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(54) **DIGITAL CAMERA AND DEFECT PIXEL COMPENSATION SYSTEM**

(75) Inventor: **Yoshihiro Sato**, Miyagi (JP)

(73) Assignee: **Fujifilm Corporation**, Tokyo (JP)

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H04N 5/225 (2006.01)
H04N 3/14 (2006.01)

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(58) **Field of Classification Search** 348/207.1, 348/207.11, 246, 247, 272–283
See application file for complete search history.

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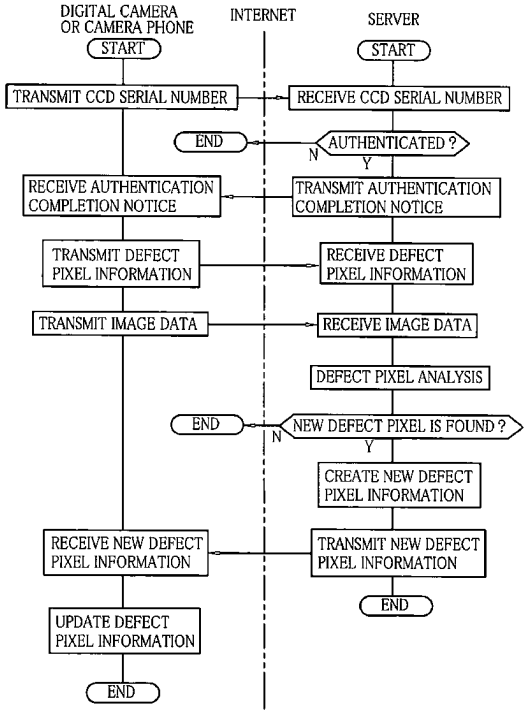
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Primary Examiner—Nhan T Tran
Assistant Examiner—Trung Diep
(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP.

(57) **ABSTRACT**

A digital camera is connected to a computer through a serial terminal. The computer is connected to a server through an internet. To the server, the digital camera transmits uncompensated image data to which no defect pixel compensation is applied, and defect pixel information preliminarily read from a nonvolatile memory. The server analyses this image data to compare with the defect pixel information, and then creates new defect pixel information. The new defect pixel information is transmitted to the digital camera, and additionally written to the nonvolatile memory. The digital camera compensates image data obtained by image capturing, based on the defect pixel information.

