US 20040165101A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2004/0165101 A1

Miyanari et al. (43) Pub. Date: Aug. 26, 2004

(54) IMAGE SENSING APPARATUS, CONTROL METHOD THEREFOR, STORAGE MEDIUM, AND PROGRAM

(76) Inventors: **Hiroshi Miyanari**, Kanagawa (JP); **Akira Egawa**, Kanagawa (JP)

Correspondence Address:
MORGAN & FINNEGAN, L.L.P.
345 PARK AVENUE
NEW YORK, NY 10154 (US)

(21) Appl. No.: **10/786,864**

(22) Filed: **Feb. 24, 2004**

(30) **Foreign Application Priority Data**

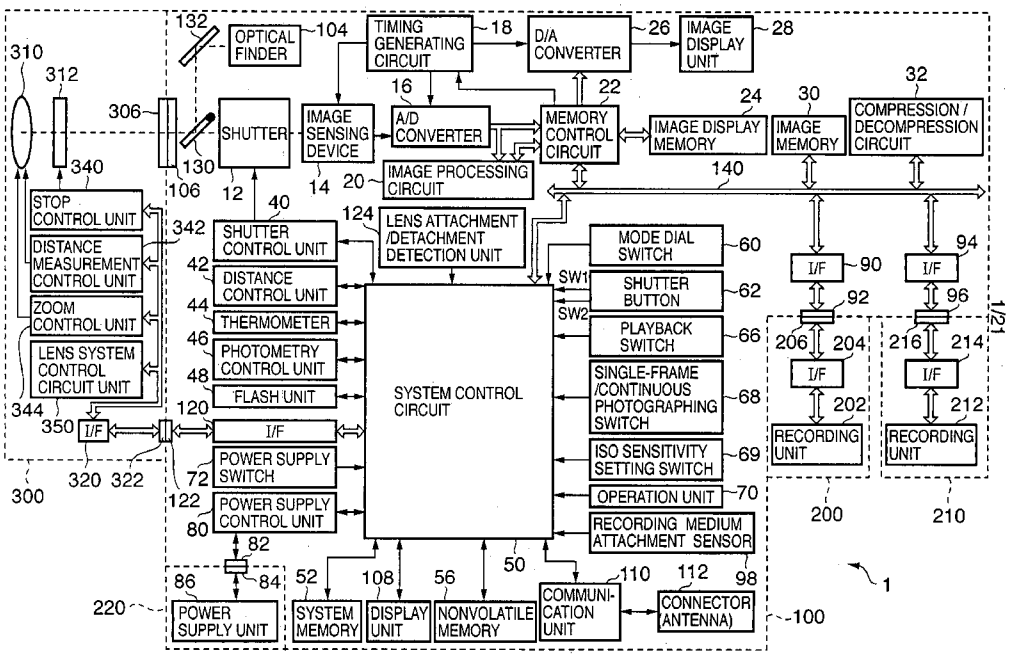
Feb. 26, 2003 (JP) 2003-049698
Jul. 31, 2003 (JP) 2003-283973

Publication Classification

(51) **Int. Cl.**[7] **H04N 5/238**
(52) **U.S. Cl.** **348/363**

(57) **ABSTRACT**

It is an object to provide an image sensing apparatus which can shorten the time required for the creation of correction data by reducing the amount of data used for the creation of correction data. In order to achieve the above object, an image sensing apparatus according to this invention includes a plurality of pixels, a first calculating unit which creates correction data by performing computation using signals which are acquired by image sensing in an unexposed state and smaller in number than said plurality of pixels, and a second calculating unit which corrects image data of the plurality of pixels, acquired by image sensing in an exposed state, by using the correction data.



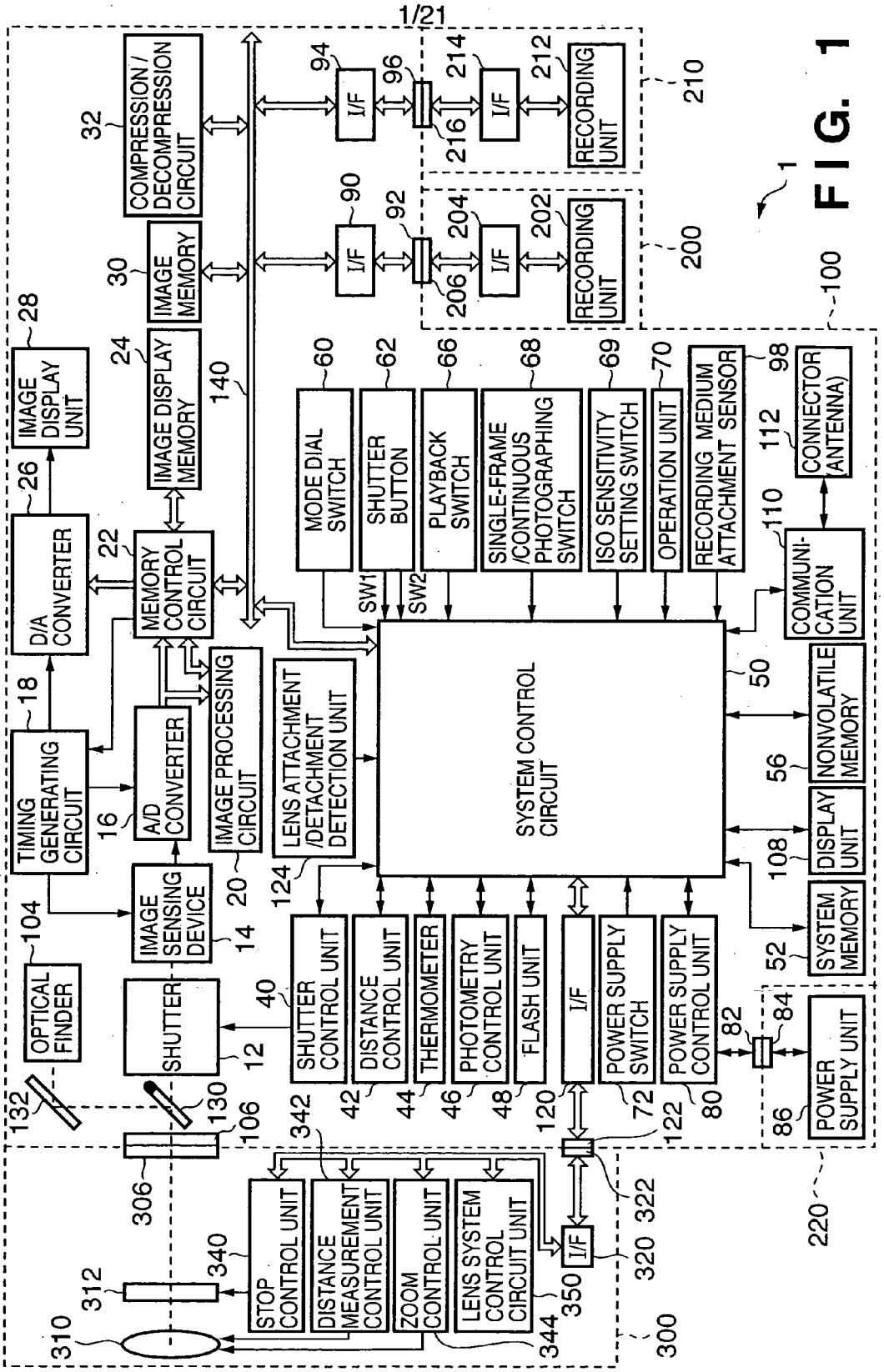

1/21
1
100
200
210
220
300
SYSTEM CONTROL CIRCUIT
50
COMPRESSION / DECOMPRESSION CIRCUIT
32
IMAGE MEMORY
30
IMAGE DISPLAY MEMORY
24
140
MEMORY CONTROL CIRCUIT
22
D/A CONVERTER
26
IMAGE DISPLAY UNIT
28
TIMING GENERATING CIRCUIT
18
A/D CONVERTER
16
IMAGE PROCESSING CIRCUIT
20
IMAGE SENSING DEVICE
14
LENS ATTACHMENT /DETACHMENT DETECTION UNIT
124
OPTICAL FINDER
104
SHUTTER
12
130
132
106
306
SHUTTER CONTROL UNIT
40
DISTANCE CONTROL UNIT
42
THERMOMETER
44
PHOTOMETRY CONTROL UNIT
46
FLASH UNIT
48
I/F
120
122
POWER SUPPLY SWITCH
72
POWER SUPPLY CONTROL UNIT
80
82
84
86
POWER SUPPLY UNIT
342
STOP CONTROL UNIT
340
DISTANCE MEASUREMENT CONTROL UNIT
ZOOM CONTROL UNIT
LENS SYSTEM CONTROL CIRCUIT UNIT
344
I/F
350
320
322
310
312
I/F
94
96
216
214
I/F
212
RECORDING UNIT
I/F
90
92
206
204
I/F
202
RECORDING UNIT
MODE DIAL SWITCH
60
SHUTTER BUTTON
62
PLAYBACK SWITCH
66
SINGLE-FRAME /CONTINUOUS PHOTOGRAPHING SWITCH
68
ISO SENSITIVITY SETTING SWITCH
69
OPERATION UNIT
70
RECORDING MEDIUM ATTACHMENT SENSOR
98
CONNECTOR (ANTENNA)
112
110
COMMUNI-CATION UNIT
SW1
SW2
NONVOLATILE MEMORY
56
DISPLAY UNIT
108
SYSTEM MEMORY
52

FIG. 1

FIG. 2

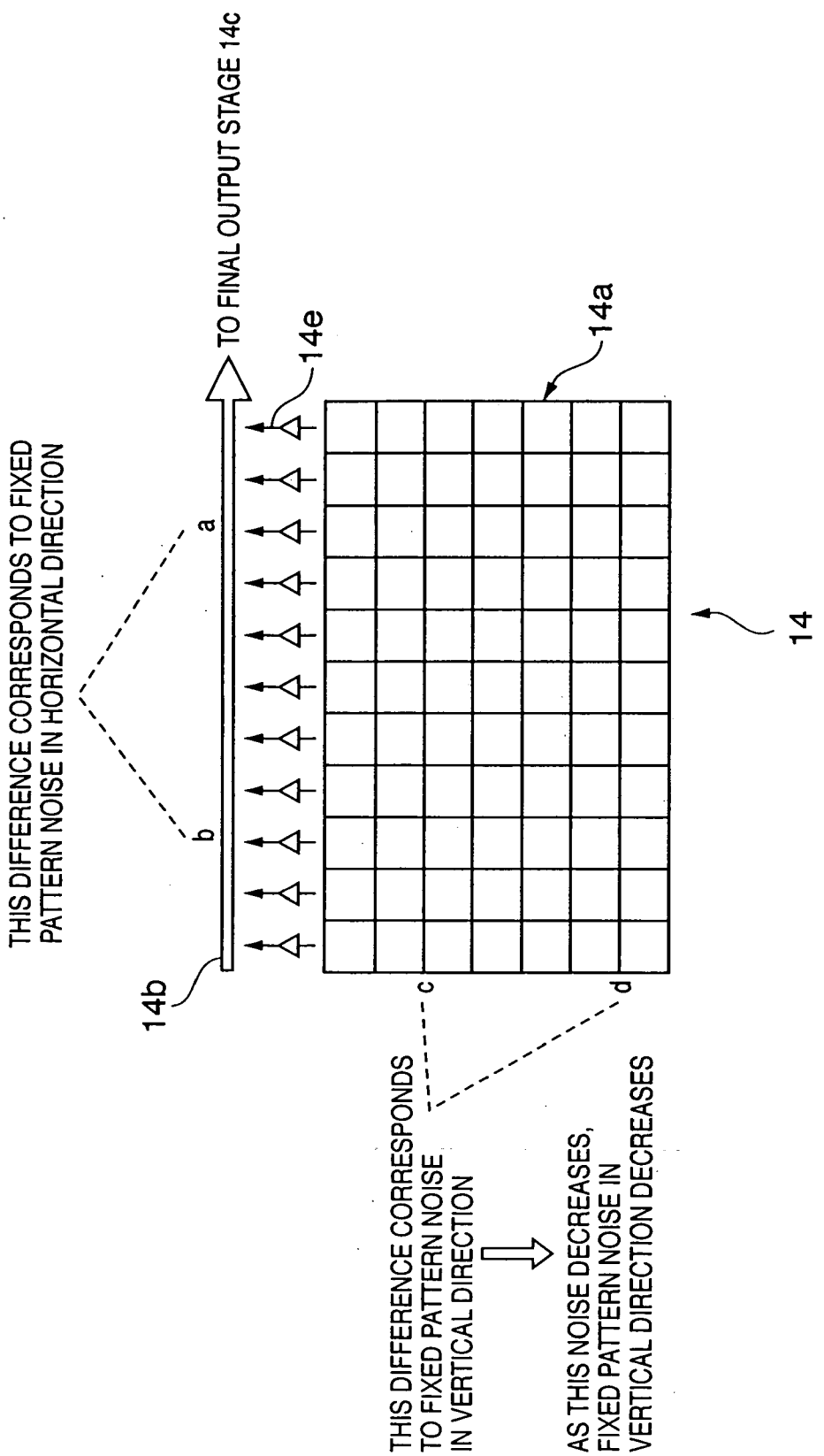

THIS DIFFERENCE CORRESPONDS TO FIXED PATTERN NOISE IN HORIZONTAL DIRECTION
TO FINAL OUTPUT STAGE 14c
14e
14a
14
a
b
14b
c
d
THIS DIFFERENCE CORRESPONDS TO FIXED PATTERN NOISE IN VERTICAL DIRECTION
AS THIS NOISE DECREASES, FIXED PATTERN NOISE IN VERTICAL DIRECTION DECREASES

FIG. 3

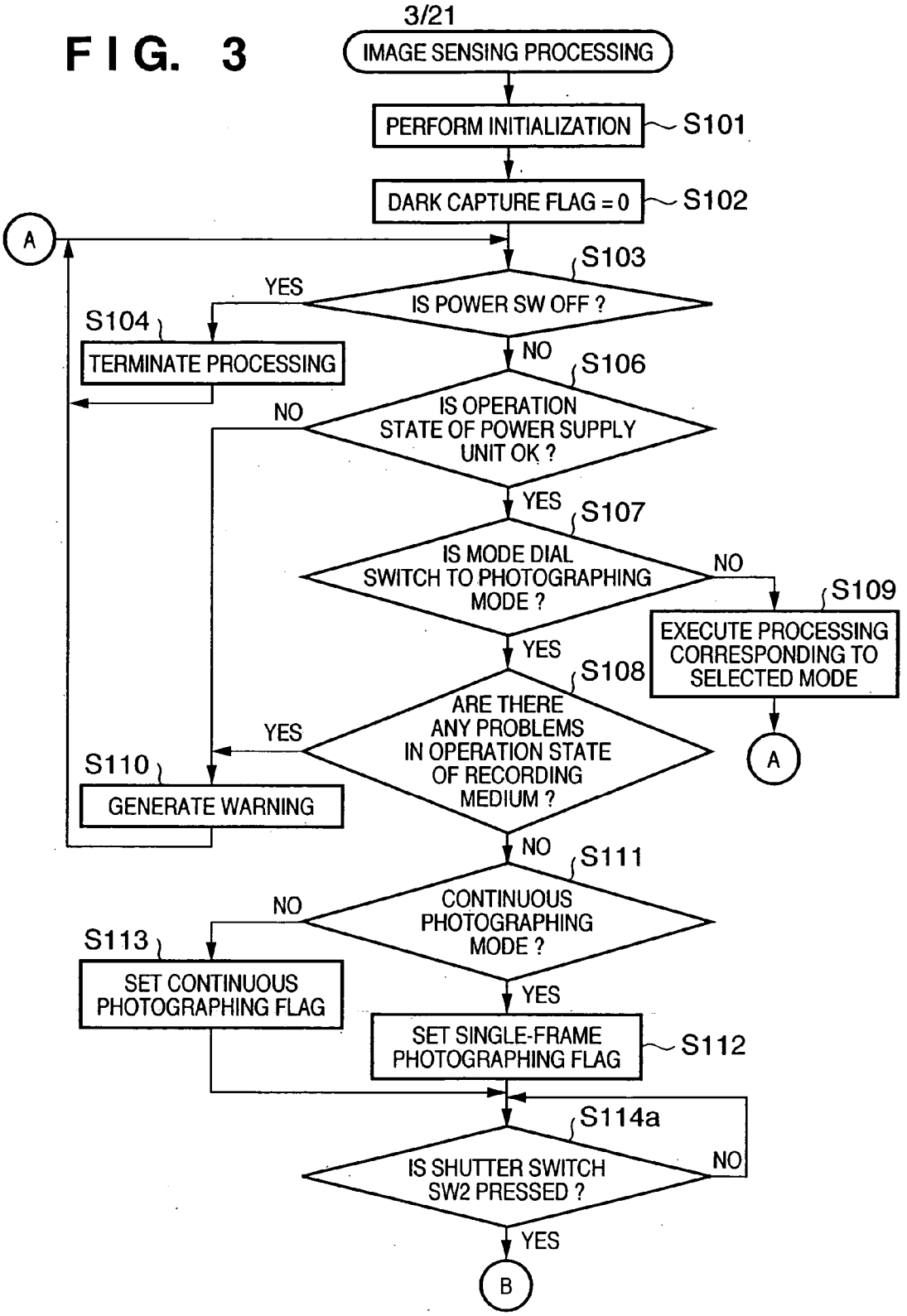

3/21
IMAGE SENSING PROCESSING
PERFORM INITIALIZATION
S101
DARK CAPTURE FLAG = 0
S102
A
S103
IS POWER SW OFF ?
YES
S104
TERMINATE PROCESSING
NO
S106
IS OPERATION STATE OF POWER SUPPLY UNIT OK ?
NO
YES
S107
IS MODE DIAL SWITCH TO PHOTOGRAPHING MODE ?
NO
S109
EXECUTE PROCESSING CORRESPONDING TO SELECTED MODE
A
YES
S108
ARE THERE ANY PROBLEMS IN OPERATION STATE OF RECORDING MEDIUM ?
YES
S110
GENERATE WARNING
NO
S111
CONTINUOUS PHOTOGRAPHING MODE ?
NO
S113
SET CONTINUOUS PHOTOGRAPHING FLAG
YES
SET SINGLE-FRAME PHOTOGRAPHING FLAG
S112
S114a
IS SHUTTER SWITCH SW2 PRESSED ?
NO
YES
B

