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(54) **IMAGING CONTROL UNIT, IMAGING APPARATUS, AND METHOD FOR CONTROLLING AN IMAGING APPARATUS**

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USPC **348/222.1**

(57) **ABSTRACT**

An imaging control unit includes: a calculating unit that obtains block brightness-values of a plurality of blocks from each pixel of an image data of a frame, the image data of a frame being divided into the plurality of blocks; a limiting unit that limits to a first limit brightness-value a block brightness-value which is larger than the first limit brightness-value among the plurality of block brightness-values; and a controlling unit that controls an exposure amount of an imaging unit so that a representing brightness-value of the plurality of the block brightness-values correspond to a target brightness-value which is less than first limit brightness-value.

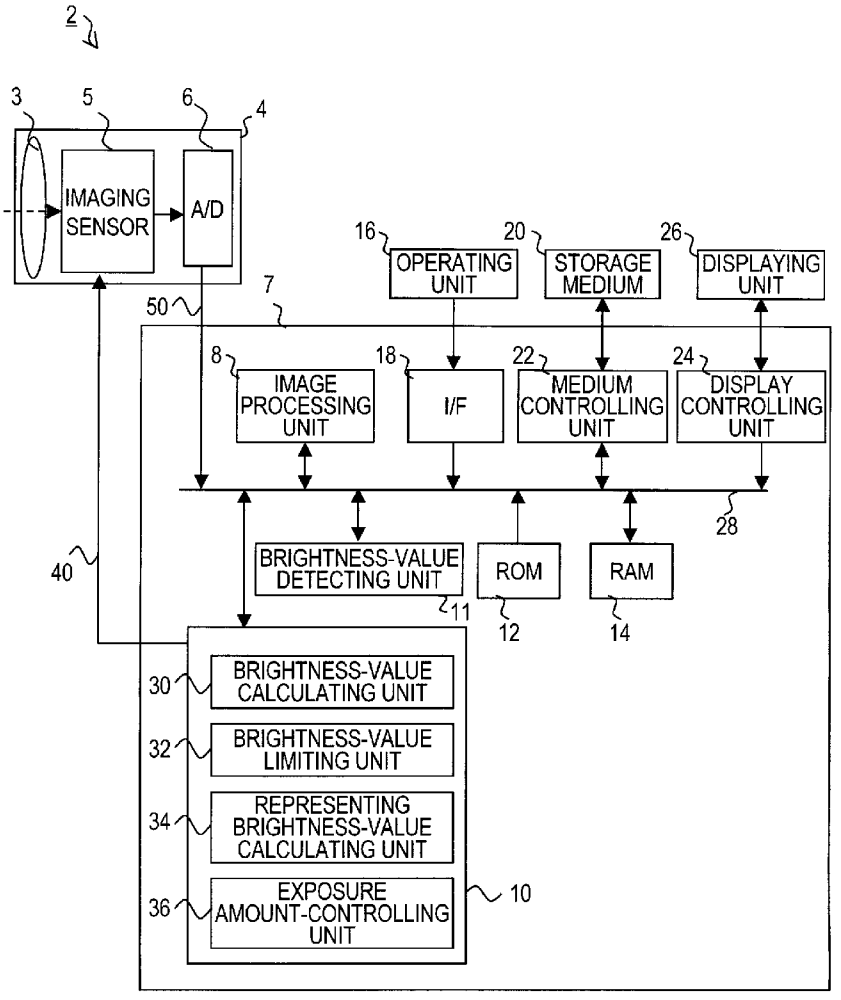

FIG. 1

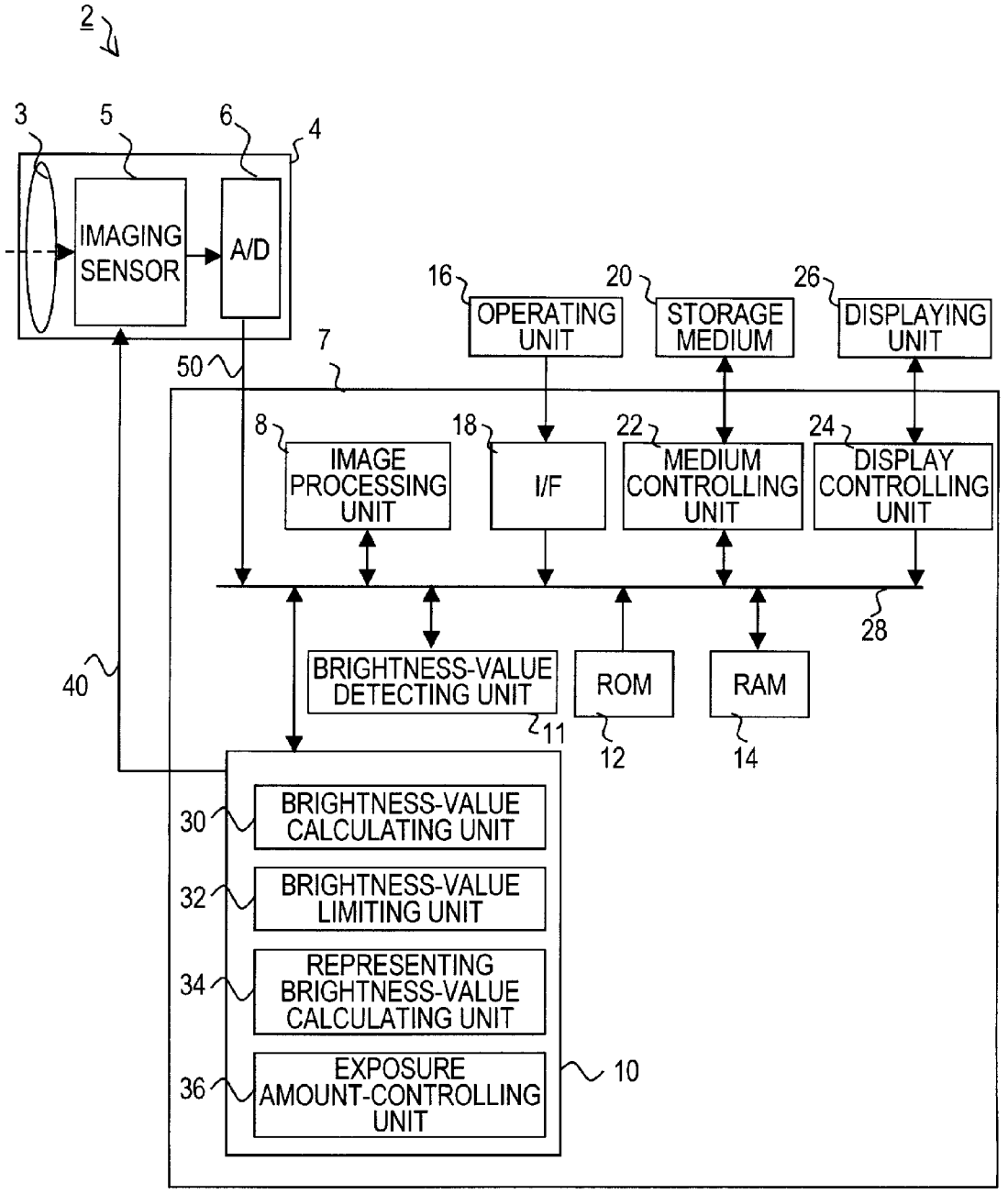
2
3
5
6
4
IMAGING SENSOR
A/D
16
OPERATING UNIT
20
STORAGE MEDIUM
26
DISPLAYING UNIT
50
7
8
IMAGE PROCESSING UNIT
18
I/F
22
MEDIUM CONTROLLING UNIT
24
DISPLAY CONTROLLING UNIT
28
40
BRIGHTNESS-VALUE DETECTING UNIT
11
ROM
12
RAM
14
30
BRIGHTNESS-VALUE CALCULATING UNIT
32
BRIGHTNESS-VALUE LIMITING UNIT
34
REPRESENTING BRIGHTNESS-VALUE CALCULATING UNIT
36
EXPOSURE AMOUNT-CONTROLLING UNIT
10