14 Claims, 5 Drawing Sheets



Sony Exhibit 1039
Sony v. Optimum

FIG.1

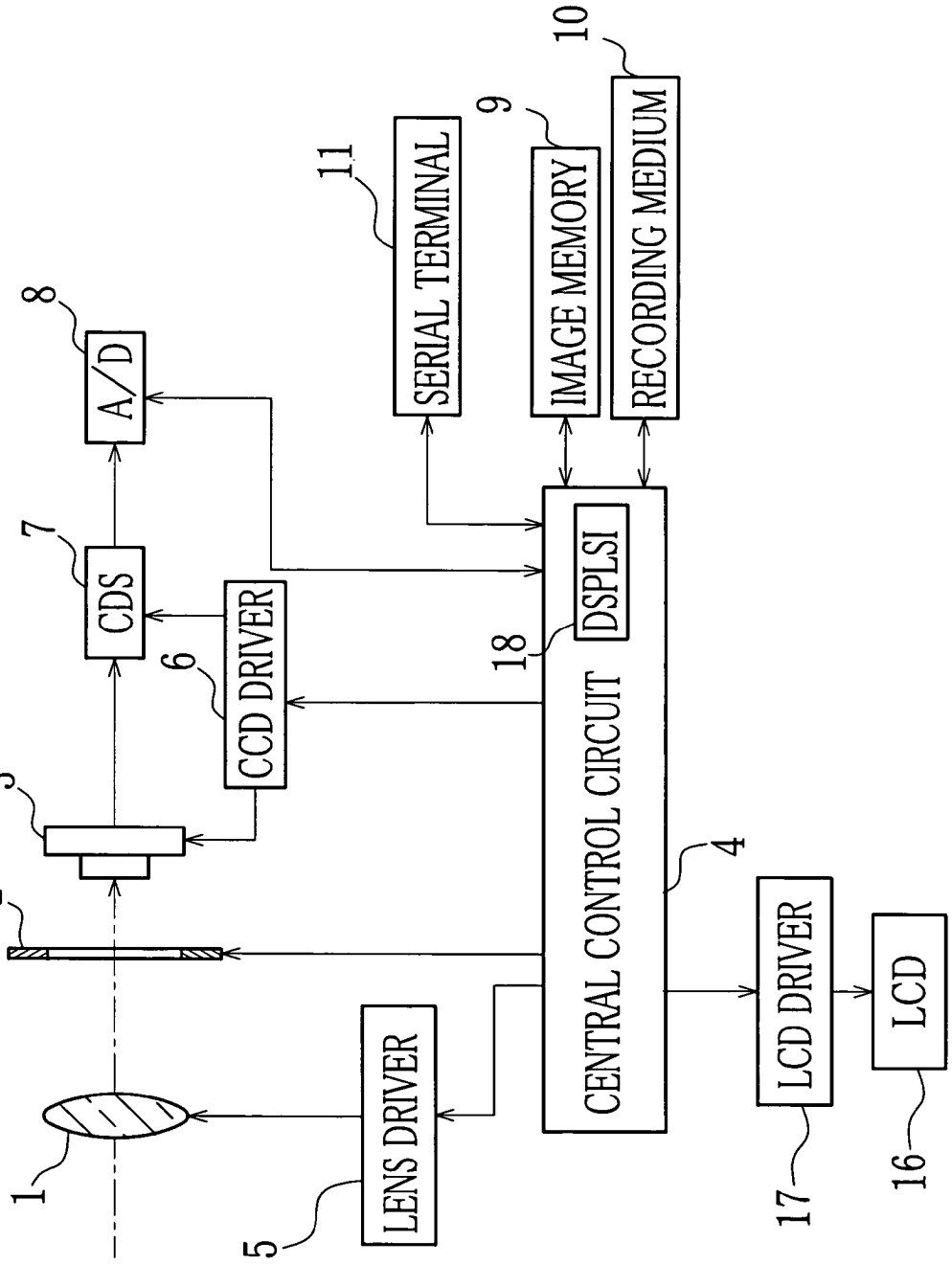

1
2
3
4
5
6
7
8
9
10
11
16
17
18
LENS DRIVER
CCD DRIVER
CDS
A/D
SERIAL TERMINAL
IMAGE MEMORY
RECORDING MEDIUM
CENTRAL CONTROL CIRCUIT
DSPLSI
LCD DRIVER
LCD

FIG.2

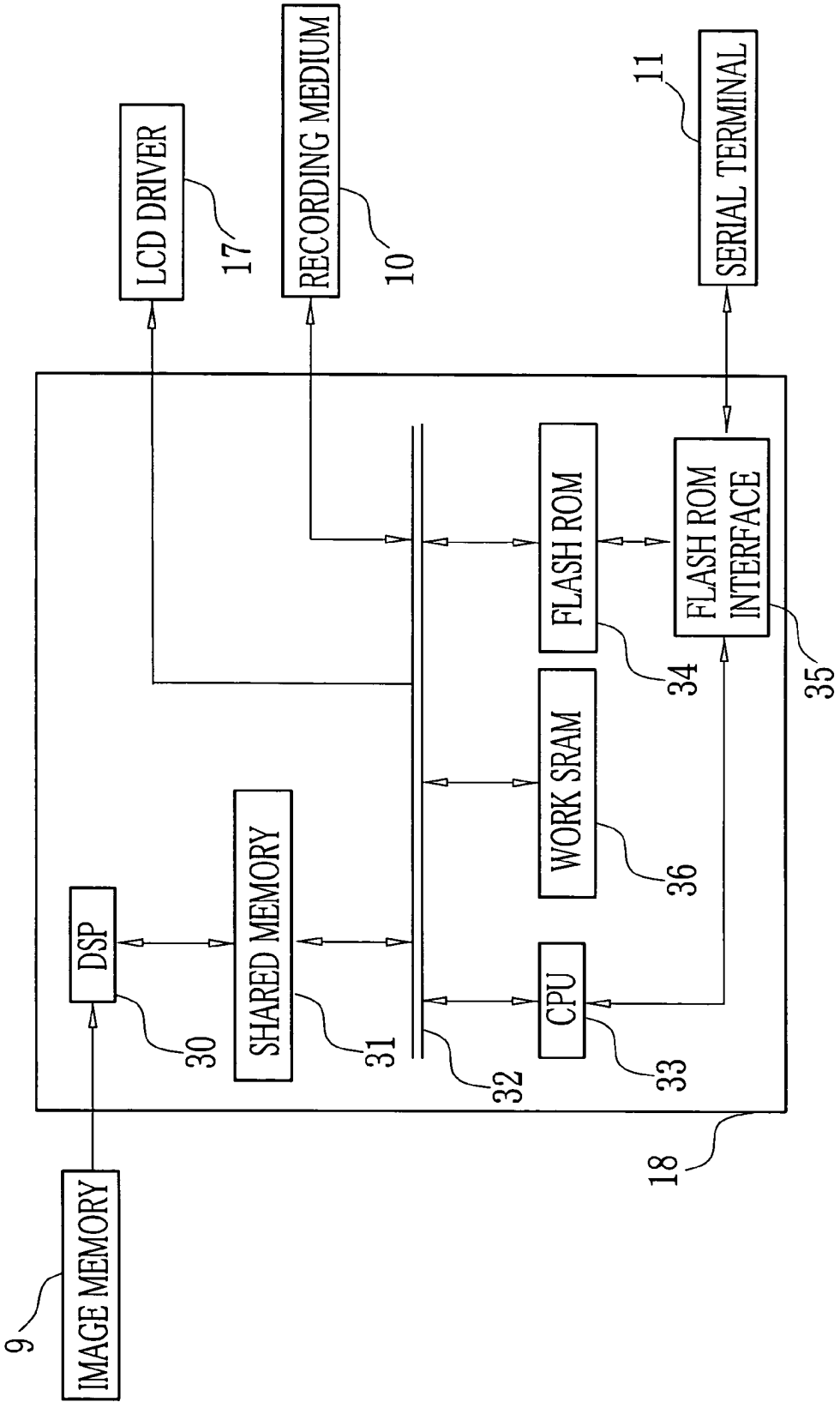

IMAGE MEMORY
9
DSP
30
SHARED MEMORY
31
32
CPU
33
WORK SRAM
36
FLASH ROM
34
FLASH ROM INTERFACE
35
18
LCD DRIVER
17
RECORDING MEDIUM
10
SERIAL TERMINAL
11