FIG. 4

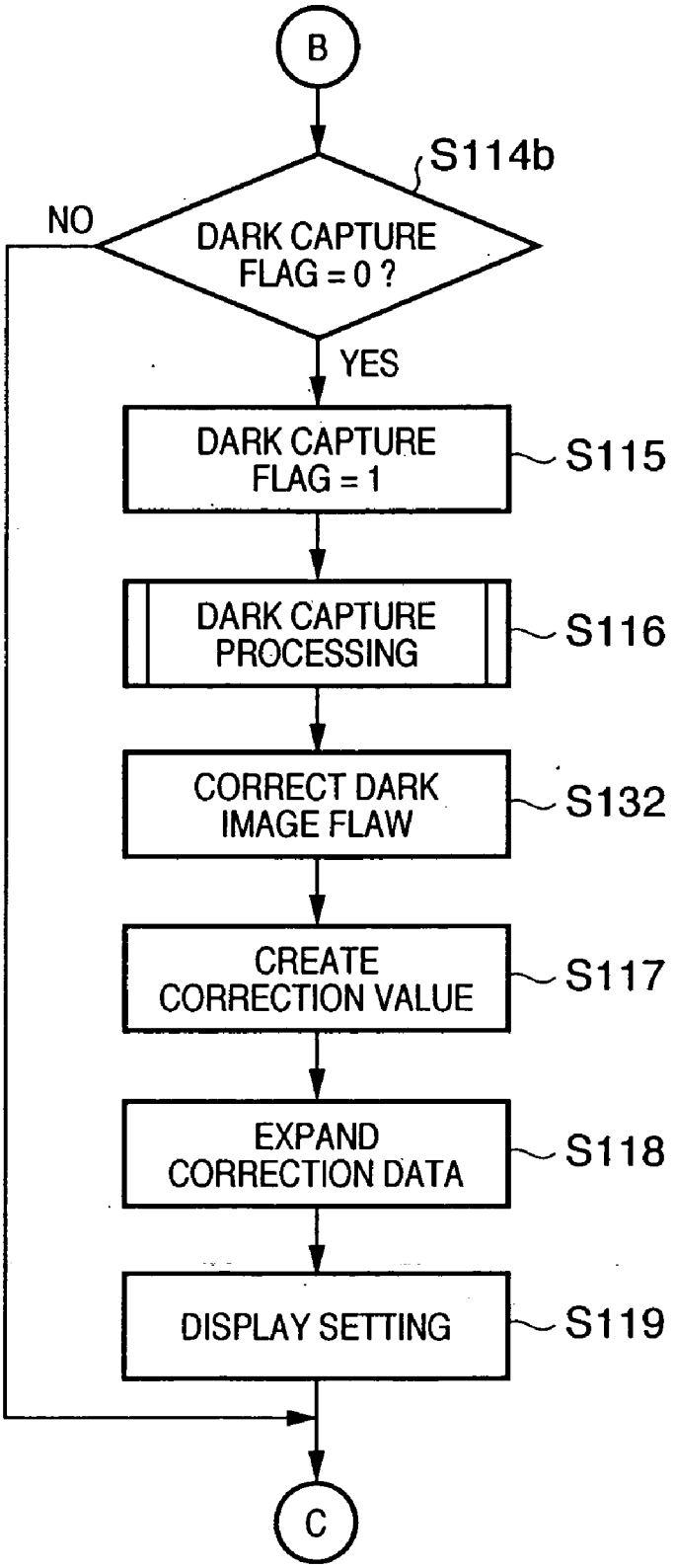

B
S114b
NO
DARK CAPTURE FLAG = 0 ?
YES
DARK CAPTURE FLAG = 1
S115
DARK CAPTURE PROCESSING
S116
CORRECT DARK IMAGE FLAW
S132
CREATE CORRECTION VALUE
S117
EXPAND CORRECTION DATA
S118
DISPLAY SETTING
S119
C

FIG. 5

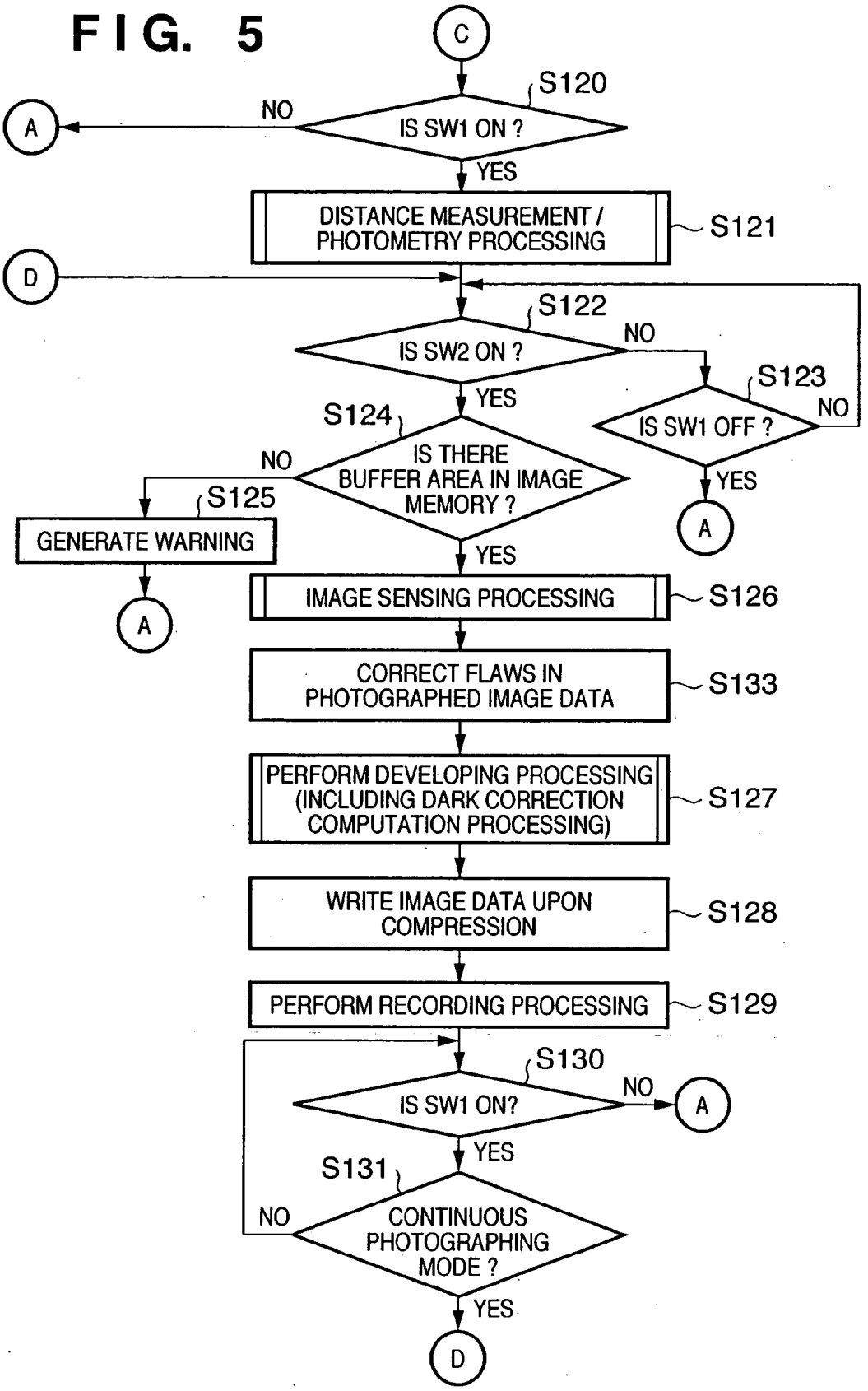

C
S120
IS SW1 ON ?
NO
A
YES
DISTANCE MEASUREMENT / PHOTOMETRY PROCESSING
S121
D
S122
IS SW2 ON ?
NO
YES
S123
IS SW1 OFF ?
NO
YES
A
S124
IS THERE BUFFER AREA IN IMAGE MEMORY ?
NO
S125
GENERATE WARNING
A
YES
IMAGE SENSING PROCESSING
S126
CORRECT FLAWS IN PHOTOGRAPHED IMAGE DATA
S133
PERFORM DEVELOPING PROCESSING (INCLUDING DARK CORRECTION COMPUTATION PROCESSING)
S127
WRITE IMAGE DATA UPON COMPRESSION
S128
PERFORM RECORDING PROCESSING
S129
S130
IS SW1 ON?
NO
A
YES
S131
CONTINUOUS PHOTOGRAPHING MODE ?
NO
YES
D

FIG. 6

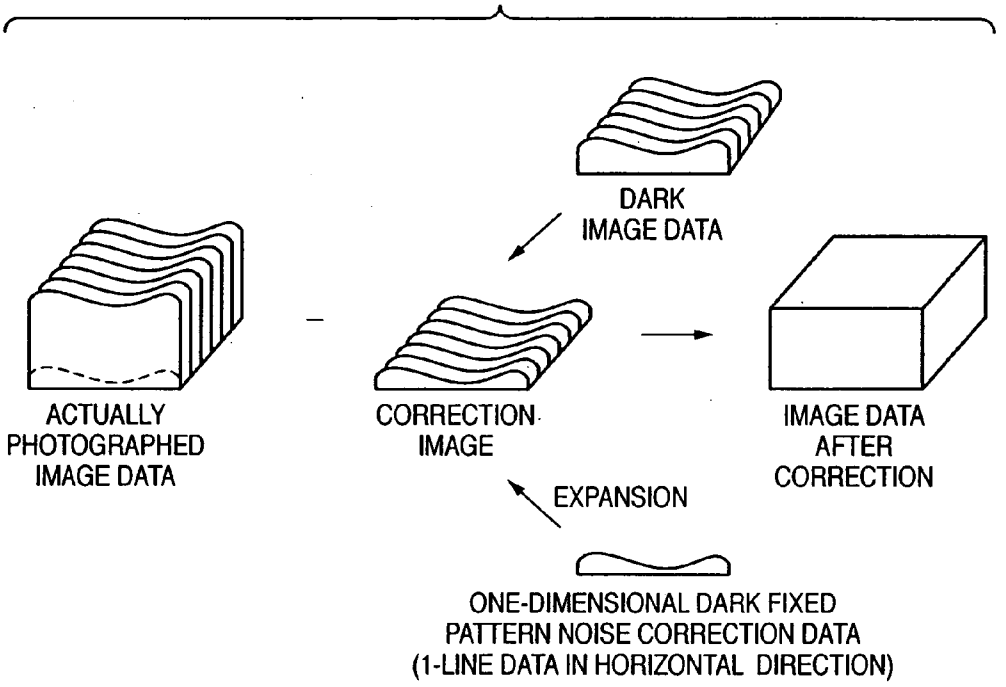

DARK
IMAGE DATA
ACTUALLY
PHOTOGRAPHED
IMAGE DATA
CORRECTION
IMAGE
IMAGE DATA
AFTER
CORRECTION
EXPANSION
ONE-DIMENSIONAL DARK FIXED
PATTERN NOISE CORRECTION DATA
(1-LINE DATA IN HORIZONTAL DIRECTION)

FIG. 7

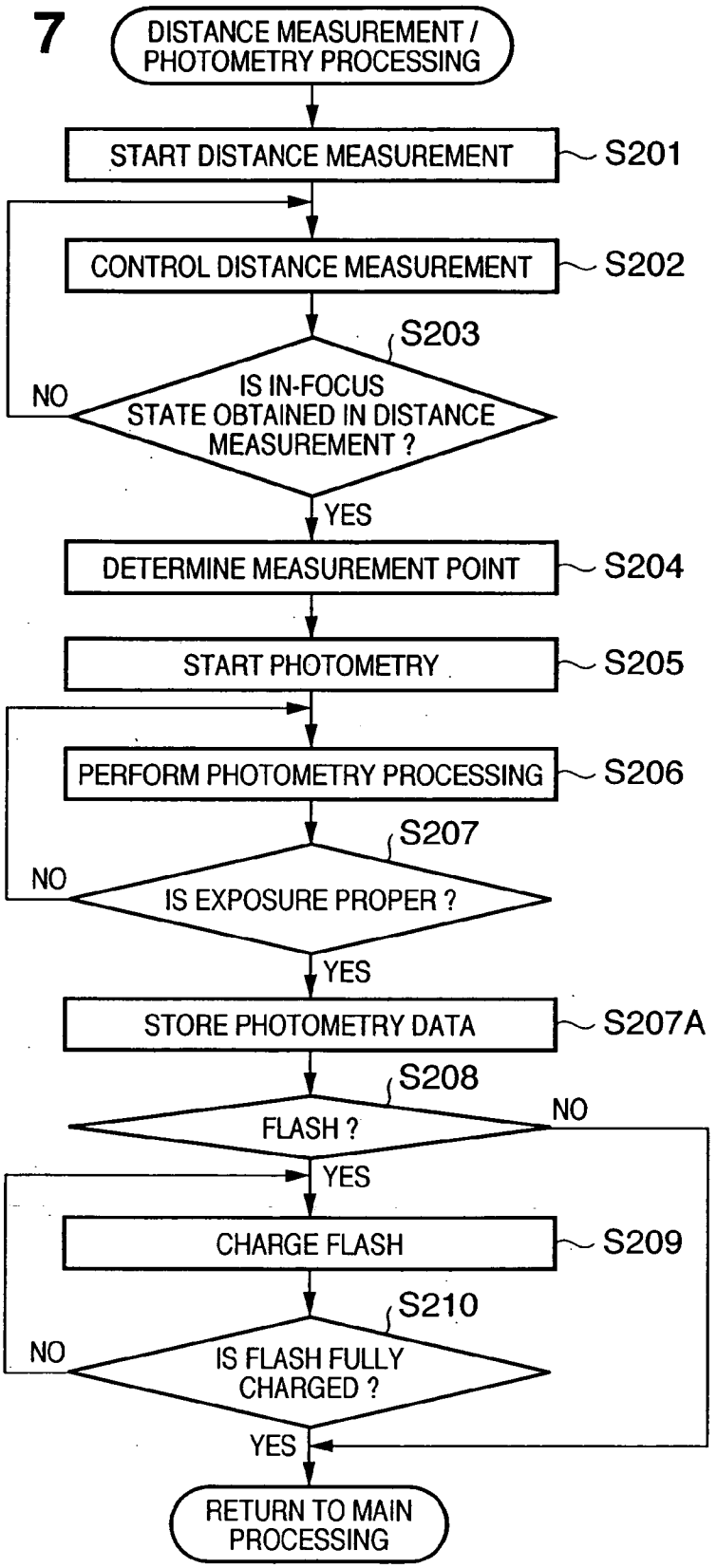

DISTANCE MEASUREMENT / PHOTOMETRY PROCESSING
START DISTANCE MEASUREMENT
S201
CONTROL DISTANCE MEASUREMENT
S202
S203
IS IN-FOCUS STATE OBTAINED IN DISTANCE MEASUREMENT ?
NO
YES
DETERMINE MEASUREMENT POINT
S204
START PHOTOMETRY
S205
PERFORM PHOTOMETRY PROCESSING
S206
S207
IS EXPOSURE PROPER ?
NO
YES
STORE PHOTOMETRY DATA
S207A
S208
FLASH ?
NO
YES
CHARGE FLASH
S209
S210
IS FLASH FULLY CHARGED ?
NO
YES
RETURN TO MAIN PROCESSING

FIG. 8

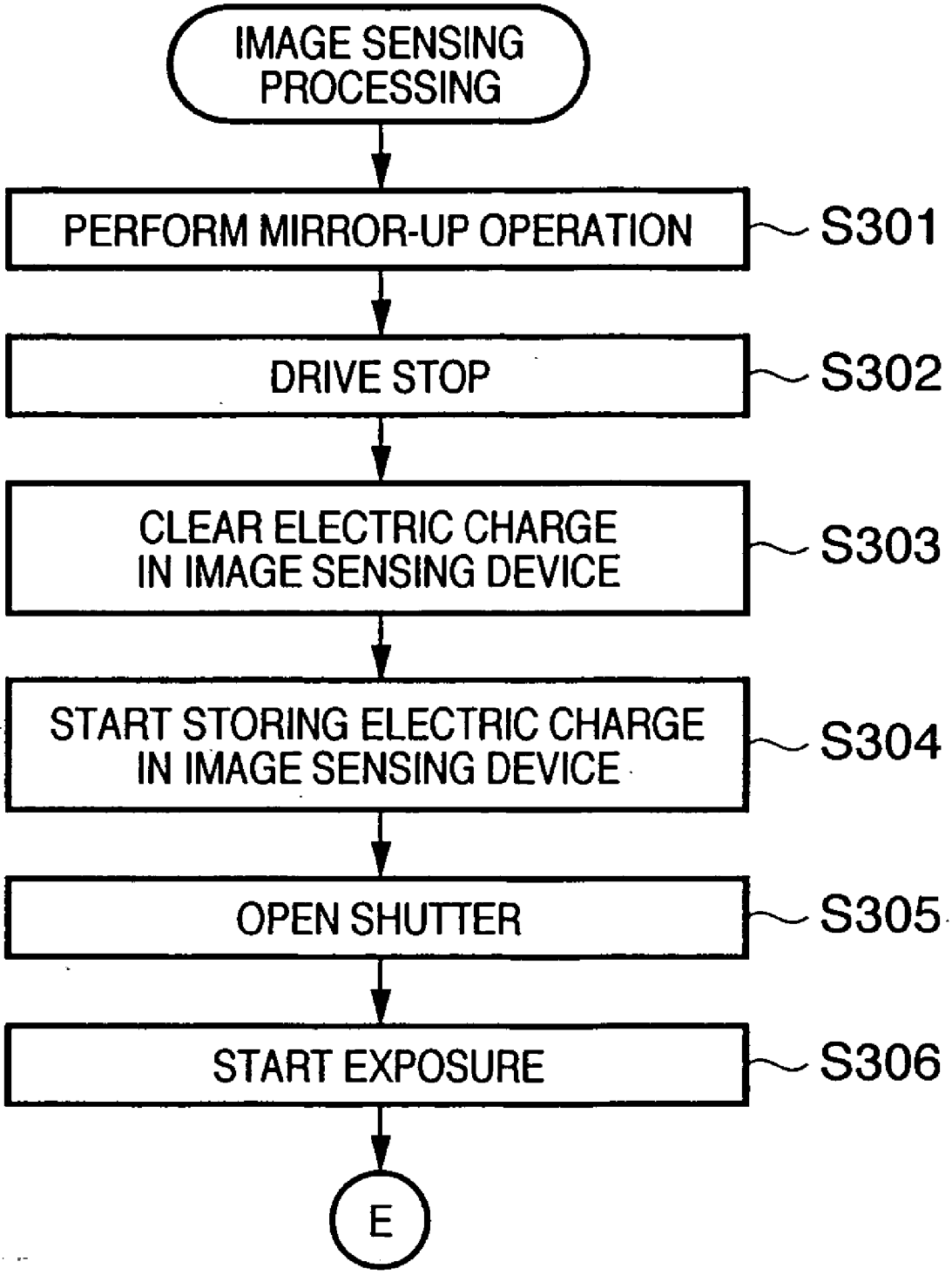

IMAGE SENSING PROCESSING
PERFORM MIRROR-UP OPERATION
S301
DRIVE STOP
S302
CLEAR ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S303
START STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S304
OPEN SHUTTER
S305
START EXPOSURE
S306
E