FIG. 2A

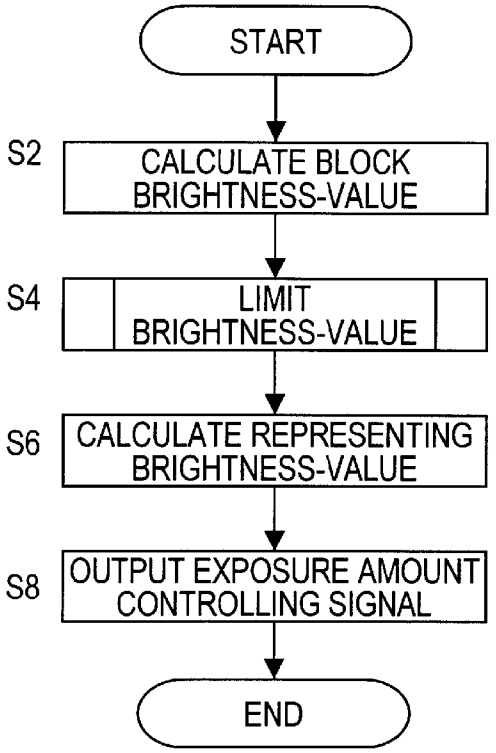
START
S2
CALCULATE BLOCK BRIGHTNESS-VALUE
S4
LIMIT BRIGHTNESS-VALUE
S6
CALCULATE REPRESENTING BRIGHTNESS-VALUE
S8
OUTPUT EXPOSURE AMOUNT CONTROLLING SIGNAL
END

FIG. 2B

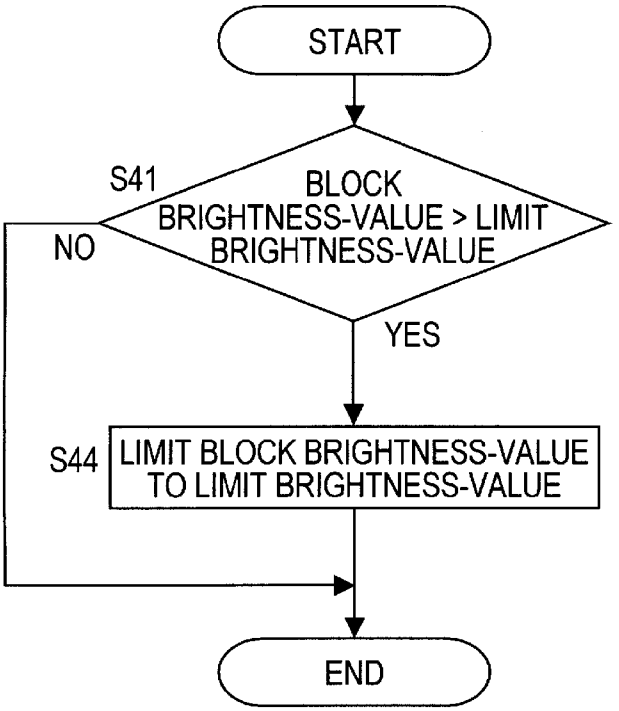
START
S41
BLOCK BRIGHTNESS-VALUE > LIMIT BRIGHTNESS-VALUE
NO
YES
S44
LIMIT BLOCK BRIGHTNESS-VALUE TO LIMIT BRIGHTNESS-VALUE
END