FIG.3

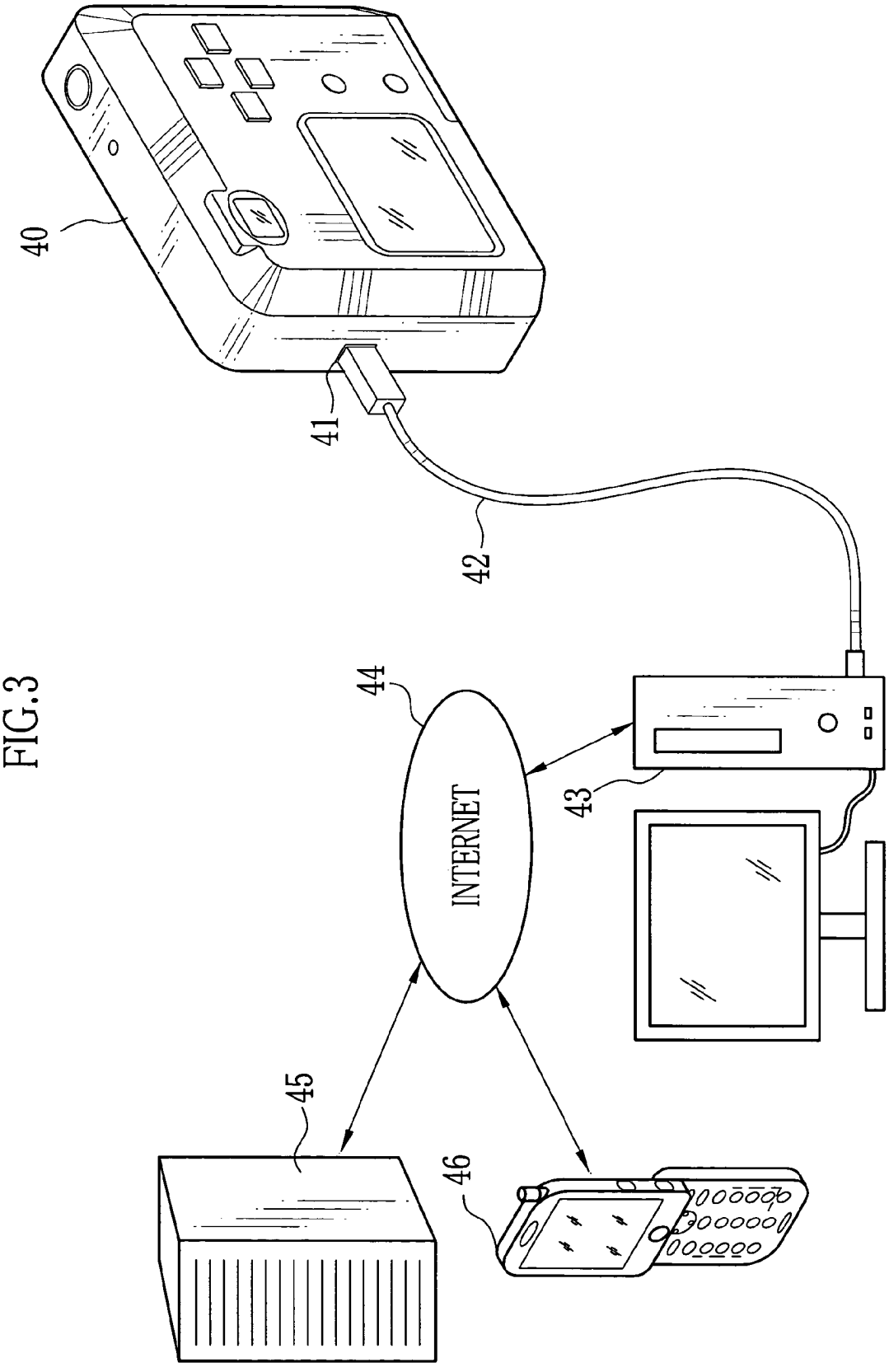


FIG.4

