maximum light reception amount for each pixel and using 2nd color information which replaces the brightness ingredient of the color information for each aforementioned pixel by the maximum light reception amount for each aforementioned pixel, the 3-dimensional display of the aforementioned surface shape is colored.

[Claim 3] The 3-dimensional measurement device according to claim 1or 2 wherein laser beam is irradiated on the aforementioned measurement target object and based on the light reception information of the reflection light or penetrated light, the information of 3-dimensional surface shape that includes aforementioned measurement target object height information is obtained

[Claim 4] A 3-dimensional measurement device that comprises: a light source that irradiates light on the measurement target object;
A photo receptor that receives light from the aforementioned measurement target object through the confocal optical system that includes the target lens;
Color information - obtaining sensor that obtains the color information of the aforementioned measurement target object for each pixel;
Z direction displacement mechanism that enables the change of relative position of the aforementioned measurement target object with respect to the focal point of the aforementioned object lens in optical axis direction;
Scanning mechanism that scans the aforementioned measurement target object using the light from the aforementioned light source in the XY direction vertical to the aforementioned light axis direction,
A processing device that seeks and stores for each pixel the height information and the aforementioned color information that correspond to the relative position in optical axis direction of the measurement target object when the light reception amount is maximized;
and a display device that uses height information for each aforementioned pixel and color information for each aforementioned pixel and engages in color 3-dimensional display of the surface shape of the measurement target object,

[Claim 5] The 3-dimensional measurement device according to claim 4 wherein the aforementioned display device, using 2nd color information which replaced the brightness ingredient of the color information for aforementioned pixel by the maximum light reception amount for the aforementioned pixel, performs the color 3-dimensional display of the aforementioned surface shape.

[Detailed Explanation of Invention]
[0001]
[Technical field of the Invention] The present invention is related to a 3-dimensional measurement device in which the light from the measurement target object is received by photo receptor and based on the light reception information, 3-dimensional surface information that includes the height information of the aforementioned measurement target object is obtained and the aforementioned surface information is displayed 3 dimensionally on the display device

[0002]
[Prior art] As one example of a 3-dimensional measurement device, there is a confocal microcopy. In confocal microcopy, the light from light source (normally laser beam) is irradiated on a sample that is a measurement target object and its penetrated light or reflected light is received by the photo receptor via confocal optical system and based on the received light amount, information of 3-dimensional surface shape that includes sample height is obtained. Its measurement principle is explained in the following.

[0003] For example, if the stage with samples placed is moved in optical axis direction (Z direction), the amount of light that comes into the photo receptor via confocal optical system, that is, the light reception amount changes, and when it is focused on the sample surface, the light reception amount is maximized. Hence, the height data of the sample surface is obtained from Z direction position of the stage when the maximum light reception amount is obtained, Then, by scanning the sample surface by the light in XY direction that is vertical to the light axis direction, the sample surface height distribution, that is, 3-dimensional surface shape information is obtained. This height distribution, is displayed 3 dimensionally (sterically) on the screen by CG (computer graphic) method.

[0004] For example, when XY plane is divided into many small areas and each area height is expressed by Z direction column, height distribution (surface shape) can be sterically displayed as many column congregation with various height. The column height of each area becomes the average value of height data of pixel that is contained in the area. Or, as in the 3-dimensional display in general, the sample (measurement target object) surface can be displayed as the congregation of small polygons.

[0005] As these 3-dimensional display models, there are wire framed model and solid model. Regarding wired frame model, the surface shape is drawn as the gathering of lines and regarding solid model, surface shape is drawn as the surface gathering. Then, coloring can be executed by various shades of pattern and color graduation depending on the height data. For example, using the dark color for low height and light color for high part, coloring of 3-dimensional display of surface shape has been done traditionally.

[0006]
[Topics the Invention attempted to solve] As described above, traditionally, using the color that was selected depending on height data, artificial coloring has been done for 3-dimensional display of surface shape, but using such coloring, 3-dimensional display of surface shape was not necessarily easy on eyes. That is, sometimes the corresponding relationship of the site of actual measurement target object and the site in the 3-dimensional display of surface shape that is displayed on the display device is not easy to tell.

[0007] The present invention, in view of the such traditionally issue, has the purpose to provide a 3-dimensional measurement device in which corresponding relationship of the site of actual measurement target object and the site in the 3-dimensional display of surface shape that is displayed on the display device is easy to tell.

[0008]
[Means to solve the issue] A 3-dimensional measurement device of the present invention receives lights from the measurement target object using photo receptor, and obtains 3-dimensional surface shape that includes the height information of the measurement target object based on the light reception information and displays 3 dimensionally surface shape on the display device, and the device comprises color filming means that obtains color of the measurement target object and using the color information for each pixel that is obtained from the color filming means, colors the 3-dimensional display of the surface shape.

[0009] According to the configuration described above, the 3-dimensional display of surface shape is colored according to the color information obtained from color filming means, hence surface shape is displayed with the color close to the actual color of the measurement target object. Hence, the corresponding relationship of the site of actual measurement target object and the site of the surface shape that is displayed on the display device is easier to tell.

