US006522432B1

(12) **United States Patent**
Lin

(10) **Patent No.: US 6,522,432 B1**
(45) **Date of Patent: Feb. 18, 2003**

(54) **IMAGE SCANNER WITH AUTOMATIC SIGNAL COMPENSATION**

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(73) Assignee: **Primax Electronics Ltd.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1049 days.

(21) Appl. No.: **08/633,389**

(22) Filed: **Apr. 16, 1996**

(51) **Int. Cl.**[7] **H04N 1/04**
(52) **U.S. Cl.** **358/475**; 358/296
(58) **Field of Search** 358/296, 461, 358/463, 465, 475, 509, 512, 516, 484; 348/234, 500, 708

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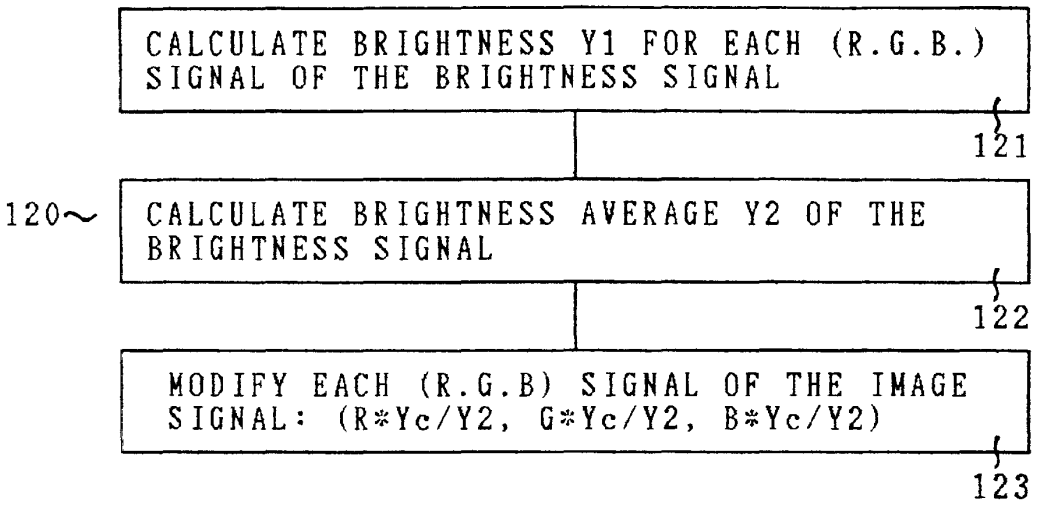
Primary Examiner—Mark Wallerson
(74) *Attorney, Agent, or Firm*—Winston Hsu

(57) **ABSTRACT**

The present invention relates to an image scanner with automatic signal compensation function for compensating the instability of a light source of the image scanner. The image scanner comprises a test region, a light source for illuminating the document and the test region, optical means for conveying the light reflected from the document and the test region, a line image sensor for receiving the light from the optical means and generating an image signal corresponding to the light reflected from the document and a brightness signal corresponding to the light reflected from the test region, and a signal compensation circuit for amplifying the image signal according to the brightness signal to compensate the instability in the brightness of the light source.