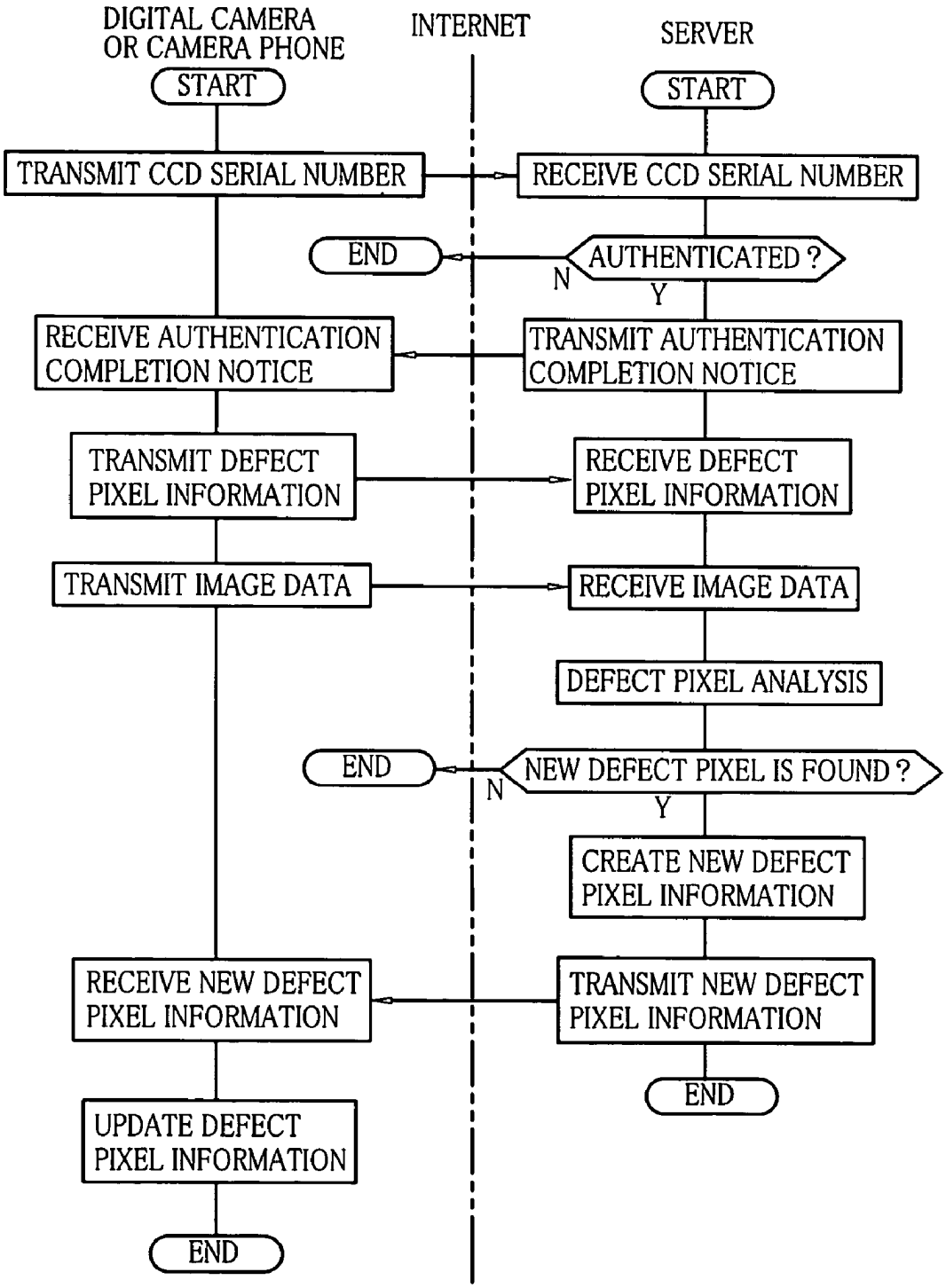
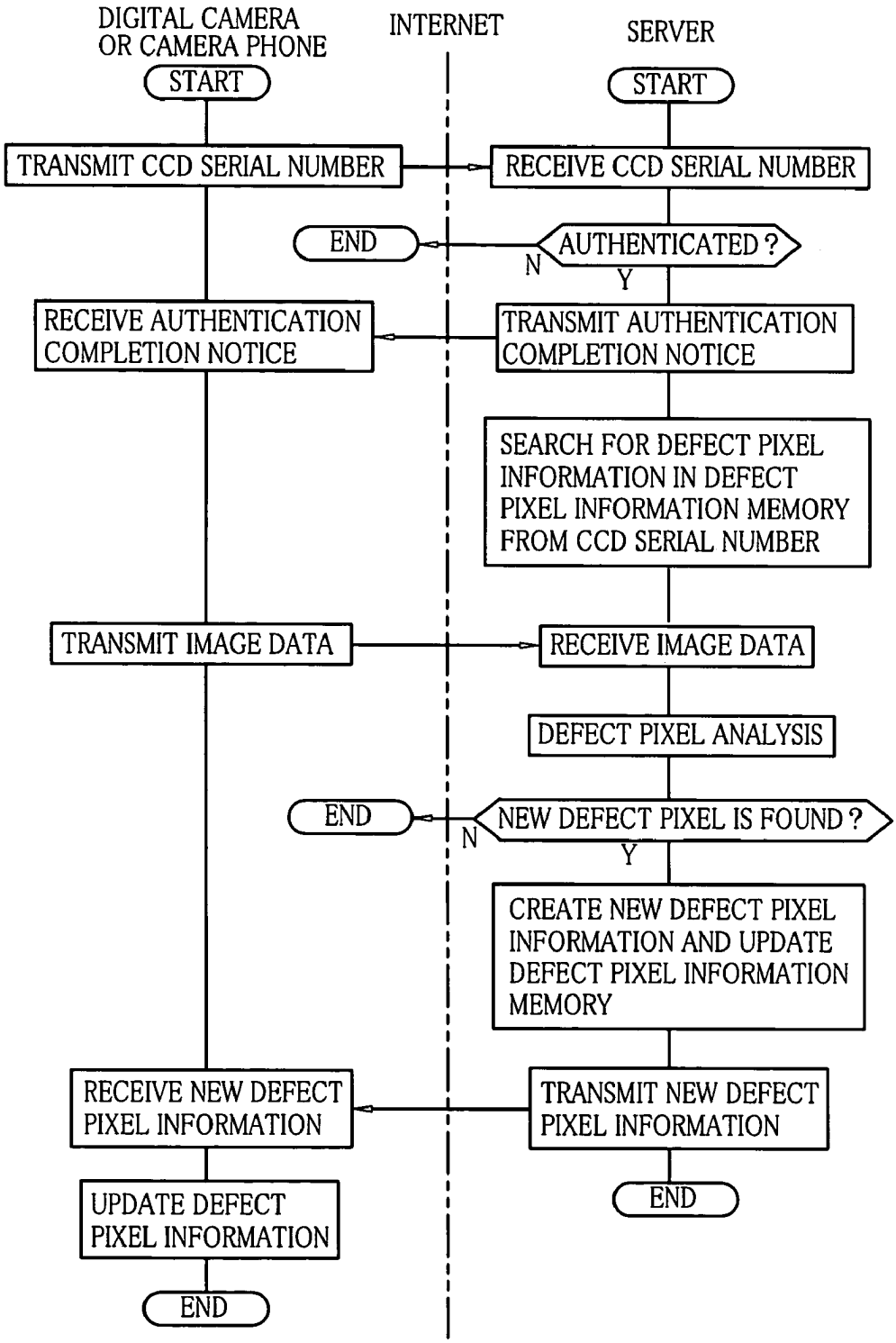