FIG. 9

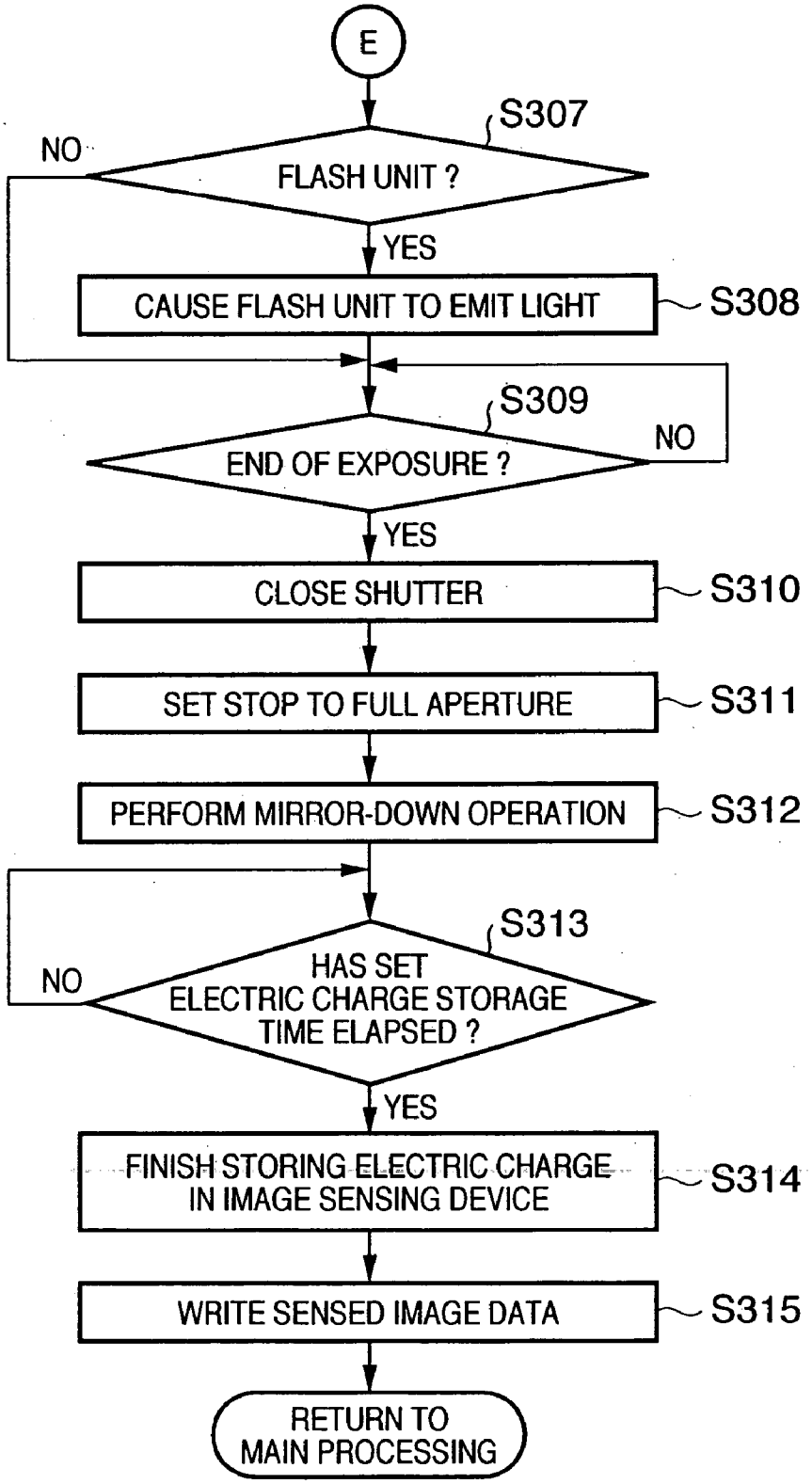

E
S307
NO
FLASH UNIT ?
YES
CAUSE FLASH UNIT TO EMIT LIGHT
S308
S309
NO
END OF EXPOSURE ?
YES
CLOSE SHUTTER
S310
SET STOP TO FULL APERTURE
S311
PERFORM MIRROR-DOWN OPERATION
S312
S313
NO
HAS SET ELECTRIC CHARGE STORAGE TIME ELAPSED ?
YES
FINISH STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S314
WRITE SENSED IMAGE DATA
S315
RETURN TO MAIN PROCESSING

FIG. 10

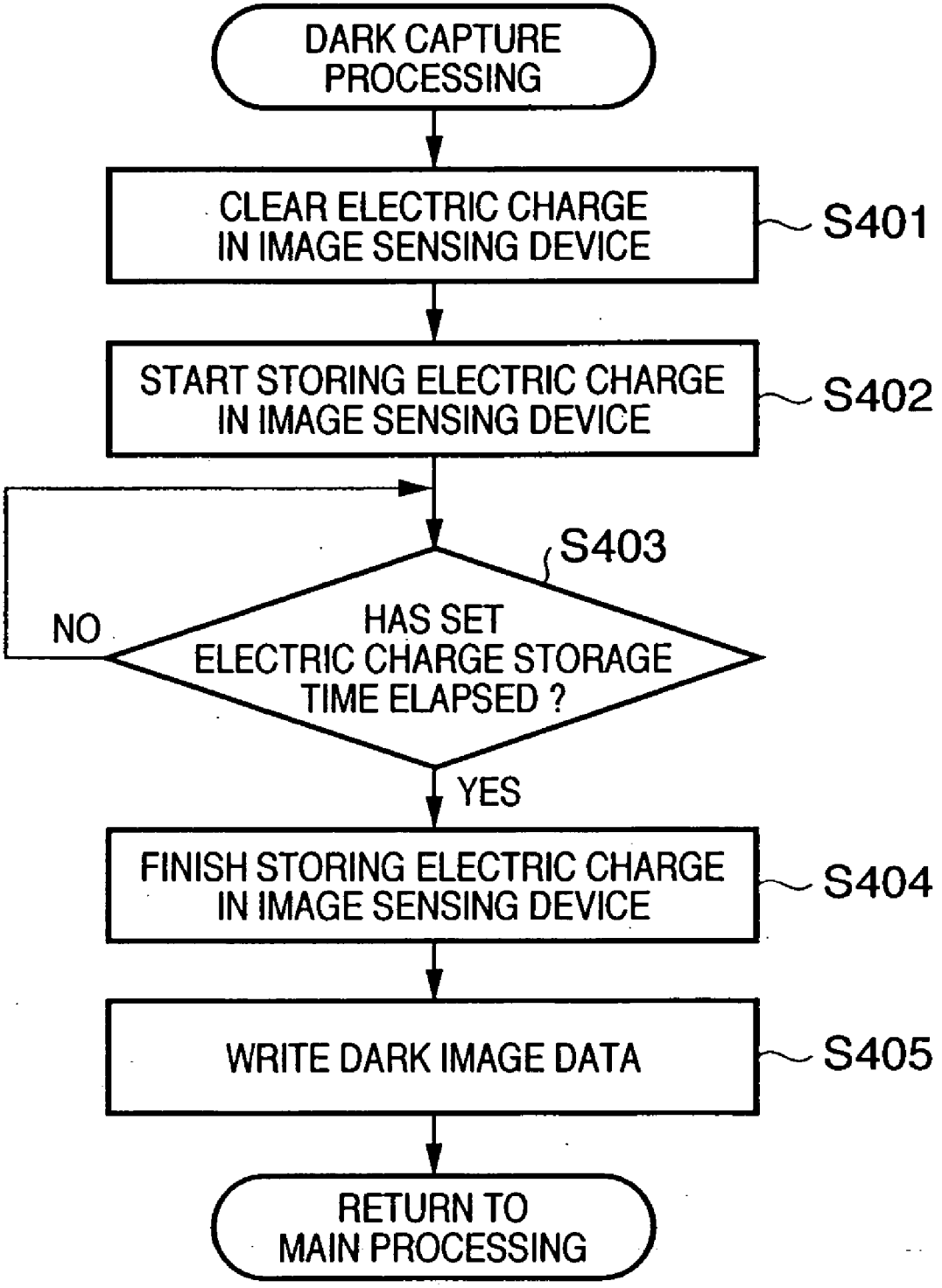

DARK CAPTURE PROCESSING
CLEAR ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S401
START STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S402
S403
HAS SET ELECTRIC CHARGE STORAGE TIME ELAPSED ?
NO
YES
FINISH STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S404
WRITE DARK IMAGE DATA
S405
RETURN TO MAIN PROCESSING

FIG. 11

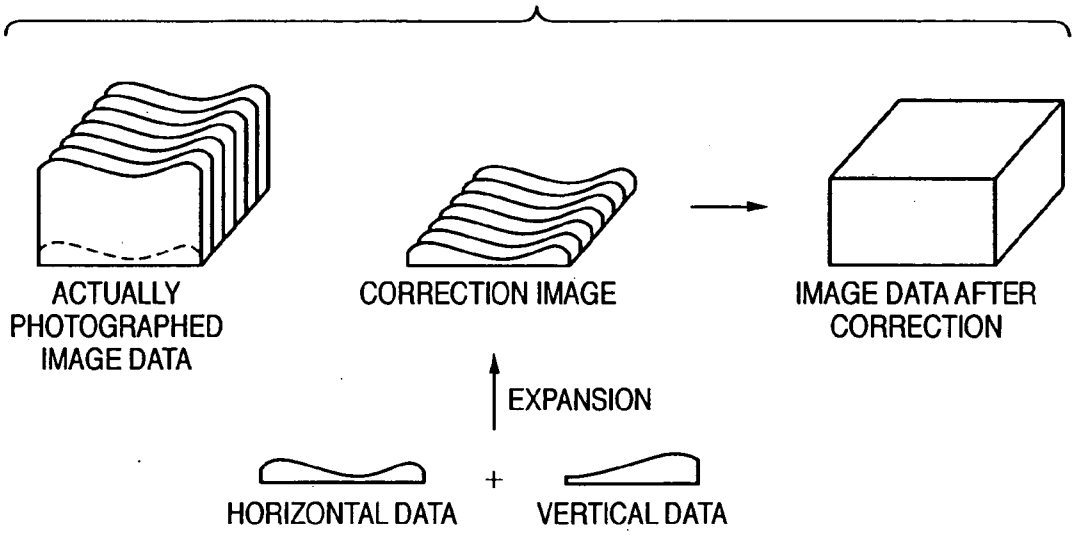

ACTUALLY PHOTOGRAPHED IMAGE DATA
CORRECTION IMAGE
IMAGE DATA AFTER CORRECTION
EXPANSION
HORIZONTAL DATA
+
VERTICAL DATA

FIG. 12

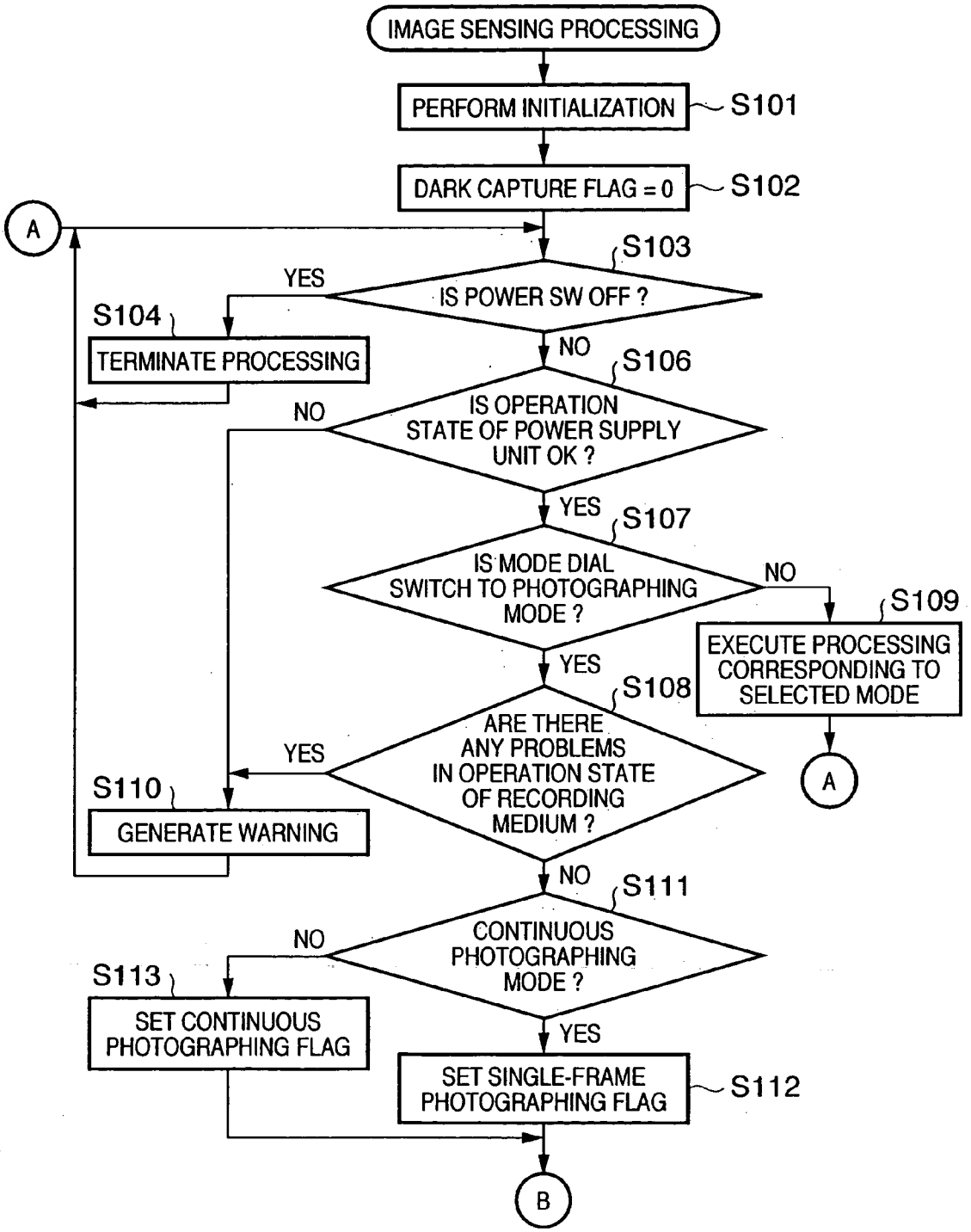

IMAGE SENSING PROCESSING
PERFORM INITIALIZATION
S101
DARK CAPTURE FLAG = 0
S102
A
S103
YES
IS POWER SW OFF ?
S104
TERMINATE PROCESSING
NO
S106
NO
IS OPERATION STATE OF POWER SUPPLY UNIT OK ?
YES
S107
IS MODE DIAL SWITCH TO PHOTOGRAPHING MODE ?
NO
S109
EXECUTE PROCESSING CORRESPONDING TO SELECTED MODE
A
YES
S108
ARE THERE ANY PROBLEMS IN OPERATION STATE OF RECORDING MEDIUM ?
YES
S110
GENERATE WARNING
NO
S111
NO
CONTINUOUS PHOTOGRAPHING MODE ?
S113
SET CONTINUOUS PHOTOGRAPHING FLAG
YES
SET SINGLE-FRAME PHOTOGRAPHING FLAG
S112
B

FIG. 13

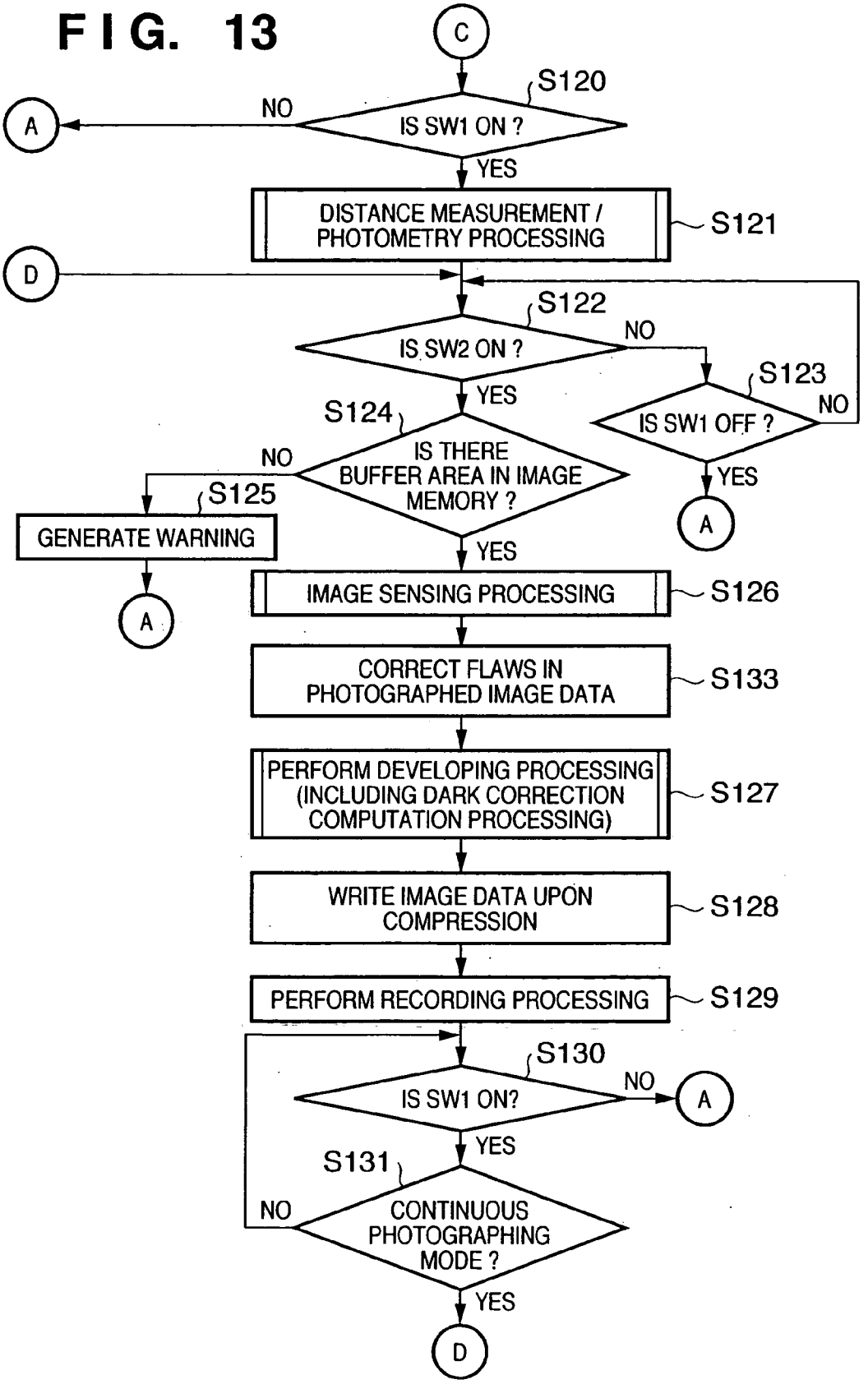

C
S120
NO
A
IS SW1 ON ?
YES
DISTANCE MEASUREMENT / PHOTOMETRY PROCESSING
S121
D
S122
IS SW2 ON ?
NO
S123
YES
S124
IS SW1 OFF ?
NO
IS THERE BUFFER AREA IN IMAGE MEMORY ?
NO
S125
YES
A
GENERATE WARNING
YES
A
IMAGE SENSING PROCESSING
S126
CORRECT FLAWS IN PHOTOGRAPHED IMAGE DATA
S133
PERFORM DEVELOPING PROCESSING (INCLUDING DARK CORRECTION COMPUTATION PROCESSING)
S127
WRITE IMAGE DATA UPON COMPRESSION
S128
PERFORM RECORDING PROCESSING
S129
S130
IS SW1 ON?
NO
A
YES
S131
NO
CONTINUOUS PHOTOGRAPHING MODE ?
YES
D