FIG. 3A

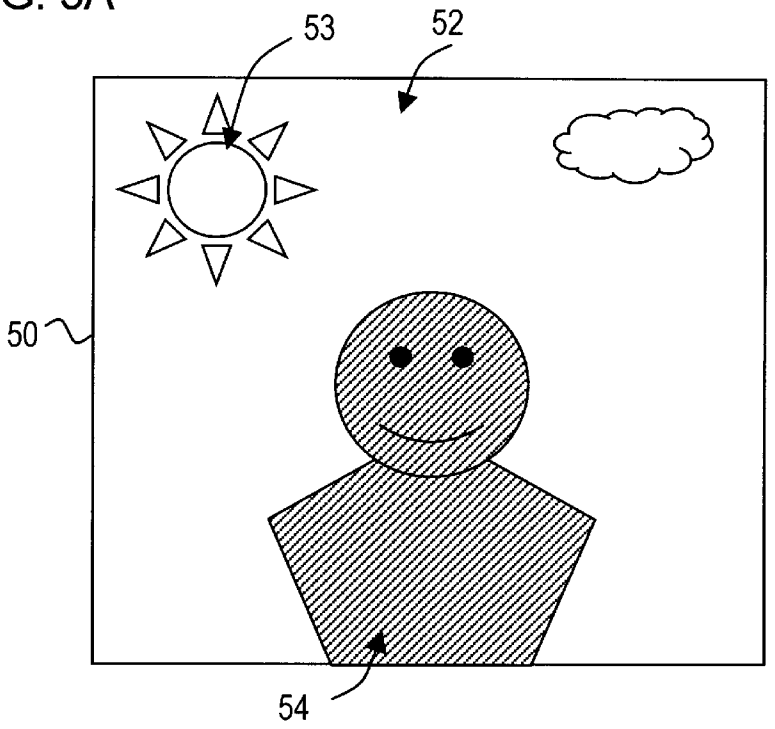

FIG. 3B

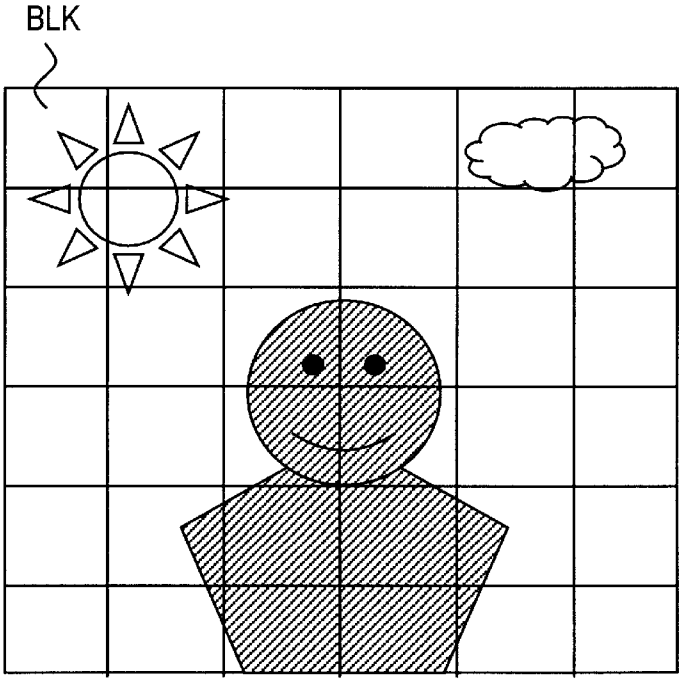

FIG. 4A

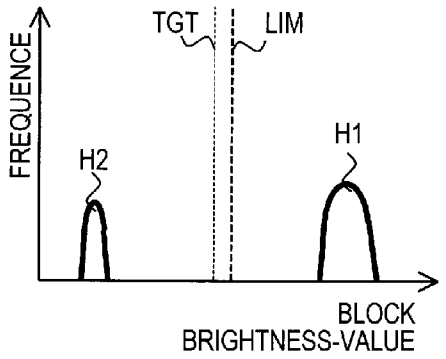

FIG. 4B

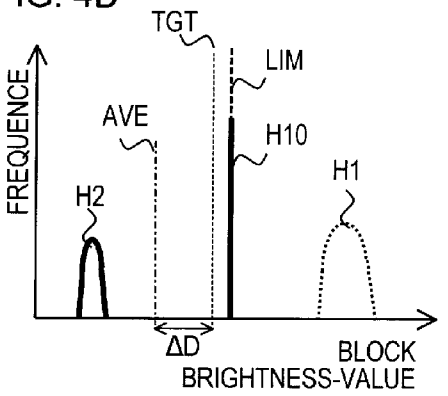

FIG. 4C

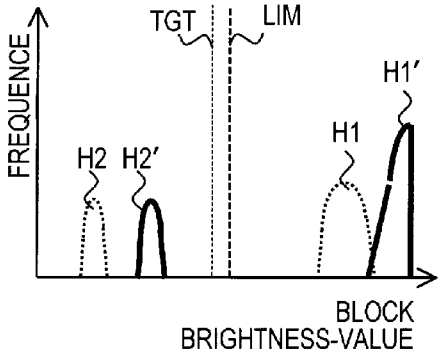

FIG. 4D

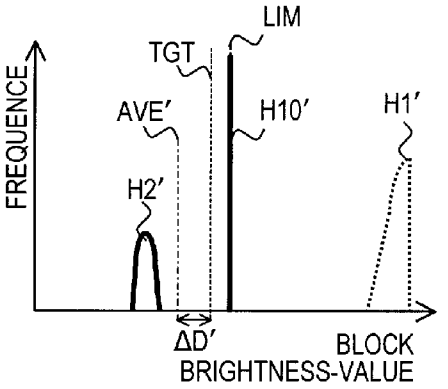