DIGITAL CAMERA OR CAMERA PHONE
INTERNET
SERVER
START
START
TRANSMIT CCD SERIAL NUMBER
RECEIVE CCD SERIAL NUMBER
END
AUTHENTICATED ?
N
Y
RECEIVE AUTHENTICATION COMPLETION NOTICE
TRANSMIT AUTHENTICATION COMPLETION NOTICE
TRANSMIT DEFECT PIXEL INFORMATION
RECEIVE DEFECT PIXEL INFORMATION
TRANSMIT IMAGE DATA
RECEIVE IMAGE DATA
DEFECT PIXEL ANALYSIS
END
NEW DEFECT PIXEL IS FOUND ?
N
Y
CREATE NEW DEFECT PIXEL INFORMATION
RECEIVE NEW DEFECT PIXEL INFORMATION
TRANSMIT NEW DEFECT PIXEL INFORMATION
END
UPDATE DEFECT PIXEL INFORMATION
END

FIG.5


DIGITAL CAMERA OR CAMERA PHONE
INTERNET
SERVER
START
START
TRANSMIT CCD SERIAL NUMBER
RECEIVE CCD SERIAL NUMBER
END
AUTHENTICATED ?
N
Y
RECEIVE AUTHENTICATION COMPLETION NOTICE
TRANSMIT AUTHENTICATION COMPLETION NOTICE
SEARCH FOR DEFECT PIXEL INFORMATION IN DEFECT PIXEL INFORMATION MEMORY FROM CCD SERIAL NUMBER
TRANSMIT IMAGE DATA
RECEIVE IMAGE DATA
DEFECT PIXEL ANALYSIS
END
NEW DEFECT PIXEL IS FOUND ?
N
Y
CREATE NEW DEFECT PIXEL INFORMATION AND UPDATE DEFECT PIXEL INFORMATION MEMORY
RECEIVE NEW DEFECT PIXEL INFORMATION
TRANSMIT NEW DEFECT PIXEL INFORMATION
UPDATE DEFECT PIXEL INFORMATION
END
END

DIGITAL CAMERA AND DEFECT PIXEL COMPENSATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital camera which compensates defect pixels of a solid state imaging device, and a system for compensating defect pixels of a solid state imaging device.

2. Description Related to the Prior Art

In recent years, a digital camera having a solid state imaging device such as a CCD sensor or a CMOS sensor is used. Since such solid state imaging device has at least millions of pixels, it is practically difficult to produce the solid state imaging device with no defect pixel. Accordingly, there is a need to use the solid state imaging device in view of the presence of certain defect pixels.

The defect pixel is a pixel which does not output the signal correctly corresponding to subject brightness. For example, there are a white defect pixel which generates signal (charge) even when the light is not entered and a black defect pixel which does not generate signal (charge) even when the light is entered. The white defect makes a picture pixel brighter, and the black defect makes a picture pixel darker. To prevent a deterioration of image quality caused by the defect pixel, it is already developed a digital camera which compensates the signals of defect pixels by software process.