FIG. 14

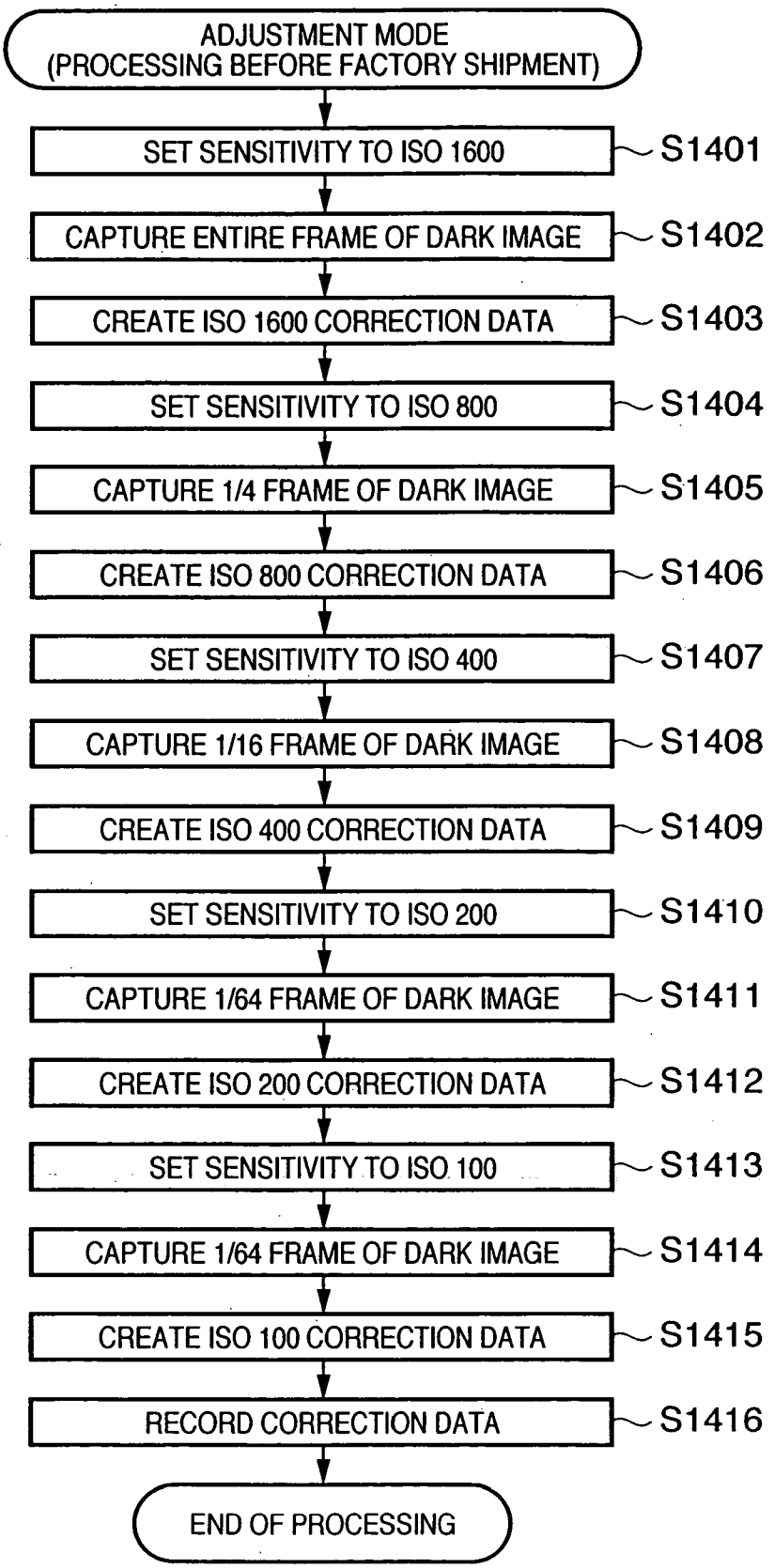

ADJUSTMENT MODE
(PROCESSING BEFORE FACTORY SHIPMENT)
SET SENSITIVITY TO ISO 1600
S1401
CAPTURE ENTIRE FRAME OF DARK IMAGE
S1402
CREATE ISO 1600 CORRECTION DATA
S1403
SET SENSITIVITY TO ISO 800
S1404
CAPTURE 1/4 FRAME OF DARK IMAGE
S1405
CREATE ISO 800 CORRECTION DATA
S1406
SET SENSITIVITY TO ISO 400
S1407
CAPTURE 1/16 FRAME OF DARK IMAGE
S1408
CREATE ISO 400 CORRECTION DATA
S1409
SET SENSITIVITY TO ISO 200
S1410
CAPTURE 1/64 FRAME OF DARK IMAGE
S1411
CREATE ISO 200 CORRECTION DATA
S1412
SET SENSITIVITY TO ISO 100
S1413
CAPTURE 1/64 FRAME OF DARK IMAGE
S1414
CREATE ISO 100 CORRECTION DATA
S1415
RECORD CORRECTION DATA
S1416
END OF PROCESSING

FIG. 15

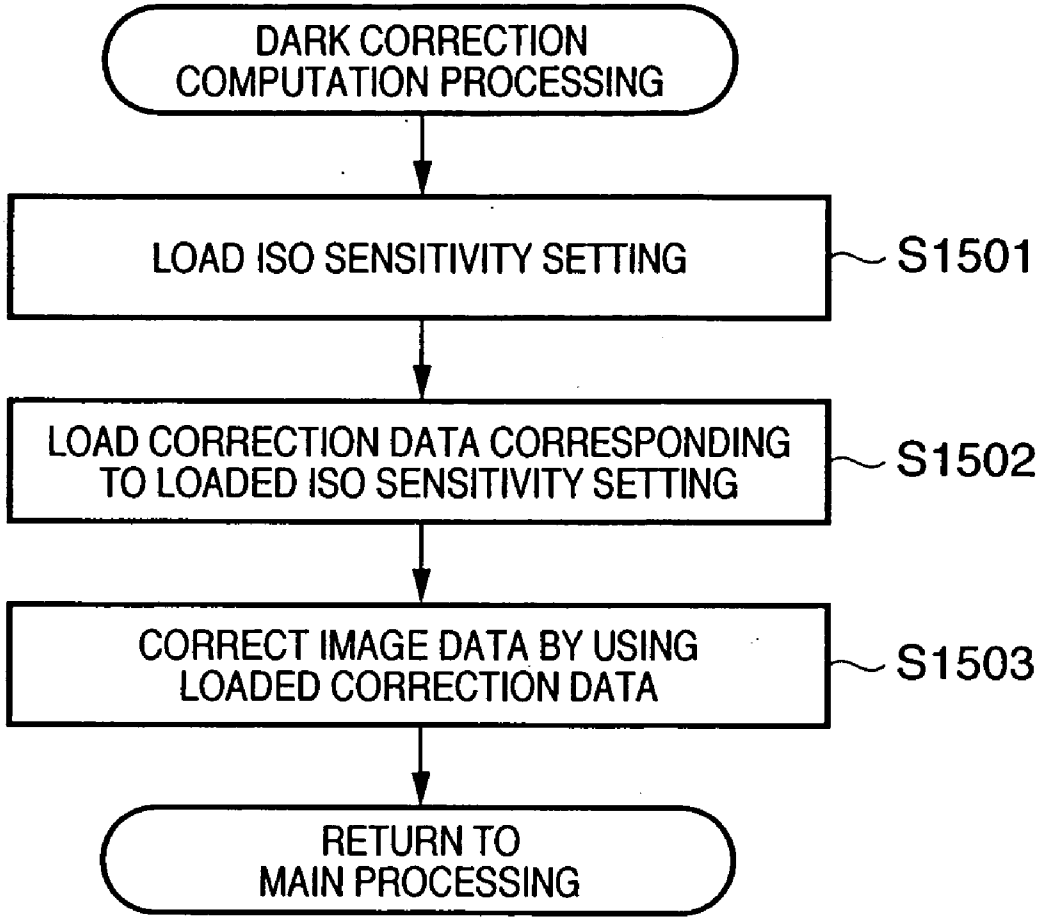

DARK CORRECTION COMPUTATION PROCESSING
LOAD ISO SENSITIVITY SETTING
S1501
LOAD CORRECTION DATA CORRESPONDING TO LOADED ISO SENSITIVITY SETTING
S1502
CORRECT IMAGE DATA BY USING LOADED CORRECTION DATA
S1503
RETURN TO MAIN PROCESSING

FIG. 16

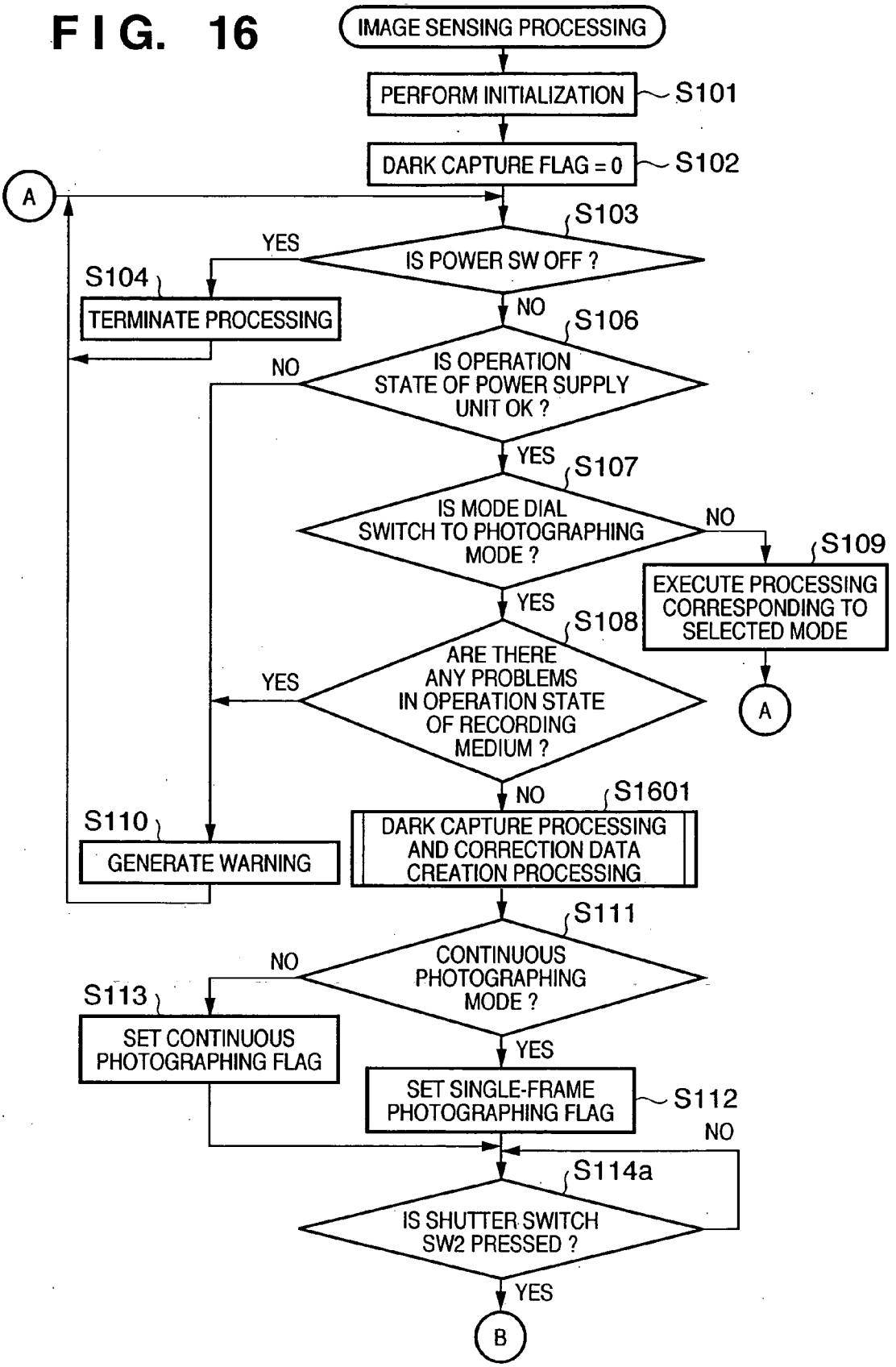

IMAGE SENSING PROCESSING
PERFORM INITIALIZATION
S101
DARK CAPTURE FLAG = 0
S102
A
S103
YES
IS POWER SW OFF ?
S104
TERMINATE PROCESSING
NO
S106
NO
IS OPERATION STATE OF POWER SUPPLY UNIT OK ?
YES
S107
IS MODE DIAL SWITCH TO PHOTOGRAPHING MODE ?
NO
S109
EXECUTE PROCESSING CORRESPONDING TO SELECTED MODE
A
YES
S108
YES
ARE THERE ANY PROBLEMS IN OPERATION STATE OF RECORDING MEDIUM ?
NO
S1601
S110
GENERATE WARNING
DARK CAPTURE PROCESSING AND CORRECTION DATA CREATION PROCESSING
S111
NO
CONTINUOUS PHOTOGRAPHING MODE ?
S113
SET CONTINUOUS PHOTOGRAPHING FLAG
YES
SET SINGLE-FRAME PHOTOGRAPHING FLAG
S112
NO
S114a
IS SHUTTER SWITCH SW2 PRESSED ?
YES
B

FIG. 17

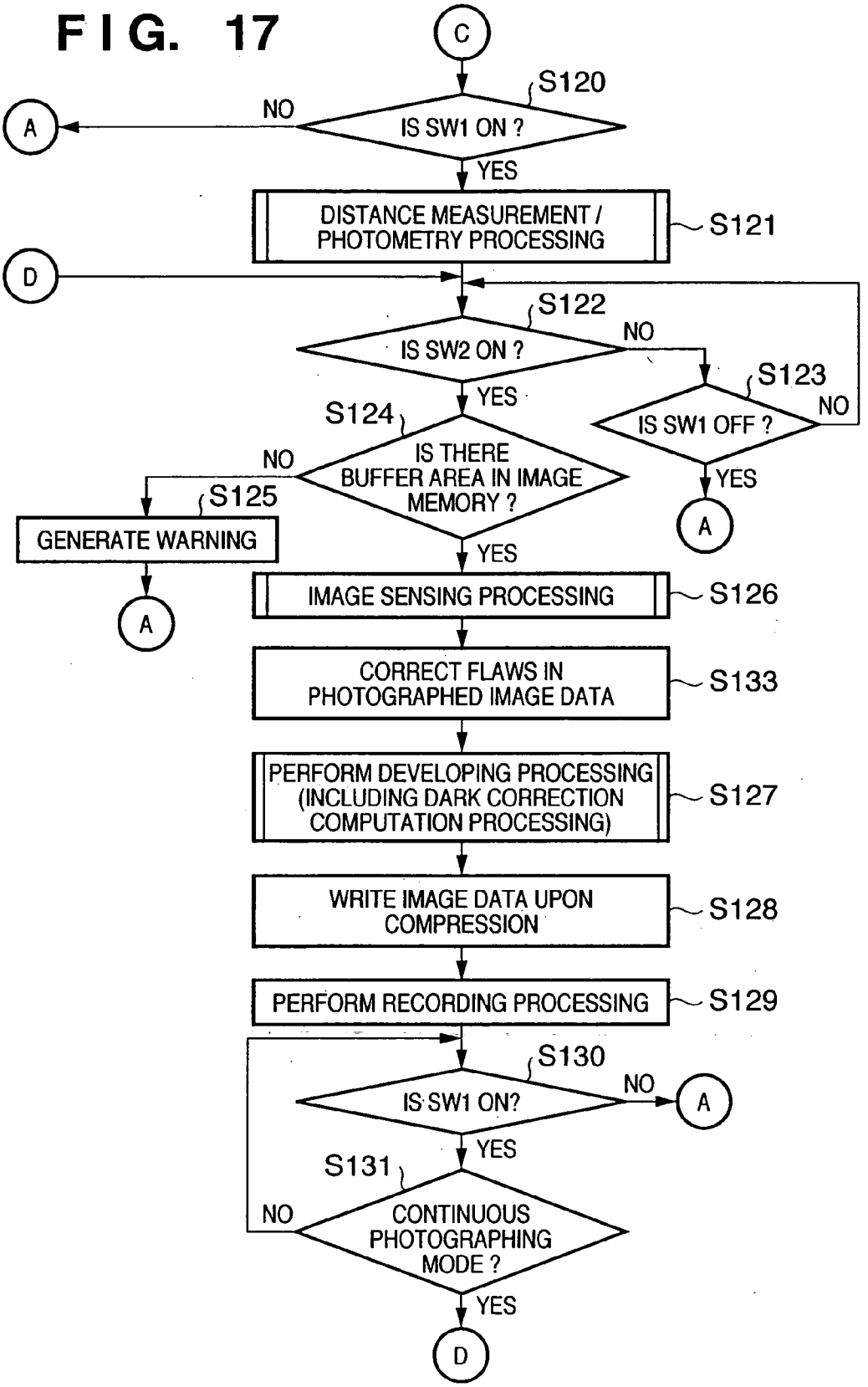

C
S120
IS SW1 ON ?
NO
A
YES
DISTANCE MEASUREMENT / PHOTOMETRY PROCESSING
S121
D
S122
IS SW2 ON ?
NO
S123
IS SW1 OFF ?
NO
YES
YES
S124
IS THERE BUFFER AREA IN IMAGE MEMORY ?
NO
S125
GENERATE WARNING
A
YES
IMAGE SENSING PROCESSING
S126
CORRECT FLAWS IN PHOTOGRAPHED IMAGE DATA
S133
PERFORM DEVELOPING PROCESSING (INCLUDING DARK CORRECTION COMPUTATION PROCESSING)
S127
WRITE IMAGE DATA UPON COMPRESSION
S128
PERFORM RECORDING PROCESSING
S129
S130
IS SW1 ON?
NO
A
YES
S131
CONTINUOUS PHOTOGRAPHING MODE ?
NO
YES
D

FIG. 18

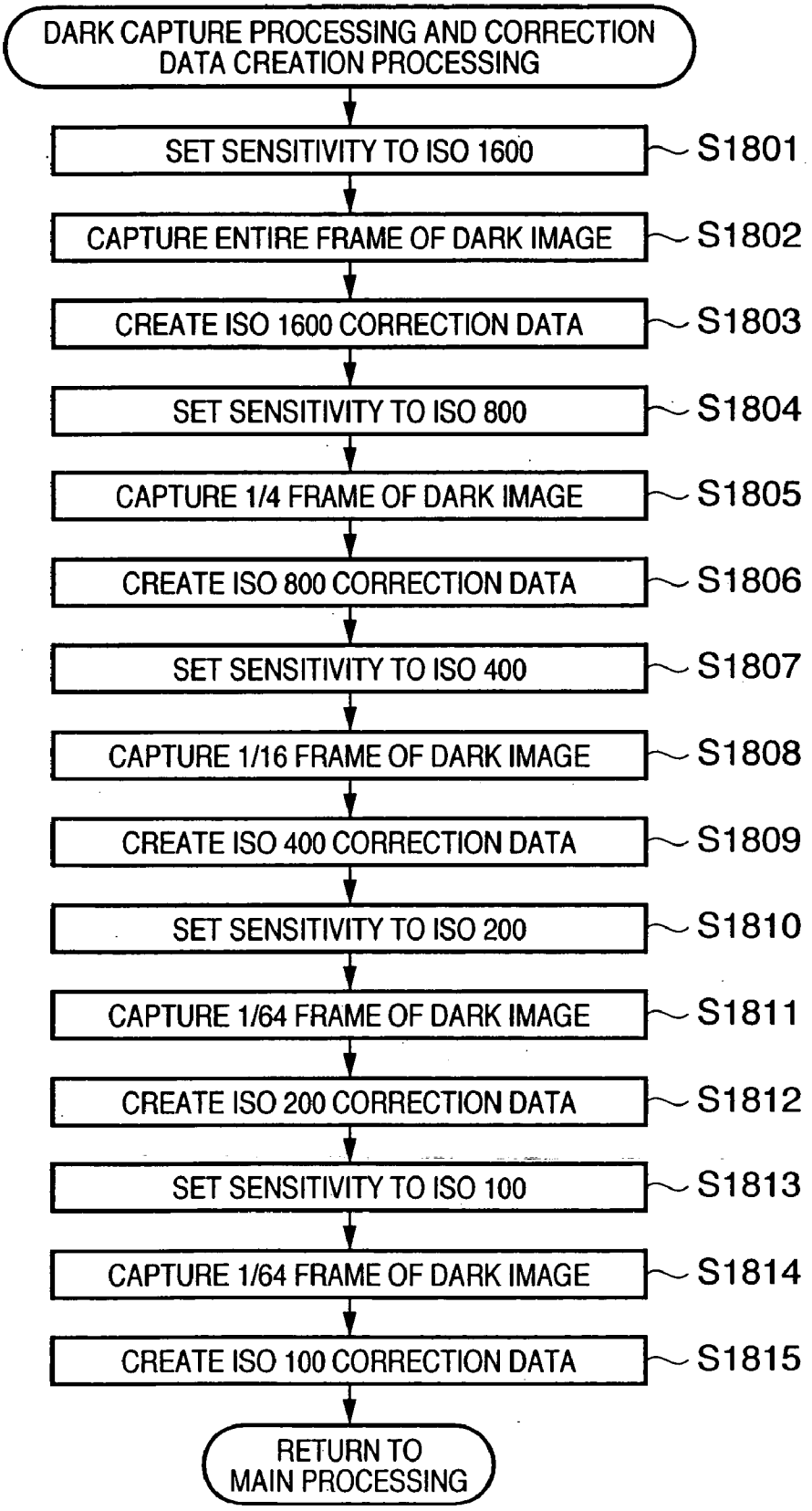

DARK CAPTURE PROCESSING AND CORRECTION DATA CREATION PROCESSING
SET SENSITIVITY TO ISO 1600
S1801
CAPTURE ENTIRE FRAME OF DARK IMAGE
S1802
CREATE ISO 1600 CORRECTION DATA
S1803
SET SENSITIVITY TO ISO 800
S1804
CAPTURE 1/4 FRAME OF DARK IMAGE
S1805
CREATE ISO 800 CORRECTION DATA
S1806
SET SENSITIVITY TO ISO 400
S1807
CAPTURE 1/16 FRAME OF DARK IMAGE
S1808
CREATE ISO 400 CORRECTION DATA
S1809
SET SENSITIVITY TO ISO 200
S1810
CAPTURE 1/64 FRAME OF DARK IMAGE
S1811
CREATE ISO 200 CORRECTION DATA
S1812
SET SENSITIVITY TO ISO 100
S1813
CAPTURE 1/64 FRAME OF DARK IMAGE
S1814
CREATE ISO 100 CORRECTION DATA
S1815
RETURN TO MAIN PROCESSING