FIG. 4E

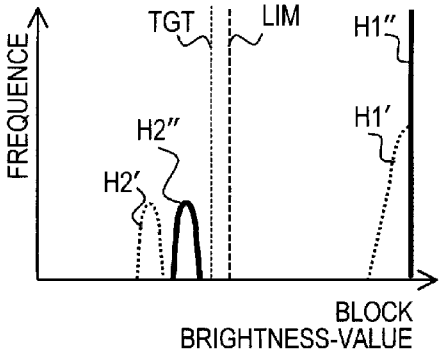

FIG. 4F

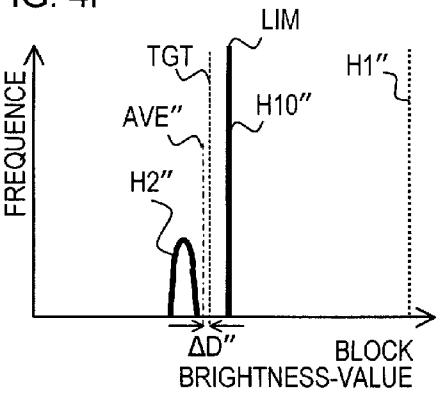

FIG. 5A

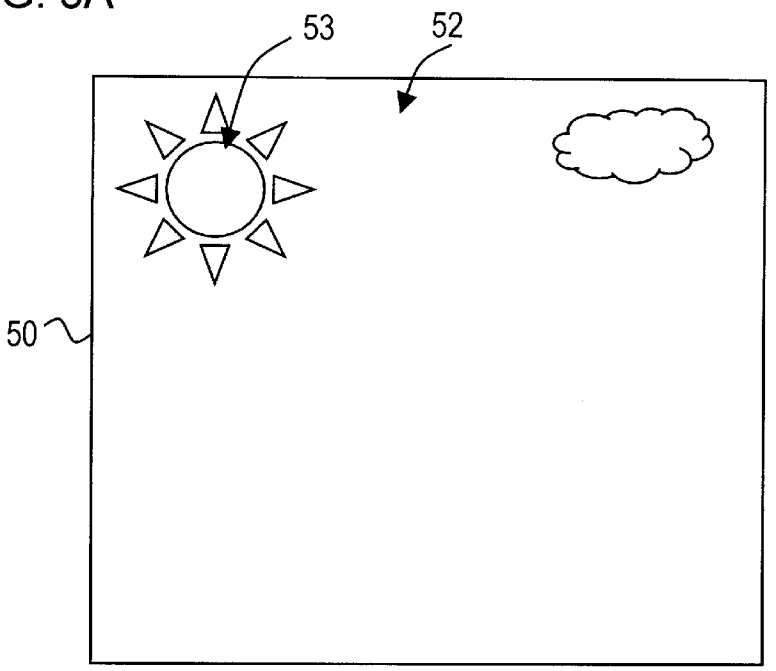

FIG. 5B

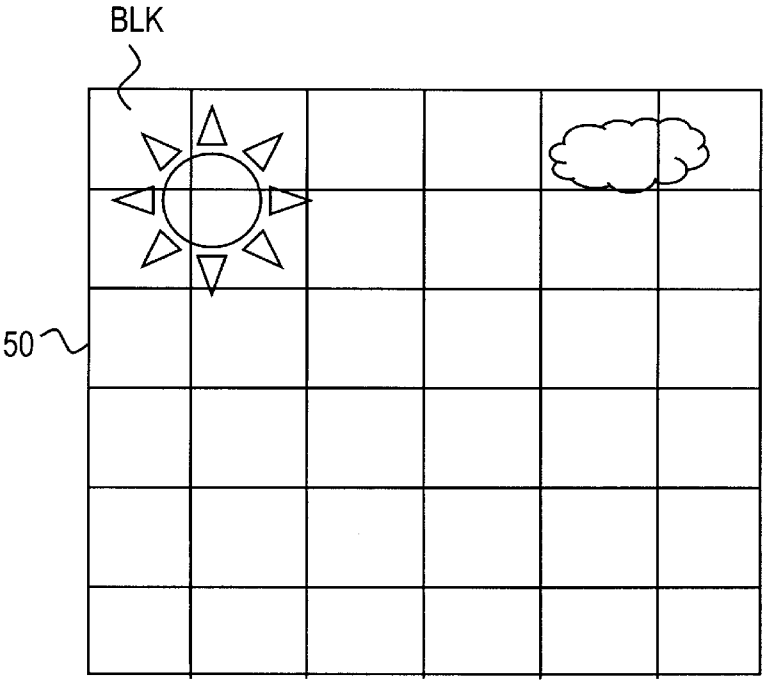

FIG. 6A

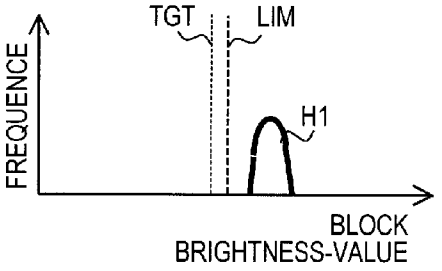

FIG. 6B

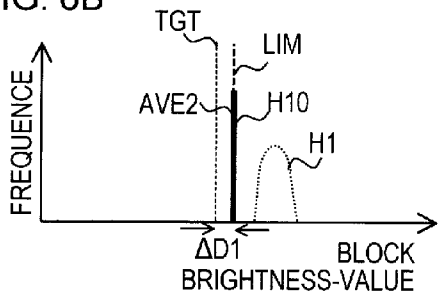

FIG. 6C