In digital cameras disclosed in Japanese Patent Laid-Open Publications No. 2000-059690 and No. 05-068209, defect pixels of a solid state imaging device are detected in a production process by a defect inspection machine. Then information of position, kind and degree of the defect of each defect pixel is stored for example in a memory incorporated in the digital camera. Accordingly, output signal of the defect pixel can be compensated by interpolating the output signal of the defect pixels with the output signal of surrounding normal pixels. The solid state imaging devices are expected to have more and more pixels, and therefore the accurate compensation of the defect pixels is essential to increase quality of product.

However, in the digital cameras disclosed in the Japanese Patent Laid-Open Publications No. 2000-059690 and No. 05-068209, although the defect pixels detected at a factory can be compensated, defect pixels newly generated by aging degradation of the solid state device after shipment cannot be compensated.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a digital camera and a defect pixel compensation system which enable to compensate defect pixels generated by aging degradation of a solid state imaging device.

In order to achieve the above object and other objects, a digital camera of the present invention comprises a rewritable nonvolatile memory for storing defect pixel information, a compensation processing section which applies defect pixel compensating process to image data based on the defect pixel information in the nonvolatile memory, a communicating section for transmitting uncompensated image data to a server through an internet and for receiving new defect pixel information from the server, and a defect pixel information recording section which updates the nonvolatile memory with the new defect pixel information. The uncompensated image data is image data to which said defect pixel compensating process is not applied, and the new defect pixel information is obtained on analysis of the uncompensated image data performed by the server.

A defect pixel compensation system of the present invention comprises an imaging apparatus and a server. The imaging apparatus compensates image data of defect pixels with use of defect pixel information. The server analyzes uncompensated image data received from the imaging apparatus to create new defect pixel information and transmitting the new defect pixel information to the imaging apparatus.

According to the present invention, the defect pixel information can be updated at any timing only by the access of the imaging apparatus to the server through the internet. Accordingly, it is possible to compensate the image captured by the solid state imaging device, which includes the defect pixels generated by the aging degradation, without using a tool such as a flash memory writer. Therefore, even if the defect pixels are generated during the lifetime of the solid state imaging device, the image with high quality can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become easily understood by one of ordinary skill in the art when the following detailed description would be read in connection with the accompanying drawings.

FIG. **1** is a block diagram showing a construction of a digital camera of the present invention;

FIG. **2** is a block diagram showing a construction of a DSPLSI in the digital camera;

FIG. **3** is a schematic view of a defect pixel compensation system comprised of a server and a digital camera or a camera phone.

FIG. **4** is a flowchart showing updating processes for defect pixel information based on the defect pixel information memorized in the digital camera or the camera phone; and

FIG. **5** is a flowchart showing updating processes for defect pixel information based on the defect pixel information memorized in the server.

PREFERRED EMBODIMENTS OF THE INVENTION

As shown in FIG. **1**, a CCD imaging device **3** is provided behind a taking lens **1** and a mechanical shutter **2**. The taking lens **1** is moved toward a focal point by a lens driver **5**, which is controlled by a central control circuit **4**, and focuses a subject light on the CCD imaging device **3**. The mechanical shutter **2** is normally in an open state. It is set in a closed state when exposure time passed after the start of image taking action by release operation of a user. Then it is set in the open state again after the image taking action.

The CCD imaging device **3** has a plurality of pixels and converts an optical image of the subject focused on the pixels into electrical signals. A CCD driver **6** generates transfer pulses and feeds them to the CCD imaging device **3**. The CCD imaging device **3** outputs image signals based on the transfer pulses.

To the CCD imaging device **3**, a CDS (correlated double sampling) circuit **7** is connected. The CDS **7** is for reducing noises, and is driven by drive pulses outputted from the CCD driver **6**. To an output terminal of the CDS **7**, an A/D converter **8** is connected. The A/D converter **8** converts the image signal of analog into digital signal (image data) and outputs the image data. The image data of each pixel obtained through the A/D converter **8** is temporarily stored in an image memory **9**.

The image data stored in the image memory **9** is subject to various image processes performed by the central control circuit **4** and is finally recorded in a recording medium **10** such as a memory card or a magnetic optical disc. One of the image processes is a process for compensating the image data from the defect pixels of the CCD imaging device **3** (defect pixel compensation process).

In the central control circuit **4**, a DSPLSI **18** is provided for performing the defect pixel compensation process. To the central control circuit **4**, a serial terminal **11** for accessing a FLASH ROM **34** incorporated in the DSPLSI **18** is connected. In addition, to the central control circuit **4**, an LCD driver **17** for driving an LCD **16** is connected.

Next, the DSPLSI **18** will be described in detail with reference to FIG. **2**. The DSPLSI **18** comprises a DSP **30** for performing the image processes, a CPU **33** which controls each process and reads/writes data from/to each device (a shared memory **31**, a work SRAM **36**, the FLASH ROM **34**, the LCD driver **17** and the recording medium **10**) through a CPU bus **32**, the shared memory **31** from/to which both the DSP **30** and the CPU **33** can read/write data, and the work SRAM **36** storing data to be processed by the CPU **33**. In addition, the DSPLSI **18** comprises the FLASH ROM **34** which is a nonvolatile memory storing data including a serial number of the CCD imaging device **3** and the defect pixel information showing positions of the defect pixels, and a FLASH ROM interface **35** which is a circuit for communicating with a computer through serial communication to read out data stored in the FLASH ROM **34** and to write data into the FLASH ROM **34**.