FIG. 19

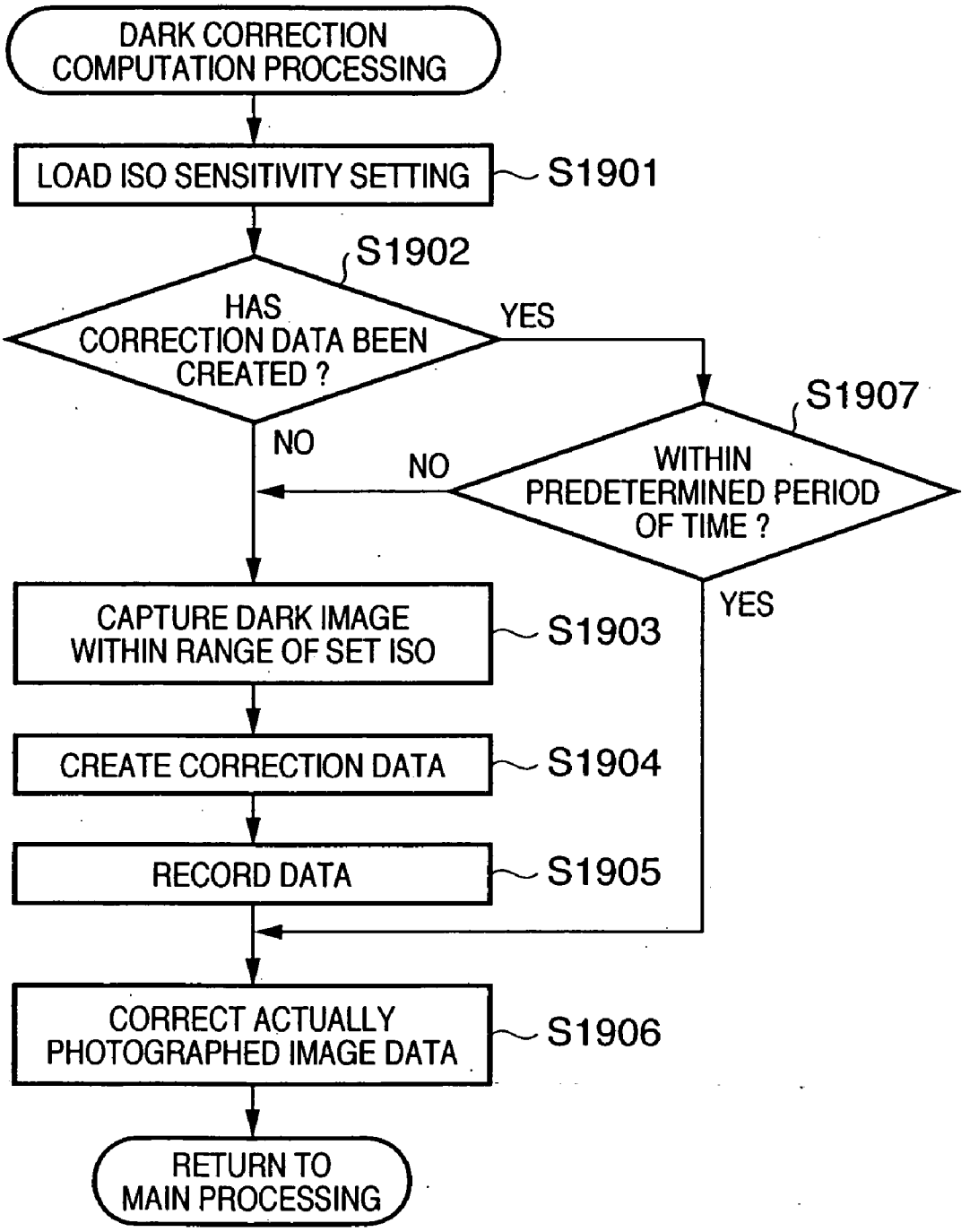

DARK CORRECTION COMPUTATION PROCESSING
LOAD ISO SENSITIVITY SETTING
S1901
S1902
HAS CORRECTION DATA BEEN CREATED ?
YES
NO
S1907
WITHIN PREDETERMINED PERIOD OF TIME ?
NO
YES
CAPTURE DARK IMAGE WITHIN RANGE OF SET ISO
S1903
CREATE CORRECTION DATA
S1904
RECORD DATA
S1905
CORRECT ACTUALLY PHOTOGRAPHED IMAGE DATA
S1906
RETURN TO MAIN PROCESSING

FIG. 20

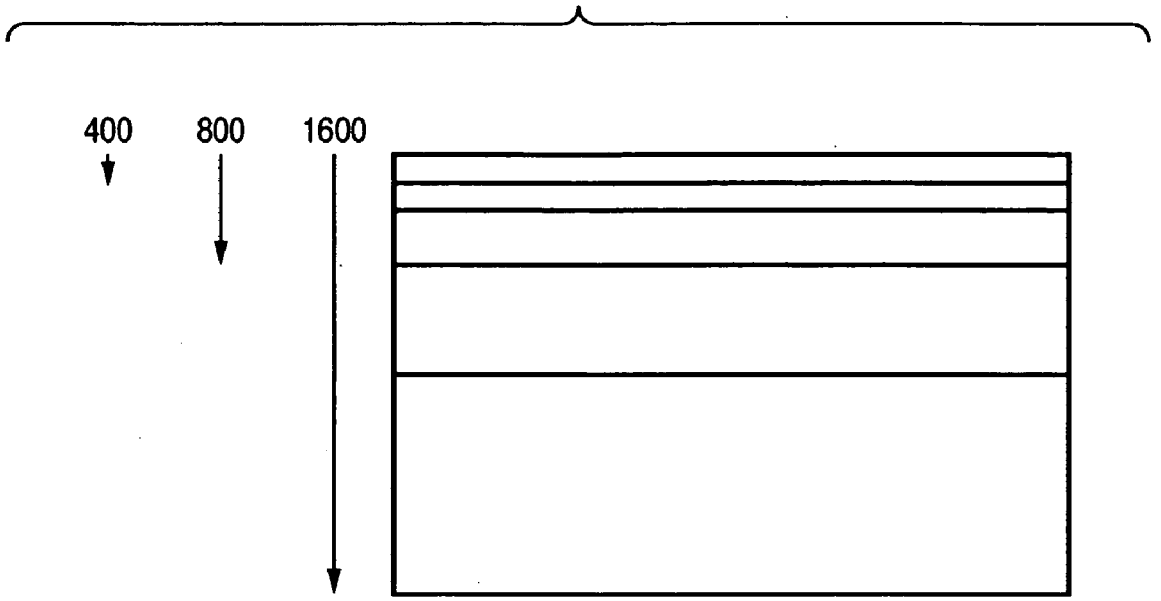


FIG. 21

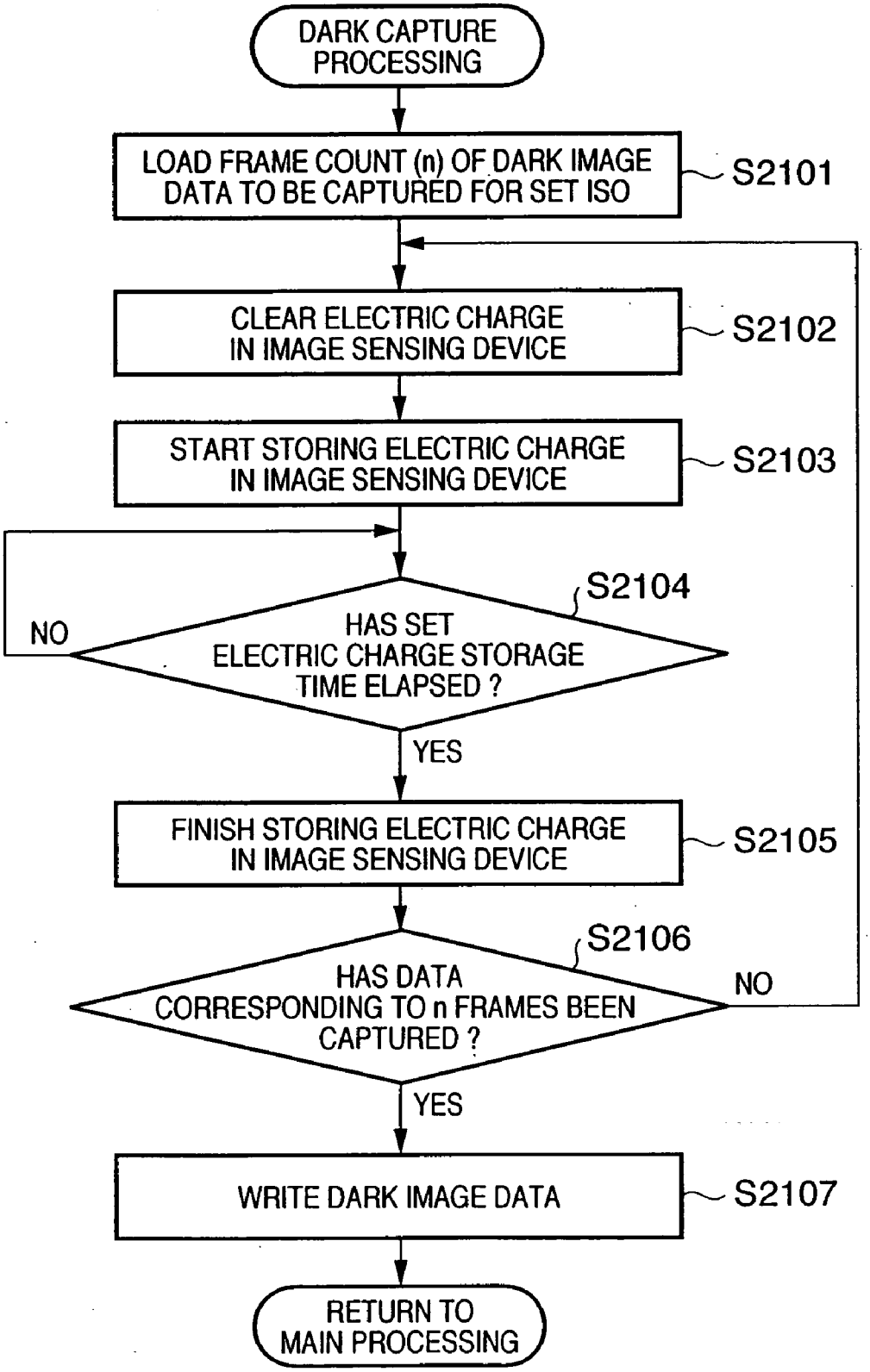

DARK CAPTURE PROCESSING
LOAD FRAME COUNT (n) OF DARK IMAGE DATA TO BE CAPTURED FOR SET ISO
S2101
CLEAR ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S2102
START STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S2103
S2104
HAS SET ELECTRIC CHARGE STORAGE TIME ELAPSED ?
NO
YES
FINISH STORING ELECTRIC CHARGE IN IMAGE SENSING DEVICE
S2105
S2106
HAS DATA CORRESPONDING TO n FRAMES BEEN CAPTURED ?
NO
YES
WRITE DARK IMAGE DATA
S2107
RETURN TO MAIN PROCESSING

IMAGE SENSING APPARATUS, CONTROL METHOD THEREFOR, STORAGE MEDIUM, AND PROGRAM

FIELD OF THE INVENTION

[0001] The present invention relates to an image sensing apparatus which senses still images and moving images.

BACKGROUND OF THE INVENTION

[0002] As an image sensing apparatus capable of sensing images and recording them on a recording medium, an electronic camera is generally known and has already been available on the market, which uses, as a recording medium, a memory card having a sold-state memory device, and can record/play back still images and moving images sensed by using a solid-state image sensing device such as a CCD or CMOS.

[0003] In general, when image sensing is performed by using a solid-state image sensing device such as a CCD or CMOS, a two-dimensional dark fixed pattern noise in the image data, obtained by the actual photographing operation while the image sensing device is in an exposed state, is corrected by using the correction value generated from the dark image data obtained by dark image photographing operation while the image sensing device is in an unexposed state. This makes it possible to suppress a deterioration in image quality due to two-dimensional fixed pattern noise such as pixel loss caused by dark current noise in the image sensing device and a fine flaw unique to the image sensing device.

[0004] The causes of a deterioration in image quality are not, however, limited to the above two-dimensional dark fixed pattern noise, and include one-dimensional dark fixed pattern noise (i.e., circuit-based noise), caused by voltage irregularity due to a resistive component in the power line in the sensor, device variations, and the like.

[0005] The above two-dimensional dark fixed pattern noise, in particular, is caused by the dark current generated when the electric charge storage time is long or the temperature of the image sensing device is high, and becomes a dominant factor for a deterioration in image quality. In contrast to this, one-dimensional dark fixed pattern noise becomes a dominant factor for a deterioration in image quality when the electric charge storage time is short or the temperature of the image sensing device is room temperature or lower. If correction data is created under the same conditions at the time of photographing operation in spite of the fact that the characteristics change depending on the settings in the image sensing apparatus, ambient temperature, and the like at the time of photographing operation, the time taken for the creation of the correction data becomes a release time lag or the like. This causes discomfort, and the user may miss a shutter chance.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in consideration of the above problems, and has as its object to provide an image sensing apparatus which can shorten the time required for the creation of correction data by reducing the amount of data used for the creation of correction data.

[0007] In order to achieve the above object, an image sensing apparatus according to the present invention has the following arrangement.

[0008] That is, an image sensing apparatus comprising:

[0009] a plurality of pixels;

[0010] a first calculating portion which creates correction data by performing computation using signals which are acquired by image sensing in an unexposed state and smaller in number than the plurality of pixels; and

[0011] a second calculating portion which corrects image data of the plurality of pixels, acquired by image sensing in an exposed state, by using the correction data.

[0012] Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0014] **FIG. 1** is a block diagram showing the schematic arrangement of an image sensing apparatus common to the respective embodiments of the present invention;

[0015] **FIG. 2** is a view showing how one-dimensional dark fixed pattern noise is mixed in in the horizontal and vertical directions in an image sensing device **14** in **FIG. 1**;

[0016] **FIG. 3** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the first embodiment;

[0017] **FIG. 4** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the first embodiment;

[0018] **FIG. 5** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the first embodiment;

[0019] **FIG. 6** is a view for explaining the difference between conventional correction of actually photographed image data based on dark subtraction and that based on one-dimensional dark fixed pattern noise correction data;

[0020] **FIG. 7** is a flow chart showing distance measurement/photometry processing executed in step **S121** in **FIG. 5**;

[0021] **FIG. 8** is a flow chart showing image sensing processing executed in step **S126** in **FIG. 5**;

[0022] **FIG. 9** is a flow chart showing image sensing processing executed in step **S126** in **FIG. 5**;

[0023] **FIG. 10** is a flow chart showing dark capture processing executed in step **S116** in **FIG. 4**;

[0024] **FIG. 11** is a view for explaining correction of image data at the time of actual photographing operation by using one-dimensional dark fixed pattern noise correction data in the vertical and horizontal directions;

[0025] **FIG. 12** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the second embodiment;

[0026] **FIG. 13** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the second embodiment;

[0027] **FIG. 14** is a flow chart showing the flow of processing for creating one-dimensional dark fixed pattern noise correction data used in the image sensing processing shown in **FIGS. 12 and 13**;

[0028] **FIG. 15** is a flow chart showing dark correction computation processing executed in step **S127** in **FIG. 13**;

[0029] **FIG. 16** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the third embodiment;

[0030] **FIG. 17** is a flow chart showing the flow of image sensing processing in the image sensing apparatus in **FIG. 1** according to the third embodiment;

[0031] **FIG. 18** is a flow chart showing dark capture processing and correction data creation processing executed in step **S1601** in **FIG. 16**;

[0032] **FIG. 19** is a flow chart showing dark correction computation processing executed in step **S127** in **FIG. 17** (fourth embodiment);

[0033] **FIG. 20** is a view showing an example of the range of dark image data for each ISO sensitivity setting which is required to create one-dimensional dark fixed pattern noise correction data; and

[0034] **FIG. 21** is a flow chart showing dark capture processing executed in step **S1402** in **FIG. 14**, step **S1802** in **FIG. 18**, or the like (fifth embodiment).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] Preferred embodiments of the present invention will now be described-in detail in accordance with the accompanying drawings.

[0036] [First Embodiment]

[0037] An image sensing apparatus according to an embodiment of the present invention will be described below with reference to the accompanying drawings.

[0038] 1. Schematic Arrangement of Image Sensing Apparatus

[0039] **FIG. 1** is a block diagram showing the schematic arrangement of an image sensing apparatus common to each embodiment of the present invention.

[0040] Referring to **FIG. 1**, an electronic camera **1** as an image sensing apparatus common to each embodiment of the present invention includes an image processing apparatus **100** connected to external memories **200** and **210** through connectors **92** and **96** and to an external power supply **220** through a connector **82**, and a lens unit **300** connected to the image processing apparatus **100** through a lens mount **306** and connector **322**.

[0041] The external power supply **220** includes a connector **84** connected to the connector **82** and a power supply unit **86**. The power supply unit **86** is constituted by a primary battery such as an alkali battery or lithium battery, a secondary battery such as a NiCd battery, NiMH battery, or Li battery, an AC adaptor, or the like.

[0042] The image processing apparatus **100** is optically and electrically connected to the lens unit **300** through a lens mount **106** connected to the lens mount **306** and through a connector **122** connected to the connector **322**. The image processing apparatus **100** includes a system control circuit **50** incorporating a known CPU for controlling the overall image processing apparatus **100** and the like.

[0043] Control signals, status signals., data signals, and the like are exchanged between the image processing apparatus **100** and the lens unit **300** through the connector **122**. In addition, currents at various voltages are also supplied through the connector **122**. The connector **122** may also be designed for optical communication, voice communication, and the like as well as telecommunication.