9 Claims, 3 Drawing Sheets



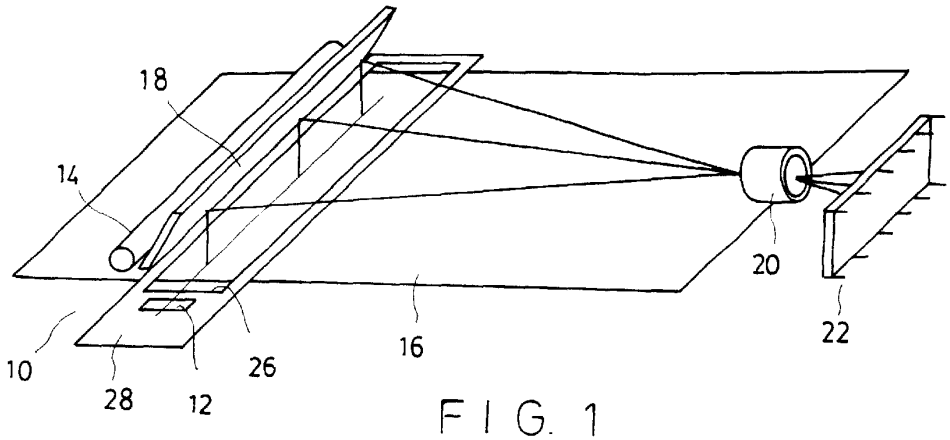


FIG. 1

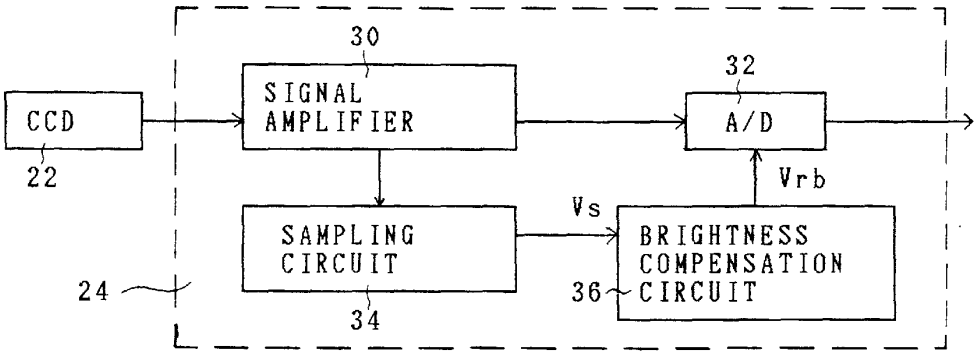


FIG. 2

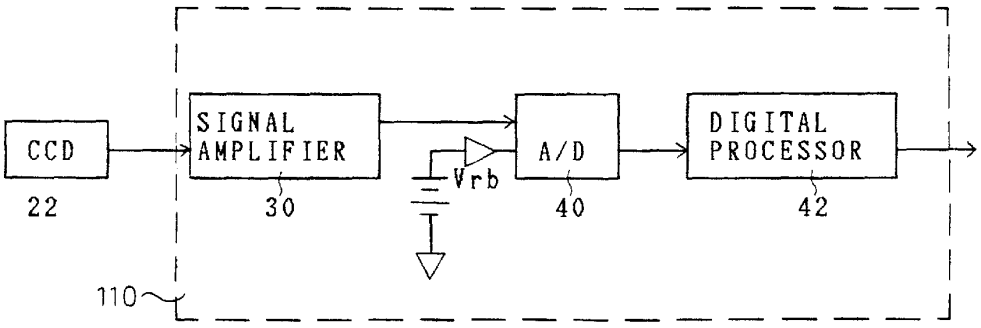


FIG. 11

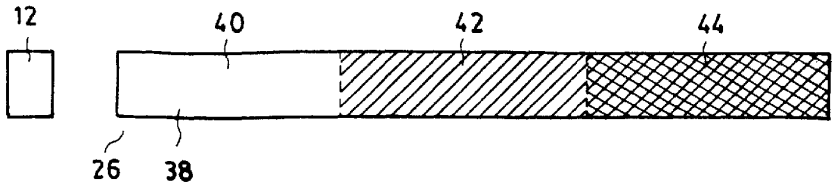


FIG. 3

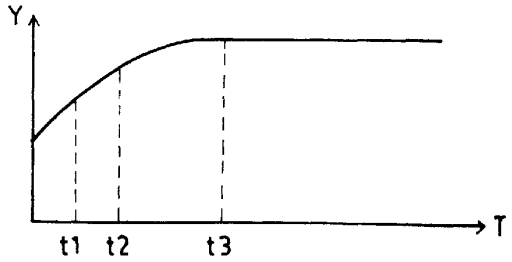


FIG. 4

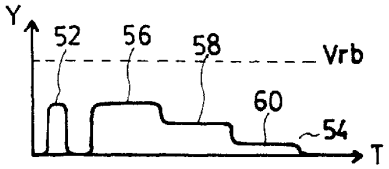


FIG. 5

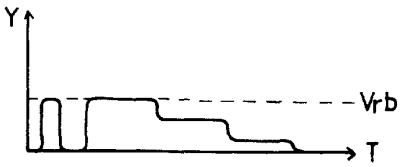


FIG. 8

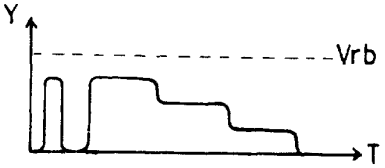


FIG. 6

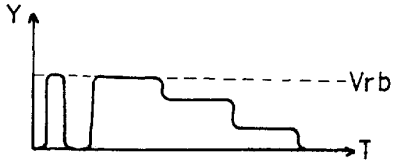


FIG. 9

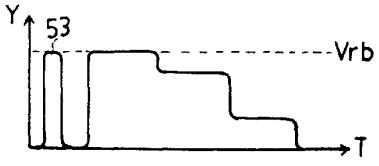


FIG. 7

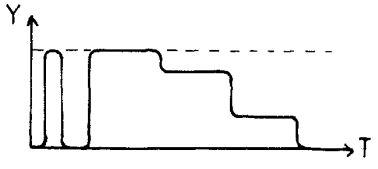


FIG. 10

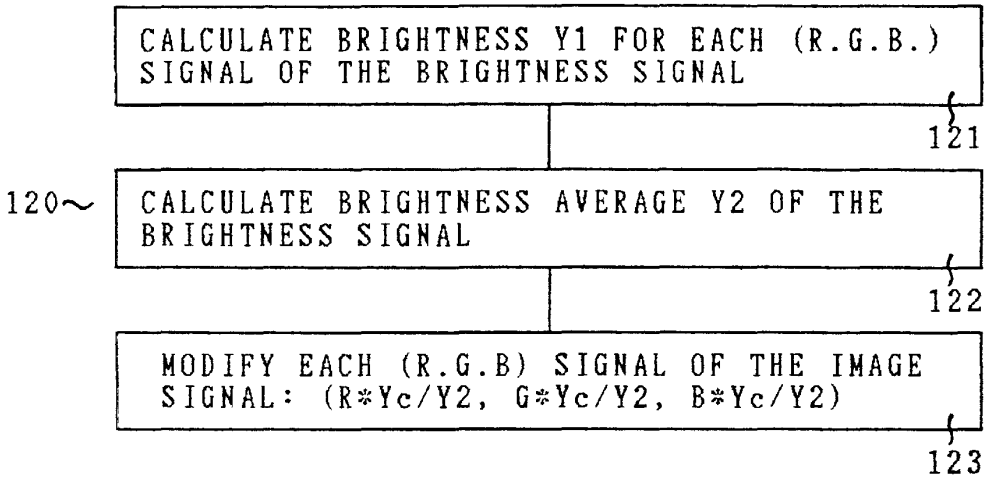


FIG. 12

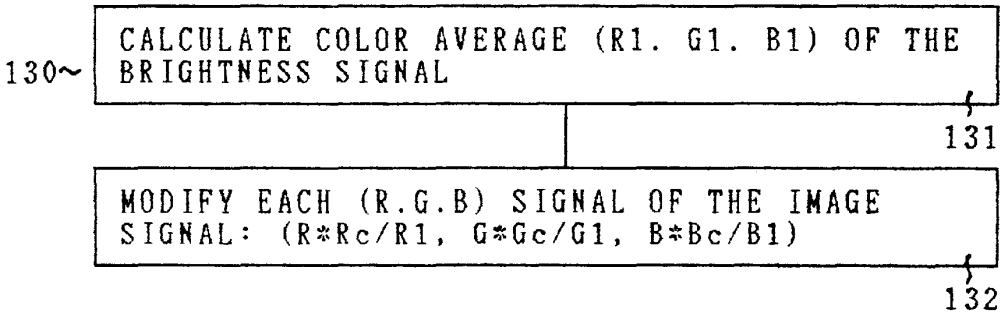


FIG. 13

IMAGE SCANNER WITH AUTOMATIC SIGNAL COMPENSATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image scanner, and signal compensation function for compensating the instability of a light source of the image scanner.

2. Description of the Prior Art

Fluorescent lamp such as cold cathode fluorescent tube (CCFT) is commonly used in color image scanner because of its broad spectrum coverage. One problem with such lamp is that its brightness will gradually change to a stable condition when it is powered on. Such period usually takes three to five minutes. In order to get a stable image output by using such a lamp, a user usually has to wait until the lamp is completely warmed up.