The defect pixel information and the serial number is written in the FLASH ROM **34** in a production process of a digital camera **40**. The defect pixel information is used to determine the positions of the defect pixels, and the serial number is used to authenticate the CCD imaging device **3** when updating of the defect pixel information through the communication with the server **45**.

Since new defect pixels are generated in the CCD imaging sensor **3** by time deterioration after shipment, the update of the defect pixel information is required. As shown in FIG. **3**, the user connects the digital camera **40** to the computer **43** at an appropriate timing to update the defect pixel information from the server **45** through an internet **44**.

The FLASH ROM interface **35** outputs the serial number of the CCD imaging device **3**, the defect pixel information and image data for a defect pixel analysis to the server **45** through the serial terminal **11** according to control signal from the CPU **33**. The image data for the analysis is image data which is read from the recording medium **10** and written in the FLASH ROM **34** by the CPU **33**. In addition, the FLASH ROM interface **35** receives an authentication completion notice of the serial number of the CCD imaging device **3** and renewed defect pixel information, from the server **45** through the serial terminal **11**. This reception is informed to the CPU **33** by control signal from the CPU **33**. When receiving the renewed defect pixel information, the FLASH ROM interface **35** updates the defect pixel information stored in the FLASH ROM **34**.

The CPU **33** reads out the defect pixel information, which is used by the DSP **30** for the image compensation, from the FLASH ROM **34** and writes it to the shared memory **31**. The DSP **30** performs the defect pixel compensation process to the image data stored in the image memory **9** using the defect pixel information written in the shared memory **31**, and writes the compensated image data into the shared memory **31**. The defect pixel compensation process may be the interpolation of the output signal from the defect pixels with the output signal from surrounding normal pixels. Then the image data in the shared memory **31** is written in the recording medium **10** by the CPU **33**. To reproduce the image, the CPU **33** reads out the image data from the recording medium **10**, and outputs the image data to the LCD **16** through the LCD driver **17**. Note that in the work SRAM **36**, data used by the CPU **33** to perform each process is stored.

For the connection between the digital camera **40** and the computer **43**, one end terminal of a serial cable **42** is connected to the serial terminal **41** of the digital camera **40**, and the other end terminal of the serial cable **42** is connected to a serial terminal of the computer **43**. The computer **43** accesses the internet **44** for communicating with the server **45**. The computer **43** stores a software for mutually converting the serial communication between the computer **43** and the digital camera **40** and the internet communication between the computer **43** and the server **45**.

With reference to FIG. **4**, the operation of the server **45** and the digital camera **40** for updating the defect pixel information will be described. In the updating, at first the CCD serial number stored in the FLASH ROM **34** is transmitted to the server **45**. The server **45** performs authentication of the CCD serial number, to determine whether the CCD imaging device **3** is the authenticated product or not. When the CCD serial number is not authenticated, the updating is stopped. When the CCD serial number is authenticated, the server **45** transmits the authentication completion notice to the digital camera **40**. The digital camera **40** transmits the defect pixel information and the image data for the defect pixel analysis stored in the FLASH ROM **34** to the server **45** after receiving the authentication completion notice. The image data for defect pixels is image data previously captured by the user, to which the defect pixel compensation process is not applied.

The server **45** analyzes this image data to compare with the defect pixel information, and determines positions of defect pixels newly generated by the aging degradation. When there is no new defect pixel, the server **45** stops the updating. When there are new defect pixels, the server **45** creates the new defect pixel information by adding the positions of the new defect pixels to the received defect pixel information, and transmits the new defect pixel information to the digital camera **40**. The digital camera **40** receives the new defect pixel information, and updates the defect pixel information stored in the FLASH ROM **34**.

In the above embodiment, the defect pixel information is stored in the digital camera and transmitted to the server from the digital camera. However, the defect pixel information may be stored in a memory of the server preliminarily. In this case, as shown in a flowchart of FIG. **5**, the defect pixel information is obtained from a defect pixel information memory provided in the server. The defect pixel information memory has plural storing regions respectively assigned to each of the CCD serial numbers, and the defect pixel information determined in the production process is stored in the corresponding storing region. After completing the receive of the CCD serial number from the digital camera and the authentication of the CCD serial number, the server searches the storing regions of the defect pixel information memory to obtain the defect pixel information corresponding to the CCD serial number. Then the server analyzes image data received from the digital camera to compare with the defect pixel information, and determines positions of defect pixels newly generated. When there is no new defect pixel, the server stops the updating. When there are new defect pixels, the server creates the new defect pixel information by adding the posi-

tions of the new defect pixels to the defect pixel information memory, and transmits the new defect pixel information to the digital camera.