[0044] The system control circuit **50** is connected to a shutter control unit **40** which controls a shutter **12**, a distance control unit **42** and photometry control unit **46** which perform processing autofocus (AF) processing, automatic exposure (AE) processing, flash light adjustment (EF) processing, and the like, a thermometer **44** which detects an ambient temperature in a photography environment, a flash unit **48** having a function of emitting auxiliary AF light and a flash light adjusting function, an I/F **120** which electrically connects the image processing apparatus **100** to the lens unit **300** through the connector **122**, a power supply switch **72** which switches/sets the power-on mode and power-off mode of the image processing apparatus **100**, a power supply control unit **80** which connects to the connector **82**, a system memory **52** which stores flags, constants, variables, programs, and the like for the operation of the system control circuit **50**, a display unit **108** having a liquid crystal display unit, speaker, and the like which display operation states, messages, and the like in character form, image form, voice form, and the like in accordance with the execution of programs in the system control circuit **50**, an electrically erasable programmable nonvolatile memory **56** in which programs are stored, a communication unit **110** which communicates with the outside world through a connector (antenna) **112**, an external memory attachment/detachment detection unit **98** which detects whether or not the external memories **200** and **210** are connected to the connectors **92** and **96**, and a lens attachment/detachment detection unit **124** which detects whether or not the lens unit **300** is mounted on the lens mount **106** and/or the connector **122**.

[0045] The system control circuit **50** includes a mode dial switch **60** which switches various modes, a shutter button **62** which transmits a signal **SW1** to the system control circuit **50** when pressed halfway, and transmits a signal **SW2** to the system control circuit **50** when pressed fully, a playback switch **66** which issues an instruction to start playback operation of reading out images sensed in a photographing mode from an image memory **30** or the external memories **200** and **210** and display them on an image display unit **28**, a single-frame/continuous photographing switch **68** which switches the setting to either the single-frame photographing mode or the continuous photographing mode, an ISO sensitivity setting switch **69** which sets an ISO sensitivity, and an operation unit **70** constituted by various buttons, a touch panel, and the like.

[0046] The system control circuit **50** includes a mirror **130** which guides part of a light beam from the lens mount **106** to an optical finder **104** through a mirror **132**, the shutter **12**

having a stop function of controlling the exposure of light beam from the mirror **130**, an image sensing device **14** which converts the light beam received through the shutter **12** into an electrical signal, an A/D converter **16** which converts the analog signal output from the image sensing device **14** into a digital signal and transmits it to an image display memory **24** or the image memory **30**, the image display memory **24** in which image data for display is written through a memory control circuit **22**, a D/A converter **26** which converts the image data for display, which is written in the image display memory **24**, from a digital signal to an analog signal, and transmits it to the image display unit **28**, a timing generating circuit **18** which supplies clock signals and control signals to the image sensing device **14**, A/D converter **16**, and D/A converter **26**, and the image display unit **28**. The timing generating circuit **18** is controlled by the memory control circuit **22** and system control circuit **50**.

[**0047**] The mirrors **130** and **132** guide the light beam incident on the lens unit **300** to the optical finder **104** by a single-lens reflex system. The mirror **132** may have either a quick-return mirror arrangement or a half mirror arrangement.

[**0048**] The memory control circuit **22** is directly connected to the A/D converter **16**, the timing generating circuit **18**, an image processing circuit **20**, the image display memory **24**, and the D/A converter **26**. The memory control circuit **22** is also connected to the image memory **30** and a compression/decompression circuit **32** through a bus **140**, and is connected to I/Fs **90** and **94** which are interfaces (I/Fs) with the external memories **200** and **210** through the bus **140** and the like. With this arrangement, the memory control circuit **22** controls these constituent elements.

[**0049**] The shutter control unit **40** controls the shutter **12** in cooperation with a stop control unit **340** which controls a stop **312** on the basis of photometry information from the photometry control unit **46**.

[**0050**] The distance control unit **42** performs AF processing, and measures the in-focus state of an image formed as an optical image by causing the light beam incident on the lens unit **300** to be incident by the single-lens reflex system through the stop **312**, the lens mounts **306** and **106**, the mirror **130**, and a sub-mirror for distance measurement (not shown).

[**0051**] The thermometer **44** detects an ambient temperature in a photography environment. In order to more accurately predict a dark current in the image sensing device **14** by using the thermometer **44**, the thermometer **44** is preferably incorporated in the image sensing device **14**.

[**0052**] The photometry control unit **46** performs AE processing, and measures the exposure state of an image formed as an optical image by causing the light beam incident on the lens unit **300** to be incident by the single-lens reflex system through the stop **312**, the lens mounts **306** and **106**, the mirror **130**, and a photometry sub-mirror (not shown). The photometry control unit **46** also has an EF processing function in cooperation with the flash unit **48**. The flash unit **48** has a function of emitting auxiliary AF light and a flash light adjusting function.

[**0053**] The image processing apparatus **100** is electrically connected to the lens unit **300** through the I/F **120**.

[**0054**] The power supply switch **72** can switch/set the power-on and power-off modes of the image processing apparatus **100**. The power supply switch **72** can also switch/set the power-on and power-off modes of various kinds of attachments such as the lens unit **300**, external flash unit, and external memories **200** and **210** connected to the image processing apparatus **100**.

[**0055**] The power supply control unit **80** is constituted by a battery detection circuit, a DC-DC converter, a switch circuit which switches blocks to be energized, and the like. The power supply control unit **80** detects the attachment/detachment of the power supply unit **86**, the type of secondary battery mounted in the power supply unit **86**, and the remaining capacity of the secondary battery, and controls the DC-DC converter on the basis of the detection result and an instruction from the system control circuit **50**, thereby applying a necessary voltage to each unit including a recording medium for a necessary period of time.

[**0056**] The system memory **52** is a memory which stores constants, variables, programs, and the like for the operation of the system control circuit **50**.

[**0057**] The display unit **108** is formed from a combination of an LCD, an LED, a sound producing device, and the like, and placed at one or a plurality of positions near the operation unit of the image processing apparatus **100** at which easy visual recognition is provided. Some functions of the display unit **108** are provided in the optical finder **104**.

[**0058**] Of the display contents on the display unit **108**, the contents to be displayed on the LCD or the like include single-frame/continuous photographing indication, self-timer indication, compression ratio indication, pixel resolution indication, recorded frame count indication, remaining frame count indication, shutter speed indication, aperture indication, exposure correction indication, flash indication, red-eye reduction indication, macro photographing indication, buzzer setting indication, timepiece battery remaining capacity indication, battery remaining capacity indication, error indication, information indication in number consisting of a plurality of digits, attachment/detachment state indication of the external memories **200** and **210**, attachment/detachment state indication of the lens unit **300**, communication I/F operation indication, date/time indication, indication representing a connection state with an external computer, and the like.

[**0059**] Of the display contents on the display unit **108**, the contents to be displayed in the optical finder **104** include in-focus indication, photographing preparation completion indication, camera shake warning indication, flash charging indication, flash ready indication, shutter speed indication, aperture indication, exposure correction indication, recording medium write operation indication, and the like.

[**0060**] Of the display contents on the display unit **108**, the contents to be displayed on the LED or the like include in-focus indication, photographing preparation completion indication, camera shake warning indication, flash-charging indication, flash ready indication, recording medium write operation indication, macro photographing setting notification indication, secondary battery charging indication, and the like.

[**0061**] Of the display contents on the display unit **108**, the contents to be displayed by lamps and the like include, for

example, information indicated by a self-timer notification lamp. The light emitted by this self-timer notification lamp may also used as auxiliary AF light.

[0062] The nonvolatile memory **56** is formed from an EEPROM or the like, and stores various kinds of parameters, set values such as an ISO sensitivity, and set modes.

[0063] The communication unit **110** has an RS232C interface, a USB interface, an IEEE1394 interface, a P1284 interface, an SCSI interface, a modem, a LAN, and various kinds of communication functions such as a radio communication function. The connector (antenna) **112** connects the image processing apparatus **100** to another equipment through the communication unit **110** or performs radio communication.

[0064] The external memory attachment/detachment detection unit **98** detects whether or not the external memories **200** and **210** are attached to the connectors **92** and **96**. Although this embodiment includes two systems of interfaces and connectors for the attachment of recording media, interfaces and connectors for the attachment of recording media may be prepared in number corresponding to a single or an arbitrary number of systems.

[0065] Using I/Fs and connectors which comply with the specifications of PCMCIA cards, CF (Compact Flash (registered trademark)) cards, and the like as the I/Fs **90** and **94** and connectors **92** and **96** makes it possible to exchange image data and management information attached to the image data with another computer or peripheral equipment such as a printer by connecting various kinds of communication cards such as a LAN card, modem card, USB card, IEEE1394 card, P1284 card, SCSI card, and PHS card.

[0066] The mode dial switch **60** can switch/set various kinds of functional photographing modes such as an automatic photographing mode, programmed photographing mode, shutter priority photographing mode, aperture priority photographing mode, manual photographing mode, focal depth priority (depth) photographing mode, portrait photographing mode, landscape photographing mode, close-up photographing mode, sports photographing mode, night scene photographing mode, and panorama photographing mode.

[0067] When pressed halfway, the shutter button **62** turns on a shutter switch SW**1** to instruct the system control circuit **50** to start AF (AutoFocus) processing, AE (Automatic Exposure) processing, AWB (Automatic White Balance) processing, EF (flash light adjustment) processing, and the like. When pressed fully, the shutter button **62** turns on a shutter switch SW**2** to instruct the system control circuit **50** to start a series of operations including exposure processing of writing the signals read from the image sensing device **14**, as image data, in the image memory **30** through the A/D converter **16** and memory control circuit **22**, developing processing based on computation in the image processing circuit **20** or memory control circuit **22**, and recording processing of reading but image data from the image memory **30**,.compressing the data in the compression/decompression circuit **32**, and writing the image data in the external memories **200** and **210**.

[0068] The playback switch **66** issues an instruction to start reading out the image photographed in a photographing mode from the image memory **30** or external memories **200** and **210** and displaying it on the image display unit **28**.

[0069] The single-frame/continuous photographing switch **68** sets one of the following modes: the single-frame photographing mode in which when the shutter switch SW**2** is pressed, one frame is photographed, and the camera is set in the standby state; and the continuous photographing mode in which photographing is continuously performed while the shutter switch SW**2** is pressed.

[0070] The ISO sensitivity setting switch **69** sets an ISO sensitivity by changing the gain setting in the image sensing device **14** or image processing circuit **20**.

[0071] The operation unit **70** is constituted by various kinds of buttons, a touch panel, and the like, which include a menu button, a set button, a macro button, a multi-window playback new page button, a flash setting button, a single -frame/continuous photographing/self-timer switching button, a menu move + (plus) button, a menu move – (minus) button, a playback image move +(plus) button, a playback image move – (minus) button, a photography image quality selection button, an exposure correction button, a date/time setting button, a selection/switching button which switches/sets photographing modes such as the panorama mode and various kinds of functions in the execution of playback operation, a determination/execution button which makes settings for the determination and execution of photographing modes such as the panorama mode and various kinds of functions in the execution of playback operation, an image display ON/OFF switch which turns on/off the image display unit **28**, a quick review ON/OFF switch which sets a quick review function of automatically playing back photographed image data immediately after the photography, a compression mode switch which is a switch for selecting a compression ratio in JPEG compression or a CCDRAW mode of directly digitizing a signal from the image sensing device and recording it on a recording medium, the playback switch **66** which can set various kinds of modes such as a playback mode, multi-window playback/erase mode, and a PC connection mode, an AF mode setting switch which can set a one-shot AF mode in which autofocus operation is started when the shutter switch SW**1** is pressed, and an in-focus state is maintained once the in-focus state is reached, and a servo-AF mode in which autofocus operation is continued while the shutter switch SW**1** is pressed, and the like.

[0072] Adding a rotating dial switch allows the functions of the above plus and minus buttons to more smoothly select numerical values and functions.

[0073] Note that the mode dial switch **60**, shutter button **62**, playback switch **66**, ISO sensitivity setting switch **69**, and operation unit **70** may be constituted by one or a plurality of combinations of switches, dials, touch panels, pointing based on line-of-sight detection, voice recognition devices, and the like.

[0074] A light beam incident from the lens unit **300** is guided to the optical finder **104** by the single-lens reflex system through the lens mount **106** and the lenses **130** and **132**. The optical finder **104** forms this light beam as an optical image and displays it. This makes it possible to perform photographing operation using only the optical finder **104** without using the electronic finder function

implemented by the image display unit **28**. Some functions of the display unit **108** are provided in the optical finder **104** to display, for example, in-focus indication, camera shake warning indication, flash charging indication, shutter speed indication, aperture indication, and exposure correction indication.

[**0075**] The A/D converter **16** converts the analog signal output from the image sensing device **14** into a digital signal. The converted signal is written in the image display memory **24** or image memory **30** through the image processing circuit **20** and memory control circuit **22** or directly.

[**0076**] The timing generating circuit **18** supplies clocks signals and control signals to the image sensing device **14**, A/D converter **16**, and D/A converter **26**. More specifically, when a control signal is transmitted from the timing generating circuit **18** to the image sensing device **14**, the image sensing device **14** transmits an electrical signal having undergone photoelectric conversion to the A/D converter **16**. When a control signal from the timing generating circuit **18** is transmitted to the A/D converter **16** which is controlled by the memory control circuit **22** and system control circuit **50**, the A/D converter **16** transmits a digital signal to the image processing circuit **20** or memory control circuit **22**. When a control signal is transmitted from the timing generating circuit **18** to the D/A converter **26**, the D/A converter **26** converts a signal from the memory control circuit **22** into an analog signal and transmits it to the image display unit **28**.

[**0077**] The image processing circuit **20** performs predetermined pixel interpolation processing and color conversion processing for data from the A/D converter **16** or data from the memory control circuit **22**. The image processing circuit **20** performs predetermined computation processing by using sensed image data as needed. The system control circuit **50** performs TTL (Though-The-Lens) AF processing, AE processing, and EF processing on the basis of the obtained computation result to control the shutter control unit **40** and distance control unit **42**. The image processing circuit **20** also performs predetermined computation processing by using sensed image data, and performs TTL AWB (Automatic White Balance) processing on the basis of the obtained computation result.

[**0078**] Since this embodiment includes the distance control unit **42** and photometry control unit **46** as dedicated units, the system control circuit **50** may be designed to perform AF processing, AE processing, and EF processing by using the distance control unit **42** and photometry control unit **46** instead of performing AF processing, AE processing, and EF processing by using the image processing circuit **20**. Alternatively, the system control circuit **50** may be designed to perform AF processing, AE processing, and EF processing by using the distance control unit **42** and photometry control unit **46** and also perform AF processing, AE processing, and EF processing by using the image processing circuit **20**. More specifically, the system control circuit **50** may perform AF processing by using the measurement result obtained by the distance control unit **42** and the computation result obtained by causing the image processing circuit **20** to perform computation for the image data sensed by the image sensing device **14**. In addition, the system control circuit **50** may perform exposure control by using the measurement result obtained by the photometry control unit **46** and the computation result obtained by causing the image processing circuit **20** to perform computation for the image data sensed by the image sensing device **14**.

[**0079**] The memory control circuit **22** controls the A/D converter **16**, timing generating circuit **18**, image processing circuit **20**, image display memory **24**, D/A converter **26**, image memory **30**, and compression/decompression circuit **32**.

[**0080**] The image display unit **28** is formed from a TFT LCD, and displays image data for display, which is written in the image display memory **24**, through the D/A converter **26**. The image display unit **28** can sequentially display sensed image data, and hence can implement an electronic finder function.

[**0081**] The image display unit **28** may have an image display switch which switches ON/OFF settings. This allows the image display unit **28** to perform various kinds of display operations described above only when the image display switch setting is ON, thus greatly reducing the power consumption of the image processing apparatus **100**.

[**0082**] The image memory **30** is a memory for storing photographed still images and moving images, and has a storage capacity large enough to store a predetermined number of still images and moving images corresponding to a predetermined period of time. Therefore, in the continuous photographing mode of continuously photographing a plurality of still images or the panorama photographing mode, large-volume image data can be written in the image memory **30** at high speed. The image memory **30** can also be used as a work area for the system control circuit **50**.

[**0083**] The compression/decompression circuit **32** compresses/decompresses image data by adaptive discrete cosine transform (ADCT) or the like. The compression/decompression circuit **32** reads an image stored in the image memory **30**, performs compression processing or decompression processing, and writes the resultant data in the image memory **30**.

[**0084**] The-external memories **200** and **210** are recording media such as a memory card and hard disk. The external memories **200** and **210** respectively recording units **202** and **212** each formed from a semiconductor memory, magnetic disk, or the like, I/Fs **204** and **214** as interfaces with the image processing apparatus **100**, and connectors **206** and **216** for connection to the image processing apparatus **100**.

[**0085**] The lens unit **300** is of an interchangeable lens type, and includes a photographing lens **310** which forms a light beam incident at the time of photography into an optical image on the image sensing device **14**, the stop **312** which adjusts the amount of light beam from the photographing lens **310**, the lens mount **306** which is mechanically coupled to the image processing apparatus **100**, the connector **322** which is electrically connected to the image processing apparatus **100** through the connector **122**, and an I/F **320** which is connected to the connector **322**, the stop control unit **340**, a distance measurement control unit **342**, a zoom control unit **344**, and a lens system control circuit unit **350**.

[**0086**] The lens mount **306** mechanically couples the lens unit **300** to the image processing apparatus **100**. The lens mount **306** incorporates various kinds of functions of electrically connecting the lens unit **300** to the image processing apparatus **100**.

[0087] The connector **322** has a function of exchanging control signals, status signals, data signals, and the like between the image processing apparatus **100** and the lens unit **300**, and receiving or supplying various kinds of currents. The connector **322** may be designed to transfer optical signals, audio signals, and the like as well as electrical signals.

[0088] The stop control unit **340** controls the stop **312** on the basis of the photometry information received from the photometry control unit **46** through the I/F **320** in cooperation with the shutter control unit **40** which controls the shutter **12**.

[0089] The distance measurement control unit **342** controls the focusing of the photographing lens **310**. The zoom control unit **344** controls the zooming of the photographing lens **310**.

[0090] The lens system control circuit unit **350** controls the overall lens unit **300**, and also includes the function of a memory storing constants, variables, programs, and the like for operation or the function of a nonvolatile memory holding identification information such as a number unique to the lens unit **300**, management information, a full aperture value or minimum aperture value, function information such as a focal length, current and past set values, and the like.

[0091] 2. Outline of One-Dimensional Dark Fixed Pattern Noise and Correction Processing

[0092] Factors that cause one-dimensional dark fixed pattern noise will be described next.

[0093] **FIG. 2** is a view showing how one-dimensional dark fixed pattern noise is mixed in in the horizontal and vertical directions of the image sensing device **14** in **FIG. 1**.

[0094] As shown in **FIG. 2**, the image sensing device **14** having a plurality of pixels two-dimensionally arranged in the horizontal and-vertical directions includes a pixel portion **14***a* which converts a received light beam into an electrical signal, and a common reading circuit **14***b* which is placed parallel to the pixel portion **14***a* and transmits the electrical signal received from the pixel portion **14***a* to a final output stage **14***c*. An amplifier **14***e* is provided for each array of pixels in the vertical direction between the common reading circuit **14***b* and the pixel portion **14***a*. Signals from the pixels are amplified by this amplifier and read by the common reading circuit **14***b*.

[0095] One-dimensional dark fixed pattern noise is produced by differences (variations) between read paths, as a main factor, which are caused when a light beam which is converted into an electrical signal by the pixel portion **14***a* of the image sensing device **14** and output reaches the final output stage **14***c*.

[0096] Fixed pattern noise in the horizontal direction depends on the difference between the read path represented by a vertical line a and the read path represented by a vertical line b in **FIG. 2**, whereas fixed pattern noise in the vertical direction depends on the difference between the read path represented by a horizontal line c and the read path represented by a horizontal line d in **FIG. 2**.