[00010] Preferably, means to seek maximum light reception amount for each pixel is provided furthermore, and using 2nd color information which replaces the brightness ingredient of the color information for each pixel by the maximum light reception amount for each pixel, the 3-dimensional display of the surface shape is colored. In this case, since the light reception amount (maximum light reception amount) when each pixel is focused is reflected in the color information as brightness information, compared with the coloring using only color information obtained from color filming means, 3-dimensional display image with a strong contract is obtained.

[0011] Moreover, a configuration is preferred in which laser beam is irradiated on measurement target object and based on the light reception information of permeated light or the reflected light, the information of 3-dimensional surface shape that includes height information of measurement target object is obtained

[0012] In preferred embodiment, the 3-dimensional measurement device of the present invention is a confocal microcopy and 3-dimensional measurement device comprise comprises: a light source that irradiates light on the measurement target object; A photo receptor that receives light from the measurement target object through the confocal optical system that includes the target lens; Color information - obtaining sensor that obtains the color information of the measurement target object for each pixel; Z direction displacement mechanism that enables the change of relative position of the measurement target object with respect to the focal point of the object lens in optical axis direction; Scanning mechanism that scans the measurement target object using the light from the light source in the XY direction vertical to the light axis direction, a processing device that seeks and stores for each pixel the height information and the color information that correspond to the relative position in optical axis direction of the measurement target object when the light reception amount is maximized; and a display device that uses height information for each pixel and color information for each pixel and engages in color 3-dimensional display of the surface shape of the measurement target object.

[0013] More preferably the display device, using 2nd color information which replaced the brightness ingredient of the color information for pixel by the maximum light reception amount for the pixel, performs the color 3-dimensional display of the surface shape.

[0014]
[Embodiment of invention] The following explains the embodiments of the present invention based on the drawings of the embodiments.

[0015] In Fig. 1 is shown an outline configuration of a confocal microcopy which is an example of 3-dimensional measurement device involving the present invention. This confocal microcopy is provided with a confocal optical system 1 to obtain the 3-dimensional surface shape information that includes sample height and non-confocal optical system 2 to obtain the sample color image.

[0016] First, the confocal optical system 1 is explained. The confocal optical system 1 comprises light source 10 to irradiate single color light on sample 2 (preferably laser beam), 1st collimated lens 11, polarized beam splitter 12, 1/4 wave length plate 13, horizontal biasing device 14a, vertical biasing device 14b, 1st relay lens 15, 2nd relay lens 16, object lens 17, image forming lens 18, pin hole plate PH, 1st photo receptor 19 etc.

[0017] For light source 10, for example the semi-conductor laser that emits red laser beam is used. Laser beam that came from light source 10 driven by laser drive circuit 44 goes through 1st collimated lens 11 and is bent by polarized beam splitter 12 and goes through 1/4 wave length plate 13. After that, after biased in horizontal direction (side way) and vertical direction (perpendicular) by horizontal biasing device 14a and vertical biasing device 14b, light goes through 1st relay lens 15 and 2nd relay lens 16 and focuses on the surface of the sample w placed on the sample stage 30 by object lens 17.

[0018] The horizontal biasing device 14a and vertical biasing device 14b is configured by Galvano mirror each, and by biasing laser beam in horizontal and vertical direction, the sample w surface is scanned by laser beam. For the ease of explanation, horizontal direction is called X direction and vertical direction Y direction. Sample stage 30 is driven in Z direction (optical axis direction) by stage control circuit 40. Thereby, the relative position at optical axis direction at object lens 17 focal point and sample w can be changed.

[0019] The relative position at optical axis direction at object lens 17 focal point and sample w can be changed by other method. For example, by fixing the position of sample stage 30 and driving the object lens 17 in Z axis direction, the focal point can be changed. Or by inserting a lens between object lens 17 and sample w in which the lens refraction index changes, a configuration is possible that can change the focal point of object lens 17. Moreover, sample stage 30 can be displaced in x direction and y direction by manual operation for approximate position matching.

[0020] The laser beam that was reflected by sample 2 goes back the light path described above in reverse. That is, it goes through object lens 17, 2nd relay lens 16 and 1st relay lens 15 and returns again to 1/4 wave length plate 13 via horizontal biasing device 14a and vertical biasing device 14b. As a result, laser beam permeates the polarized beam splitter 12 and is concentrated by image forming lens18. Focused laser beam goes through the pin hole of pinhole plate PH placed at the focal position of image forming 18 and enters into 1st photo receptor 19. 1st photo receptor 19 is configured by for instance photo multiplier or photo diode and converts the light reception amount into electric signal. The electric signal that is equivalent to reception light amount is given to 1st A/D converter 41 via output amp and gain control circuit (not shown in figure) and converted into digital values.

[0021] As a result of the confocal optical system **1** having the configuration described above, information

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