U.S. Pat. No. 5,212,376, which is assigned to the same assignee of the present invention, discloses an image scanner with an optic fiber connected to a line image sensor for measuring the brightness of the image scanner's light source and a signal compensation circuit for adjusting the brightness of the scanned image according to the measured brightness of the light source. The optic fiber method is very effective in measuring the brightness of the light source, but it requires high precision parts and installation process which is very expensive and time consuming. Besides, the brightness of the light measured by the optic fiber is very sensitive to the distance between the input end of the optic fiber and the light source. Any shock or vibration over the scanner may change this distance or move the input end of the optic fiber which may have great consequence over the output of the signal compensation circuit.

SUMMARY OF THE INVENTION

It is therefore a primary objective of the present invention to provide an image scanner which can measure the brightness of the scanner's light source to compensate a scanned image and avoid the above mentioned problem.

It is another objective of the present invention to provide an image scanner which can measure color variations of the scanner's light source to compensate the scanned image accordingly.

Briefly, in a preferred embodiment, the present invention includes an image scanner for scanning a document comprising:

(1) a test region;

(2) a light source for illuminating the document and the test region;

(3) optical means for conveying the light reflected from the document and the test region;

(4) a line image sensor for receiving the light from the optical means and generating an image signal corresponding to the light reflected from the document and a brightness signal corresponding to the light reflected from the test region; and

(5) a signal compensation circuit for amplifying the image signal according to the brightness signal to compensate the instability in the brightness of the light source.

The line image sensor comprises an array of (red, green, blue) (R,G,B) sensing elements for converting the light received from the optical means into an array of corresponding (R,G,B) signals wherein both the image signal and the brightness signals generated by the line image sensor are formed by an array of (R,G,B) signals. The signal compensation circuit comprises an A/D converter for digitizing the (R,G,B) signals of the image signal and the brightness signal, and a digital processor for adjusting the digitized (R,G,B) signals of the image signal according to the digitized (R,G,B) signals of the brightness signal. Each digitized (R,G,B) signal of the image signal is multiplied by a color compensation factor calculated which is obtained from the digitized (R,G,B) signals of the brightness signal to compensate the brightness and the color of the image signal.

It is an advantage of the present invention that it provides an image scanner which can measure the brightness of the scanner's light source by measuring the light reflected from the test region instead of by using an optic fiber.

It is another advantage of the present invention that the image scanner can measure color variations of the scanner's light source by measuring the light reflected from the test region to compensate the digitized RGB signals of the image signal.

These and other objects and the advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiment which is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a hand-held image scanner's optical components according to the present invention.

FIG. **2** is a hardware block diagram of the signal compensation circuit of the scanner according to the present invention.

FIG. **3** shows the test region and a document viewed through a transparent window of the scanner.

FIG. **4** shows a curve of the brightness of the scanner's light source after it is powered on.

FIGS. **5** to **7** shows the brightness and image signals generated by the signal amplifier of the scanner.

FIGS. **8** to **10** shown each of the resulting reference voltages Vrb generated by the brightness compensation circuit of the scanner.

FIG. **11** is an alternative hardware block diagram of the signal compensation circuit.

FIG. **12** shows a process for compensating the brightness of the image signal.

FIG. **13** shows another process for compensating both the brightness and the color of the image signal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Please refer to FIGS. **1** and **2**. FIG. **1** is a perspective view of a hand-held image scanner's optical components according to the present invention and FIG. **2** is a hardware block diagram of the signal compensation circuit **24** attached to the CCD **22** shown in FIG. **1**. The scanner **10** comprises a transparent window **26** for scanning a document **16** lying underneath, a rectangular glass **28** installed inside the window **26**, a test region **12** installed on the glass **28** next to one side of the window **26**, a light source **14** above the window **26** for illuminating a document **16** under the window **26** and the test region **12**, an optical means which comprises a reflex mirror **18** and a lens **20** for conveying the light reflected from the document **16** and the test region **12**, a line image sensor **22** which is a CCD (charge couple device) for

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