[0097] As in the image sensing device **14** shown in **FIG. 2**, therefore, if the horizontal lines of each pixel portion **14***a* share the common reading circuit **14***b*, and a circuit layout or the like is designed to reduce fixed pattern noise in the vertical direction which is mixed in when a signal on each horizontal line is transferred to the common reading circuit, the fixed pattern noise in the vertical direction is reduced to eliminate the need to correct it. In an image sensing apparatus using the image sensing device **14**, by correcting actually photographed image data using only one-dimensional dark fixed pattern noise correction data in the horizontal direction, one-dimensional dark fixed pattern noise can be removed. Obviously, this operation may be applied to the vertical direction instead of the horizontal direction.

[0098] Fixed pattern noise due to the differences between the characteristics of the amplifiers provided for the respective arrays can be corrected by one-dimensional dark fixed pattern noise correction data in the horizontal direction. This greatly contributes to an improvement in image quality.

[0099] An outline of correction processing for actually photographed image data by using one-dimensional dark fixed pattern noise correction data will be described next with reference to **FIG. 6**.

[0100] **FIG. 6** is a view for explaining the difference between dark subtraction which is a conventional correction method and correction of actually photographed image data by using one-dimensional dark fixed pattern noise correction data.

[0101] As shown in **FIG. 6**, correction is conventionally performed by subtracting the dark image data obtained by photographing operation in an unexposed state from actually photographed image data. In contrast, in this embodiment, one-dimensional dark fixed pattern noise correction data (1-line data in the horizontal direction) is created by performing projection operation for the dark image data obtained by photographing operation in an unexposed state in the vertical direction (or horizontal direction). Actually photographed image data is then corrected by performing subtraction processing for it by using the data obtained by expanding the one-dimensional dark fixed pattern noise correction data in the horizontal direction (or vertical direction) as a correction image.

[0102] Performing subtraction processing by using one-dimensional dark fixed pattern noise correction data can prevent image quality from deteriorating due to one-dimensional dark fixed pattern noise in the horizontal direction which is produced in the image sensing device **14**.

[0103] 3. Outline of Image Sensing Processing

[0104] An outline of image sensing processing by the image processing apparatus **100** in **FIG. 1** will be described below.

[0105] FIGS. **3** to **5** are flow charts showing the image sensing processing in the image sensing apparatus in **FIG. 1**.

[0106] Referring to FIGS. **3** to **5**, first of all, the system memory **52** initializes the flags, control variables, and the like stored inside when power is turned on after battery change or the like, and performs predetermined initialization necessary for each unit of the image processing apparatus **100** (step **S101**). Thereafter, the dark capture flag value is set to "0" (step **S102**).

[0107] The system control circuit **50** checks whether or not the power supply switch **72** is OFF (step **S103**). If the

power supply switch **72** is OFF, the system control circuit **50** performs termination processing (step **S104**). The flow then returns to the processing from step **S103**. In this case, the termination processing in step **S104** is the processing of changing the display on each display unit **108** to the end state, recording parameters and set values including flags, control variables, and the like, and set modes on the non-volatile memory **56**, and shutting down unnecessary power to the respective units of the image processing apparatus **100** including the image display unit **28** under the control of the power supply control unit **80**.

[**0108**] If it is determined in step **S103** that the power supply switch **72** is ON, it is checked whether there is any problem in the operation state of the power supply unit **86** (step **S106**). Whether there is any problem in the operation state of the power supply unit **86** is determined by causing the power supply control unit **80** to check the remaining capacity or operation of the secondary battery of the power supply unit **86**.

[**0109**] If it is determined in step **S106** that there is a problem in the operation state of the power supply unit **86**, a predetermined warning is made by causing the display unit **108** to display an image or output a sound (step **S110**). The flow then returns to the processing from step **S103**. If there is no problem in the operation state of the power supply unit **86**, it is checked whether the setting of the mode dial switch **60** is a photographing mode (step **S107**).

[**0110**] If it is determined in step **S107** that the setting of the mode dial switch **60** is not a photographing mode, processing corresponding to the set mode is executed (step **S109**). Thereafter, the flow returns to the processing in step **S103** and subsequent steps. If the setting of the mode dial switch **60** is a photographing mode, it is checked whether there is any problem in the operation state of the recording medium (step **S108**).

[**0111**] If it is determined in step **S108** that there is a problem in the state of the recording medium, the processing in step **S110** and subsequent steps is performed. More specifically, whether there is any problem in the state of the recording medium is determined by checking whether the external memories **200** and **210** are mounted, and checking the acquisition of management information of the image data recorded on the external memories **200** and **210** and the operation states of the external memories **200** and **210**. This makes it possible to check whether there is any problem in the operation of the image processing apparatus **100**, and more specifically, the recording/playing back of image data on/from a recording medium.

[**0112**] If it is determined in step **S108** that there is no problem in the state of the recording medium, it is checked whether the setting of the single-frame/continuous photographing switch **68** is the single-frame photographing mode (step **S111**). If the setting of the single-frame/continuous photographing switch **68** is the single-frame photographing mode, the single-frame/continuous photographing flag stored in the system memory **52** is set to the single-frame photographing mode (step **S112**). The flow then advances to step **S114***a*. If the setting of the single-frame/continuous photographing switch **68** is not the single-frame photographing mode (i.e., is the continuous photographing flag), the single-frame/continuous photographing flag stored in the system memory **52** is set to the continuous photographing mode (step **S113**). The flow then advances to step **S114***a*. Note that the state of the single-frame/continuous photographing flag is stored in a memory incorporated in the system control circuit **50** or the system memory **52**.

[**0113**] In step **S114***a*, when the shutter switch **SW2** is pressed, photographing operation is performed in the corresponding mode. The flow then advances to step **S114***b*. More specifically, when the single-frame/continuous photographing flag is set to the single-frame photographing mode, and the shutter switch **SW2** is pressed, one frame is photographed, and the camera is set in the standby state. When the single-frame/continuous photographing flag is set to the continuous photographing mode, and the shutter switch **SW2** is pressed, photographing operation can be continuously performed while the shutter switch **SW2** is pressed.

[**0114**] In step **S114***b*, it is checked whether or not the value of the dark capture flag is set to "0". If it is determined that the value of the dark capture flag is not set to "0", (i.e., the value of the dark capture flag is set to "1") (NO in step **S114***b*), the flow advances to step **S120**. If the value of the dark capture flag is set to "0" (YES in step **S114**), the value of the dark capture flag is set to "1" (step **S115**), and dark capture processing in **FIG. 10** (to be described later) is performed to create flaw correction data (step **S116**).

[**0115**] Subsequently, flaws in the dark image data are corrected for each pixel of the sensor on the basis of the flaw correction data created in step **S116** (step **S132**). Since small flaws are rounded off in projection operation, this correction may be performed with respect to only large flaws of the flaws in the dark image data.

[**0116**] In step **S117**, a one-dimensional dark fixed pattern noise correction value is generated. This one-dimensional dark fixed pattern noise correction data is created by, for example, a method of obtaining data corresponding to one horizontal line by performing projection operation with respect to the dark image data, obtained by dark image photographing operation, in the horizontal direction, and obtaining data corresponding to one vertical line by performing projection operation in the horizontal direction. Therefore, dark image data need not be captured with respect to the entire frame in step **S116**. That is, dark image data to be captured may have the minimum size that is free from the influence of random noise in projection operation. Capturing dark image data in an area having the minimum size that is free from the influence of random noise and using the data for the creation of correction data in this manner can shorten the time required for the creation of correction data than capturing dark image data of all pixels and creating correction data.

[**0117**] The one-dimensional dark fixed pattern noise correction data created in step **S117** is repeatedly expanded in a predetermined area in the image memory **30** in the vertical direction by the number of times equal to the number of lines of the actual image (step **S118**). Various settings in the image processing apparatus **100** are displayed in image or voice by using the display unit **108** (step **S119**), and the flow advances to step **S120**. Note that if the image display unit **28** has an image display switch, the processing in step **S119** may be performed only when the setting of the image display switch is ON. This makes it possible to greatly reduce the power consumption of the image processing apparatus **100**.

[**0118**] It is checked in step **S120** whether or not the shutter switch **SW1** is ON. If the shutter switch **SW1** is not ON, the

flow returns to the processing in step S103 and subsequent steps. If the shutter switch SW1 is ON, distance measurement/photometry processing in **FIG. 7** (to be described later) is performed (step S121). In this case, distance measurement processing is the processing of focusing the photographing lens **310** on an object by using the distance control unit **42**. The photometry processing is the processing of determining the aperture value and shutter speed of the shutter **12** by using the photometry control unit **46**. Note that in photometry processing, a flash setting may be made.

[0119] It is checked in step S122 whether or not the shutter switch SW2 is ON. If the shutter switch SW2 is not ON, it is checked whether or not the shutter switch SW1 is OFF. The processing in steps S122 and S123 is repeated until the shutter switch SW1 becomes OFF or the shutter switch SW2 is becomes ON. When it is determined in step S123 that the shutter switch SW1 is OFF, the flow advances to the processing in step S103.

[0120] If it is determined in step S122 that the-shutter switch SW2 is ON, the system control circuit **50** checks whether or not the image memory **30** has an image storage buffer area in which the photographed image data can be stored (step S124). If no area in which new image data can be stored is present in the image storage buffer area of the image memory **30**, a predetermined warning is made by causing the display unit **108** to display an image or output a sound (step S125). The flow then returns to the processing in step S103.

[0121] For example, immediately after continuous photographing is performed up to the maximum number of frames that can be stored-in the image storage buffer area of the image memory **30**, there is no area in which new image data can be stored in the image storage buffer area of the image memory **30**. In this state, for example, the first image data that should be read out from the image memory **30** and written in the external memories **200** and **210** has not been recorded yet on the external memories **200** and **210**, and even a free space corresponding to one frame has not been ensured on the image storage buffer area of the image memory **30**.

[0122] Note that when photographed image data is to be stored in the image storage buffer area of the image memory **30** upon compression processing, it is checked whether there is any area in which the image data can be-stored in the image storage buffer area of the image memory **30**, in consideration of the fact that the image data amount after compression varies depending on the compression mode setting (step S124).

[0123] If it is determined in step S124 that the image memory **30** has an image storage buffer area in which photographed image data can be stored, the system control circuit **50** executes the photography processing (to be described later with reference to **FIGS. 8 and 9**) of reading out image sensing signals obtained by image sensing and stored for a predetermined period of time from the image sensing device **14**, and writing the photographed image data in a predetermined area of the image memory **30** through the A/D converter **16**, image processing circuit **20**, and memory control circuit **22** or directly from the A/D converter **16** through the memory control circuit **22** (step S126).

[0124] Subsequently, flaws in the photographed image data are corrected on a pixel basis to prevent image quality from being affected by pixel flaws in developing processing (step S133).

[0125] The system control circuit **50** performs WB (White Balance) integral computation processing and OB (Optical Black) integral computation processing necessary for developing processing by reading out part of the image data written in the predetermined area of the image memory **30** through the memory control circuit **22**, and stores the computation result in the memory in the system control circuit **50** or the system memory **52**.

[0126] The system control circuit **50** then reads out the actually photographed image data written in the predetermined area of the image memory **30** by using the memory control circuit **22** and, if needed, image processing circuit **20**, and performs various kinds of developing processing including AWB (Automatic White Balance) processing, gamma conversion processing, and color conversion processing by using the computation result stored in the memory in the system control circuit **50** or the system memory **52** (step S127). In this developing processing, dark correction computation processing is also performed, which is subtraction processing using the one-dimensional dark fixed pattern noise correction data expanded in step S118.

[0127] The system control circuit **50** further reads out the image data written in the predetermined area of the image memory **30**, performs image compression processing corresponding to the set mode by using the compression/decompression circuit **32**, and writes the image data obtained by photograph operation and having undergone a series of operations in a free space in the image storage buffer area of the image memory **30** (step S128).

[0128] The system control circuit **50** performs recording processing of reading out the image data stored in the image storage buffer area of the image memory **30**, and writing the readout image data in the external memories **200** and **210** such as a memory card and compact flash (registered trademark) card through the I/Fs **90** and **94** and connectors **92** and **96** (step S29). Every time image data obtained by photographing operation and having undergone a series of operations is newly written in a free space in the image storage buffer area of the image memory **30**, this recording processing is executed for the image data.

[0129] While image data is written in the external memories **200** and **210**, recording medium writing indication is performed by, for example, causing the display unit **108** to blink the LED to indicate that data is being written while image data is written in the external memories **200** and **210**.

[0130] The system control circuit **50** also checks whether or-not the shutter switch SW1 is pressed (step S130). If the shutter switch SW1 is released (NO in step S130), the flow returns to step S103. If the shutter switch SW1 is pressed, the state of the simple-frame/continuous photographing flat stored in the memory in the system control circuit **50** or the system memory **52** is checked (step S131); If the single-frame photographing mode is set, the flow returns to step S130 to repeat the current processing until the shutter switch SW1 is released. If the continuous photographing mode is set, the flow returns to step S122 to continuously perform photographing operation, thereby preparing for the next

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photograph operation. With this processing, a series of operations associated with photographing operation is terminated.

[0131] 4. Details of Image Sensing Processing (Distance Measurement/Photometry Processing)

[0132] **FIG. 7** is a flow chart showing distance measurement/photometry processing executed in step S121 in **FIG. 5**.

[0133] In the distance measurement/photometry processing, the system control circuit **50** and the stop control unit **340** or distance measurement control unit **342** exchange various kinds of signals through the I/F **120**, connector **122**, connector **322**, I/F **320**, and lens system control circuit unit **350**.

[0134] The system control circuit **50** starts AF (AutoFocus) processing by using the image sensing device **14**, distance control unit **42**, and distance measurement control unit **342** (step S201).

[0135] The system control circuit **50** causes a light beam incident on the photographing lens **310** to be incident on the distance control unit **42** through the stop **312**, the lens mounts **306** and **106**, the mirror **130**, and a sub-mirror for distance measurement (not shown), thereby determining the in-focus state of an image formed as an optical image. The system control circuit **50** keeps executing the AF control of detecting an in-focus state by using the distance control unit **42** while driving the photographing lens **310** using the distance measurement control unit **342** until an in-focus state is obtained in distance measurement (AF) (steps S202 and S203).

[0136] If it is determined that an in-focus state is obtained in distance measurement (AF) (YES in step S203), the system control circuit **50** determines one of a plurality of distance measurement points in a photographing frame at which the in-focus state is obtained, and stores the data of the determined distance measurement point and distance measurement data and/or a set parameter in the memory in the system control circuit **50** or the system memory **52** (step S204). If no in-focus state is obtained in distance measurement (NO in step S203), the flow returns to step S202.

[0137] The system control circuit **50** starts photometry by using the photometry control unit **46** (step S205). The system control circuit **50** causes a light beam incident on the photographing lens **310** to be incident on the photometry control unit **46** through the stop **312**, the lens mounts **306** and **106**, the mirrors **130** and **132**, and a lens for photometry (not shown), thereby measuring the exposed state of an image formed as an optical image. The system control circuit **50** keeps performing photometry processing by using the shutter control unit **40** until it is determined that the exposure (AE) is proper (steps S206 and S207).

[0138] If it is determined that the exposure (AE) is proper (YES in step S207), the system control circuit **50** stores the photometry data and/or a set parameter in the memory in the system control circuit **50** or the system memory **52** (step S207A). If it is determined that the exposure (AE) is not proper (NO in step S207), the flow returns to step S206.

[0139] The system control circuit **50** determines an aperture value (Av value) and a shutter speed (Tv value) in accordance with the exposure (AE) result detected in the photometry processing in step S206 and the photographing mode set by the mode dial switch **60**.

[0140] In accordance with the determined shutter speed (Tv value), the system control circuit **50** determines an electric charge storage time, and performs photographing processing and dark capture processing in this determined electric charge storage time.

[0141] In accordance with the measurement data obtained by the photometry processing in step S206, the system control circuit **50** checks whether or not a flash is required (step S208). If a flash is required, the flash flag is set to fully charge the flash unit **48** (step S209). When the flash unit **48** is fully charged (step S210), this processing is terminated, and the flow returns to the main processing. If it is determined in step S208 that the flash unit **48** has not yet been fully charged, the flow returns to step S209.

[0142] 5. Details of Image Sensing Processing (Image Sensing Processing Step S126)

[0143] **FIGS. 8 and 9** are flow charts showing the photographing processing sequence executed in step S126 in **FIG. 5**.

[0144] In this photographing processing, the system control circuit **50** and the stop control unit **340** or distance measurement control unit **342** exchange various kinds of signals through the I/F **120**, connector **122**, connector **322**, I/F **320**, and lens system control circuit unit **350**.

[0145] The system control circuit **50** causes a mirror driving unit (not shown) to move the mirror **130** to the mirror-up position (step S301), and also causes the stop control unit **340** to drive the stop **312** to a predetermined aperture value in accordance with the photometry data stored in the memory in the system control circuit **50** or the system memory **52** (step S302).

[0146] The system control circuit **50** clears the electric charge in the image sensing device **14** (step S303), and then starts charging the image sensing device **14** (step S304). The system control circuit **50** causes the shutter control unit **40** to open the shutter **12** (step S305), and starts exposing the image sensing device **14** (step S306).

[0147] The system control circuit **50** checks on the basis of the flash flag whether or not the flash unit **48** is required (step S307). If it is determined that the flash unit **48** is required, the flash unit **48** is caused to emit light (step S308). If it is determined that the flash unit **48** is not required, the flow advances to step S309.

[0148] When the exposure of the image sensing device **14** is completed in accordance with photometry data (YES in step S309), the system control circuit **50** causes the shutter control unit **40** to close the shutter **12** (step S310), and terminates the exposure of the image sensing device **14**.

[0149] The system control circuit **50** causes the stop control unit **340** to drive the stop **312** to the full aperture value (step S311), and also causes the mirror driving unit (not shown) to move the mirror **130** to the mirror-down position (step S312).

[0150] The system control circuit **50** checks whether or not a set electric charge storage time has elapsed (step S313). If the set electric charge storage time has elapsed, the system control circuit **50** finishes charging the image sensing device

14 (step S**314**). The system control circuit **50** then reads an electric charge signal from the image sensing device **14**, and writes the photographed image data in a predetermined area in the image memory **30** through the A/D converter **16**, image processing circuit **20**, and memory control circuit **22** or directly from the A/D converter **16** through the memory control circuit **22** (step S**315**). If it is determined in step S**313** that the set electric charge storage time has not elapsed, step S**313** is repeated. When a series of operations are complete, this processing is terminated, and the flow returns to the main processing.

[**0151**] 6. Details of Image Sensing Processing (Dark Capture Processing Step S**116**)

[**0152**] **FIG. 10** is a flow chart showing the dark capture processing sequence executed in step S**116** in **FIG. 4**.

[**0153**] After clearing the electric charge in the image sensing device **14** (step S**401**), the system control circuit **50** starts charging the image sensing device **14** while the shutter **12** is closed (step S**402**). When a predetermined electric charge storage time has elapsed (YES in step S**403**), the system control circuit **50** finishes charging the image sensing device **14** (step S**404**). The system control circuit **50** then reads out an electric charge signal from the image sensing device **14**, and writes the image data (dark image data) in a predetermined area in the image memory **30** through the A/D converter **16**, image processing circuit **20**, and memory control circuit **22** or directly from the A/D converter **16** through the memory control circuit **22** (step S**405**). This dark image date is used for the execution of developing processing in a state wherein photographing processing has been executed, and the photographed image data has been read from the image sensing device **14** and written in the image memory **30**.