In the above embodiment, the digital camera **40** is used in the defect pixel compensation system. However, a camera phone **46** also may be used in this system. In this case, the camera phone **46** communicates with the server **45** through a wireless communication function incorporated in the camera phone, to perform the processes shown in FIG. **4** and FIG. **5**. Accordingly, the updating of the defect pixel information can be performed as same as the system with the digital camera **40**. In addition, although the CCD imaging device is used in the above embodiment, a CMOS imaging device also may be used.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A digital camera, which includes a solid state imaging device having a plurality of pixels for photoelectrically converting a subject image to obtain image data of said subject image, comprising:

a rewritable nonvolatile memory for storing defect pixel information about defect pixels;

a compensation processing section which applies defect pixel compensating process to said image data based on said defect pixel information stored in said nonvolatile memory;

a communicating section for transmitting uncompensated image data to a server through an internet and for receiving new defect pixel information from said server, said uncompensated image data being image data to which said defect pixel compensating process is not applied, and said new defect pixel information being obtained by analysis of said uncompensated image data performed by said server; and

a defect pixel information recording section which updates said nonvolatile memory with said new defect pixel information.

2. A digital camera claimed in claim **1**, wherein said communicating section transmits said defect pixel information with said uncompensated image data to said server.

3. A digital camera claimed in claim **1**, wherein said communicating section transmits unique identification information of said solid state imaging device with said uncompensated image data to said server.

4. A digital camera claimed in claim **1**, wherein said communicating section has a serial terminal for serial communication with an external computer, said external computer accessing said internet for internet communication with said server.

5. A defect pixel compensation system comprising:

an imaging apparatus including:

a solid state imaging device having a plurality of pixels for photoelectrically converting a subject image;

a rewritable nonvolatile memory for storing defect pixel information about defect pixels; and

a compensation processing section which applies defect pixel compensating process to said image data based on said defect pixel information stored in said nonvolatile memory, and

a server for analyzing uncompensated image data received from said imaging apparatus to create new defect pixel information and transmitting said new defect pixel information to said imaging apparatus, said uncompensated image data being image data to which said defect pixel compensating process is not applied.

6. A defect pixel compensation system claimed in claim **5**, wherein said imaging apparatus comprises:

a communicating section for transmitting said uncompensated image data to said server through an internet and for receiving said new defect pixel information from said server; and

a defect pixel information recording section which updates said nonvolatile memory with said new defect pixel information.

7. A defect pixel compensation system claimed in claim **6**, wherein said server analyzes said uncompensated image data to compare with said defect pixel information, said server creating said new defect pixel information by adding positions of said new defect pixels to said defect pixel information when detecting new defect pixels generated by aging degradation.

8. A defect pixel compensation system claimed in claim **6**, wherein said server has a defect pixel information memory for preliminarily storing said defect pixel information and analyzes said uncompensated image data to compare with said defect pixel information in said defect pixel information memory, said server creating said new defect pixel information by adding positions of said new defect pixels to said defect pixel information memory when detecting new defect pixels generated by aging degradation.

9. A defect pixel compensation system claimed in claim **8**, wherein said defect pixel information memory has plural recording regions each of which contains said defect pixel information and unique identification information of a solid state imaging device incorporated in each of imaging apparatuses, said imaging apparatus transmitting said identification information with said uncompensated image data to said server, said server creating said new defect pixel information by adding positions of said new defect pixels to said recording region designated by said identification information.

10. A defect pixel compensation system claimed in claim **6**, wherein said communicating section has a serial terminal for performing serial communication with an external computer, said external computer accessing said internet for performing internet communication with said server.

11. A defect pixel compensation system claimed in claim **6**, wherein said communicating section has a wireless communication function and wirelessly accesses said internet for performing internet communication with said server.

12. A defect pixel compensation method for an imaging device comprising:

storing information about defective pixels in nonvolatile memory;

photoelectrically converting a subject image by a solid state imaging device having a plurality of pixels;

transmitting uncompensated image data, the stored defect pixel information and unique identification information of the solid state imaging device to a server, the uncompensated image data being image data to which a defect pixel compensating process is not applied;

receiving new defect pixel information from the server, the new defect pixel information being obtained by analysis of the uncompensated image data performed by the server; and

updating the nonvolatile memory with the new defect pixel information; and

applying a defect pixel compensating process to the image data based on the defect pixel information stored in the nonvolatile memory.

13. A defect pixel compensating method for a server comprising:

receiving uncompensated image data, defect pixel information and unique identification information of a solid state imaging device from an imaging device, the uncompensated image data being image data to which a defect pixel compensating process is not applied;

performing authentication of the unique identification information of the solid state imaging device to determine whether or not the solid state imaging device is an authentic product;

analyzing uncompensated image data to compare with the defect pixel information to create new defect pixel information; and

transmitting the new defect pixel information to the imaging device.

14. A defect pixel compensation method claimed in claim **13**, wherein the server has a defect pixel information memory for preliminarily storing the defect pixel information and analyzes the uncompensated image data to compare with the defect pixel information in the defect pixel information memory, the server creating the new defect pixel information by adding positions of the new defect pixels to the defect pixel information memory when detecting new defect pixels generated by aging degradation.

* * * * *