[**0154**] By performing developing processing (step S**127**) using one-dimensional dark fixed pattern noise correction data using this dark image data, photographed image data can be corrected against a deterioration in image quality such as pixel loss caused by dark current noise produced in the image sensing device **14** or flaws unique to the image sensing device **14**. Thereafter, this processing is terminated, and the flow returns to the main processing.

[**0155**] The above description is about the first embodiment of the present invention. The present invention is not limited to the arrangement of the embodiment, however, and can be applied to any arrangement that can realize the functions defined in the appended claims or the functions of the arrangement of the embodiment. For example, in this embodiment, when correction is to be performed by using one-dimensional dark fixed pattern noise correction data (1-line data one line in the horizontal direction), the correction data is expanded in the image memory **30**. Correction, however, can be performed so as to sequentially subtract one-dimensional dark fixed pattern noise correction data from actually photographed image data while loading actually photographed image data from the image sensing device **14** without performing this expansion processing.

[**0156**] In this embodiment, expansion processing for one-dimensional dark fixed pattern noise correction data (step S**118**) is performed after the shutter switch SW**2** is pressed. This processing, however, may be performed after the power of the camera is turned on.

[**0157**] Additionally, this one-dimensional fixed pattern noise correction data is one-dimensional data in the horizontal direction. One-dimensional data in the vertical direction, however, may be used instead. Furthermore, as shown in **FIG. 11** (to be described later), both one-dimensional data in the horizontal and vertical directions may be stored in advance, and when the one-dimensional data in the horizontal direction is to be expanded in the expansion processing for the correction data (step S**118**), the correction amount may be increased/decreased for each line by using the one-dimensional data in the vertical direction, thereby correcting one-dimensional dark fixed pattern noise in the horizontal and vertical directions.

[**0158**] **FIG. 11** is a view for explaining how image data is corrected by using both one-dimensional data in the vertical and horizontal directions.

[**0159**] In this case, the data in the vertical direction may be stored as a mathematical expression instead of being stored as one-dimensional correction data, and when one-dimensional data in the horizontal direction is to be expanded, one-dimensional dark fixed pattern noise in the vertical direction may be corrected by using this mathematical expression.

[**0160**] The above embodiment has exemplified the case wherein the single-frame photographing mode and continuous photographing mode are switched by using the single-frame/continuous photographing switch **68**. The single-frame photographing mode and continuous photographing mode, however, may be switched in accordance with the selection of an operation mode with the mode dial switch **60**.

[**0161**] Additionally, in this embodiment, the electric charge storage time in actual photographing operation is made equal to the electric charge storage time in dark capture processing. Different electric charge storage times, however, may be set within the range in which data enough to correct dark current noise and the like can be obtained.

[**0162**] Furthermore, in this embodiment, photographing operation is performed upon movement of the mirror **130** to the mirror-up position or mirror-down position. However, the mirror **130** may not have a half mirror arrangement, and photographing operation may be performed without moving the mirror **130**.

[**0163**] Moreover, the external memories **200** and **210** may be formed from optical disks such as micro DATs, magnetooptical disks, CD-Rs, and CD-RWs, phase change optical disks such as optical disks and DVDs as well as memory cards such as PCMCIA cards and compact flash (registered trademark) cards, hard disks, and the like. The external memories **200** and, **210** may be an integrated medium of a memory card and a hard disk or the like. In this case, part of the composite medium may be detachable.

[**0164**] In the above embodiment, the external memories **200** and **210** are separated from the image processing apparatus **100** and can be arbitrarily connected. Either or all of the recording media, however, may be fixed to the image processing apparatus **100**. In addition, the present invention may have an arrangement in which a single or an arbitrary number of external memories **200** and **210** can be connected to the image processing apparatus **100**.

[**0165**] As is obvious from the above description, according to this embodiment, one-dimensional dark fixed pattern

noise correction data is created by performing projection operation in the vertical or horizontal direction with respect to the dark image data obtained by image sensing in an unexposed state, and actually photographed image data is corrected by using the one-dimensional dark fixed pattern noise correction data, thereby eliminating one-dimensional dark fixed pattern noise and preventing a deterioration in image quality.

[0166] [Second Embodiment]

[0167] In the first embodiment described above, in order to prevent image quality from deteriorating due to one-dimensional dark fixed pattern noise, one-dimensional dark fixed pattern noise correction data is created, and actually photographed image data is corrected by using the correction data. The created correction data, however, varies depending on the ISO sensitivity setting in dark capture operation. If, therefore, the ISO sensitivity setting in dark capture operation differs from that in actual photographing operation, the created correction data cannot be used without any modification. A case wherein actually photographed image data is to be corrected will be described.

[0168] **FIGS. 12 and 13** are flow charts showing the flow of image sensing processing according to this embodiment. These flow charts are basically the same as those (FIGS. **3** to **5**) which indicate the flow of image sensing processing in the first embodiment. In this embodiment, image sensing processing is executed on the assumption that one-dimensional dark fixed pattern noise correction data is stored in advance, and hence the processing in step S114*a* in **FIG. 4** is omitted.

[0169] **FIG. 14** is a flow chart showing the flow of processing for creating one-dimensional dark fixed pattern noise correction data used in the image sensing processing shown in **FIG. 13**. This embodiment is based on the assumption that this processing is executed in advance before factory shipment after the manufacture of the image sensing apparatus.

[0170] As shown in **FIG. 14**, the sensitivity of the image sensing apparatus is set to ISO 1600, and dark image data corresponding to an entire frame is captured in step S**1402** while a shutter **12** is closed and no exposure is performed. In step S**1403**, one-dimensional dark fixed pattern noise correction data is created from the dark image data corresponding to the entire frame captured in step S**1402** by projection operation.

[0171] In step S**1404**, the sensitivity of the image sensing apparatus is set to ISO 800. In step S**1405**, data corresponding to ¼ of the-frame of dark image data is captured in the same as in step S**1402**. In step S**1406**, one-dimensional dark fixed pattern noise correction data is created from the dark image data corresponding to ¼ of the frame captured in step S**1405** by projection operation.

[0172] When the ISO sensitivity is reduced to ½, it suffices to create data corresponding to ¼ of one-dimensional dark fixed pattern noise correction data. This is because random noise due to averaging is reduced in square root.

[0173] Likewise, in step S**1407**, the sensitivity of the image sensing apparatus is set to ISO 400. In step S**1408**, data corresponding to 1/16 of the frame of dark image data is captured in the same manner as in step S**1402**. In step S**1409**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/16 of the frame captured in step S**1408** by projection operation.

[0174] In step S**1410**, the sensitivity of the image sensing apparatus is set to ISO 200. In step S**1411**, data corresponding to 1/64 of the frame of dark image data is captured in the same manner as in step S**1402**.

[0175] In step S**1412**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/64 of the frame captured in step S**1411** by projection operation.

[0176] In step S**1413**, the sensitivity of the image sensing apparatus is set to ISO 100. In step S**1414**, data corresponding to 1/64 of the frame of dark image data is captured in the same manner as in step S**1402**. In step S**1415**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/64 of the frame captured in step S**1414** by projection operation.

[0177] The reason why both one-dimensional dark fixed pattern noise correction data under ISO 100 and ISO 200 are obtained from 1/64 of the frame is that with a too small amount of correction data, image data becomes susceptible to the influences of damaged pixels and the like other than random noise. In addition, no problem occurs in terms of time because it takes only a short period of time.

[0178] Finally, in step S**1416**, the one-dimensional dark fixed pattern noise correction data under each ISO sensitivity is recorded on a nonvolatile memory **56**.

[0179] As described above, preparing one-dimensional dark fixed pattern noise correction data for the respective ISO sensitivities in the image sensing apparatus before factory shipment makes it possible to switch the one-dimensional dark fixed pattern noise correction data in accordance with the switching of the ISO sensitivities. Just for reference, **FIG. 20** shows an example of the range of dark image data required to create correction data for the respective ISO sensitivities. In this case, horizontal correction data is created by projection operation in the vertical direction.

[0180] **FIG. 15** is a flow chart showing the details of dark correction computation processing (step S**127**) in the image sensing apparatus in which one-dimensional dark fixed pattern noise correction data for each ISO sensitivity setting is prepared by executing the processing shown in **FIG. 14**.

[0181] As shown in **FIG. 15**, in step S**1501**, the ISO sensitivity setting at the time of actual photographing operation is loaded. In step S**1502**, one-dimensional dark fixed pattern noise correction data corresponding to the loaded ISO sensitivity setting is loaded. In step S**1503**, the actually photographed image data is corrected by using the loaded one-dimensional dark fixed pattern noise correction data.

[0182] [Third Embodiment]

[0183] In the second embodiment, the image sensing apparatus in which one-dimensional dark fixed pattern noise correction data for each ISO sensitivity setting is prepared in advance has been described. The present invention, however, is not limited to this, and correction data may be created before actual photographing operation.

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[0184] **FIGS. 16 and 17** are flow charts showing the flow of image sensing processing in a case wherein one-dimensional dark fixed pattern noise correction data is created after a power supply SW of the image sensing apparatus is turned on. This processing is wherein if it is determined in step **S108** that there is no problem in the operation state of a recording medium, dark capture processing and correction data creation processing are executed in step **S1601**. Note that processing other than step **S1601** is the same as that in **FIGS. 13 and 14**, and hence a description thereof will be omitted.

[0185] **FIG. 18** is a flow chart showing the details of dark capture processing and correction data creation processing in step **S1601**.

[0186] Referring to **FIG. 16**, the sensitivity of the image sensing apparatus is set to ISO 1600 in step **S1801**. In step **S1802**, dark image data corresponding to an entire frame is captured while a shutter **12** is closed and no exposure is performed. In step **S1803**, one-dimensional dark fixed pattern noise correction data is created from the dark image data corresponding to the entire frame captured in step **S1802** by projection operation.

[0187] In step **S1804**, the sensitivity of the image sensing apparatus is set to ISO 800. In step **S1805**, data corresponding to ¼ of the frame of the dark image data is captured in the same manner as in step **S1802**. In step **S1806**, one-dimensional dark fixed pattern noise correction data is created from the dark image data corresponding to ¼ of the frame captured in step **S1805**.

[0188] When the ISO sensitivity is reduced to ½, it suffices to create data corresponding to ¼ of one-dimensional dark fixed pattern noise correction data. This is because random noise due to averaging is reduced in square root.

[0189] Likewise, in step **S1807**, the sensitivity of the image sensing apparatus is set to ISO 400. In step **S1808**, data corresponding to 1/16of the frame of dark image data is captured in the same manner as in step **S1802**. In step **S1809**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/16 of the frame captured in step **S1808** by projection operation.

[0190] In step **S1810**, the sensitivity of the image sensing apparatus is set to ISO 200. In step **S1811**, data corresponding to 1/64 of the frame of dark image data is captured in the same manner as in step **S1802**.

[0191] In step **S1812**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/64 of the frame captured in step **S1811** by projection operation. This makes it possible to set a signal capturing area in accordance with the ISO sensitivity setting, and hence to shorten the time required for the creation of correction data.

[0192] In step **S1813**, the sensitivity of the image sensing apparatus is set to ISO 100. In step **S1814**, data corresponding to 1/64 of the frame of dark image data is captured in the same manner as in step **S1802**. In step **S1815**, one-dimensional dark fixed pattern noise correction data is created from dark image data corresponding to 1/64 of the frame captured in step **S1814** by projection operation.

[0193] The reason why both one-dimensional dark fixed pattern noise correction data under ISO 100 and ISO 200 are obtained from 1/64 of the frame is that with a too small amount of correction data, image data becomes susceptible to the influences of damaged pixels and the like other than random noise. In addition, no problem occurs in terms of time because it takes only a short period of time.

[0194] Creating one-dimensional dark fixed pattern noise correction data for each ISO sensitivity setting in this manner makes it possible to improve the correction precision and further prevent a deterioration in image quality as compared with a case wherein such correction data are created before factory shipment (the second embodiment).

[0195] [Fourth Embodiment]

[0196] In the third embodiment, after the power supply switch **72** is turned on, one-dimensional dark fixed pattern noise correction data for all the ISO sensitivity settings are created. The present invention is not, however, limited to this. For example, one-dimensional dark fixed pattern noise correction data may be created after the execution of image sensing processing (step **S126**). In addition, there is no need to create one-dimensional dark fixed pattern noise correction noise for all the ISO sensitivity settings. When dark image photographing operation is performed after actual photographing processing, only dark image photographing operation for the same ISO sensitivity setting as that made at the time of the photographing operation may be performed to create one-dimensional dark fixed pattern noise correction data. Furthermore, one-dimensional dark fixed pattern noise correction data need not be created after every actual photographing processing, and correction data may be created only when a predetermined period of time has elapsed from the time point at which one-dimensional dark fixed pattern noise correction data is created.

[0197] **FIG. 19** is a flow chart showing the flow of dark correction computation processing (step **S127**) for correcting actually photographed image data by creating one-dimensional dark fixed pattern noise correction data on the basis of this point of view.

[0198] As shown in **FIG. 19**, the ISO sensitivity setting made at the time of actual photographing operation is loaded in step **S1901**. In step **S1902**, it is checked whether or not one-dimensional dark fixed pattern noise correction data corresponding to the loaded ISO sensitivity setting has already been created.

[0199] If it is determined in step **51902** that one-dimensional dark fixed pattern noise correction data has already been created, the flow advances to step **S1907** to check whether or not a predetermined period of time has elapsed after the creation of the one-dimensional dark fixed pattern noise correction data. Note that the predetermined period of time is a time during which one photographing scene is expected to continue. This is because one-dimensional dark fixed pattern noise correction data within the predetermined period of time can be regarded as having undergone a small change in conditions, and hence can be used for correction.

[0200] If, therefore, it is determined in step **S1907** that the predetermined period of time has not elapsed yet, the flow advances to step **S1906** to correct the actually photographed image data by using the above correction data.

[0201] If it is determined in step **S1902** that no one-dimensional dark fixed pattern noise correction data has

been created, or it is determined in step **S1907** that the predetermined period of time has elapsed, the flow advances to step **S1903** to capture dark image data so as to create one-dimensional dark fixed pattern noise correction data corresponding to the set ISO sensitivity setting. In step **S1904**, one-dimensional dark fixed pattern noise correction data is created. In step **S1905**, the created correction data is recorded.

[**0202**] Subsequently, the flow advances to step **S1906** to correct the actually photographed image data by using the correction data created in step **S1904**.

[**0203**] [Fifth Embodiment]

[**0204**] In the first to fourth embodiments, when dark image data is to be captured, 1-frame dark image data is captured. The present invention, however, is not limited to this. The number of frames to be captured may be set in advance, and dark image data may be captured by an amount corresponding to the set number of frames.

[**0205**] **FIG. 21** is a flow chart showing the flow of processing in dark capture processing executed in, for example, step **S1402** in **FIG. 14** or step **S1802** in **FIG. 18**, in a case wherein dark image data corresponding to a preset number of frames are to be captured.

[**0206**] Referring to **FIG. 21**, in step **S2101**, the number of images to be captured (the number of frames) which is set in accordance with the ISO sensitivity setting is loaded. Assume that the number of frames is set to one with ISO 100; two with ISO 200; and four with ISO 400.

[**0207**] Subsequently, a system control circuit **50** clears the electric charge in an image sensing device **14** (step **S2102**). The system control circuit **50** then starts charging the image sensing device **14** while a shutter **12** is closed (step **S2103**). When a predetermined electric charge storage time has elapsed (YES in step **S2104**), the system control circuit **50** finishes charging the image sensing device **14** (step **S2105**), and reads an electric charge signal from the image sensing device **14**.

[**0208**] In step **S2101**, it is checked whether or not data corresponding to a loaded frame count (n) have been captured (step **S2106**). If the data have not been captured yet, the flow returns to step **S2102**.

[**0209**] If it is determined in step **S2101** that the data corresponding to the loaded frame count (n) have been captured, the image data (dark image data) are written in a predetermined area in an image memory **30** (step **S2107**). Subsequently, this processing is terminated, and the flow returns to the main processing.

[**0210**] [Other Embodiment]

[**0211**] The present invention can also be applied to a case wherein software program codes for realizing the functions of the above embodiments are supplied to a system or apparatus. In this case, the program codes themselves realize the novel functions of the present invention, and the program itself and a storage medium storing the program constitute the present invention.

[**0212**] In the above embodiments, the program codes shown in the flow charts of FIGS. **3** to **5**, **7**, **8**, **10**, **12** to **19**, and **21** are stored in a ROM as a recording medium. The recording medium for supplying the program codes is not limited to the ROM. For example, a flexible disk, hard disk, nonvolatile memory card, and the like can be used.

[**0213**] The present invention can be realized by loading software programs (the flow charts of FIGS. **3** to **5** and the like) for realizing the functions of the above embodiments into the system memory **52**, supplying them to the CPU in the system control circuit **50**, and causing the CPU to read out the supplied programs and execute them.

[**0214**] In this case, the above programs are directly supplied from the storage medium on which the programs are recorded or supplied by being downloaded from another computer or database (not shown) connected to the Internet, a commercial network, a local area network, or the like.

[**0215**] The above programs may take the form of object codes, program codes executed by an interpreter, script data supplied to an OS (Operating System), or the like.

[**0216**] The object of the present invention can also be realized even by supplying a storage medium storing the software programs for realizing the functions of the above embodiments to a CPU and causing the CPU to read out and execute the programs stored in the storage medium.

[**0217**] In this case, the program codes themselves read out from the storage medium realize the functions of the respective embodiments described above, and the storage medium storing the program codes constitutes the present invention.

[**0218**] As a storage medium storing the program codes, for example, a ROM, RAM NV-RAM, floppy (registered trademark) disk, hard disk, optical disk, magnetooptical disk, CD-ROM, MO, CD-R, CD-RW, DVD-ROM, DVD-RAM, DVD-RW, DVD+RW, magnetic tape, and nonvolatile memory card can be used.

[**0219**] The functions of the above embodiments can be realized not only when the program codes read out from the computer are executed but also when the OS (Operating System) or the like running on the computer performs part or all of actual processing on the basis of the instructions of the program codes.

[**0220**] The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention. Therefore, to apprise-the public of the scope of the present invention, the following claims are made.

What is claimed is:

1. An image sensing apparatus comprising:

a plurality of pixels;

a first calculating portion which creates correction data by performing computation using signals which are acquired by image sensing in an unexposed state and smaller in number than said plurality of pixels; and

a second calculating portion which corrects image data of said plurality of pixels, acquired by image sensing in an exposed state, by using the correction data.

2. The apparatus according to claim 1, wherein said first calculating portion changes the number of signals to be used-for creation of correction data in accordance with a sensitivity condition set at the time of image sensing.

3. The apparatus according to claim 1, wherein in that said plurality of pixels are arrayed in the horizontal direction and

the vertical direction, and said first calculating portion creates the correction data by vertically mixing signals from pixels which are smaller in number than said plurality of pixels and arrayed in the horizontal direction and the vertical direction.

4. The apparatus according to claim 3, further comprising an amplifier for each array of pixels arrayed in the vertical direction, wherein said first calculating portion creates the correction data by vertically mixing signals from pixels, which are smaller in number than said plurality of pixels and arrayed in the horizontal direction and the vertical direction, through the corresponding amplifiers.

5. The apparatus according to claim 1, wherein said first calculating portion operates in accordance with ON operation of a power switch of the image sensing apparatus.

6. A control method for an image sensing apparatus having a plurality of pixels, comprising:

a first calculating step which creates correction data by performing computation using signals which are acquired by image sensing in an unexposed state and smaller in number than said plurality of pixels; and

a second calculating step which corrects image data of said plurality of pixels, acquired by image sensing in an exposed state, by using the correction data.

7. A control program for causing a computer to realize a control method defined in claim 6.

8. A storage medium storing a control program for causing a computer to realize a control method defined in claim 6.

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