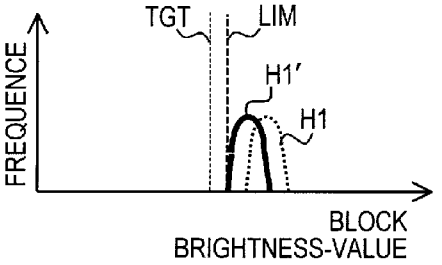

FIG. 6D

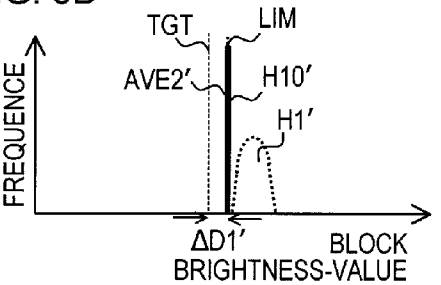

FIG. 6E

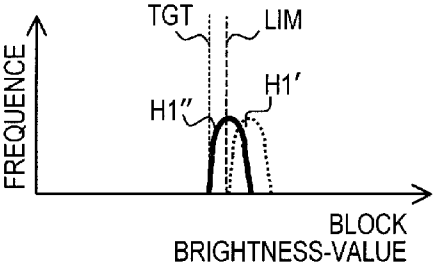

FIG. 6F

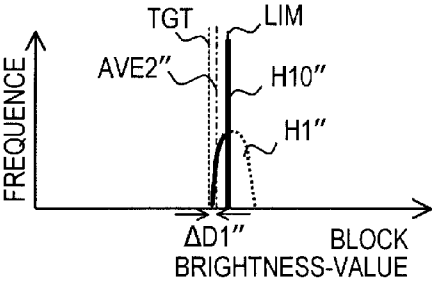

FIG. 6G

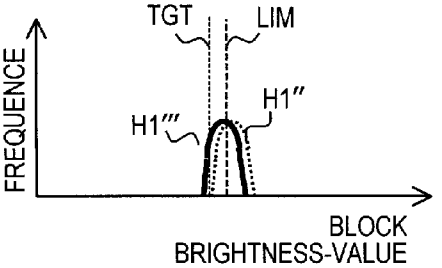

FIG. 6H

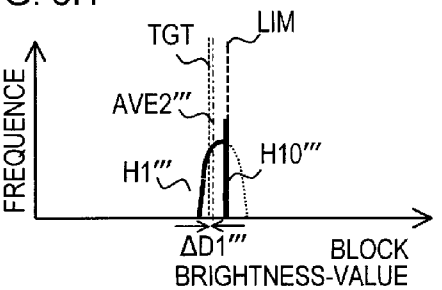

FIG. 7A

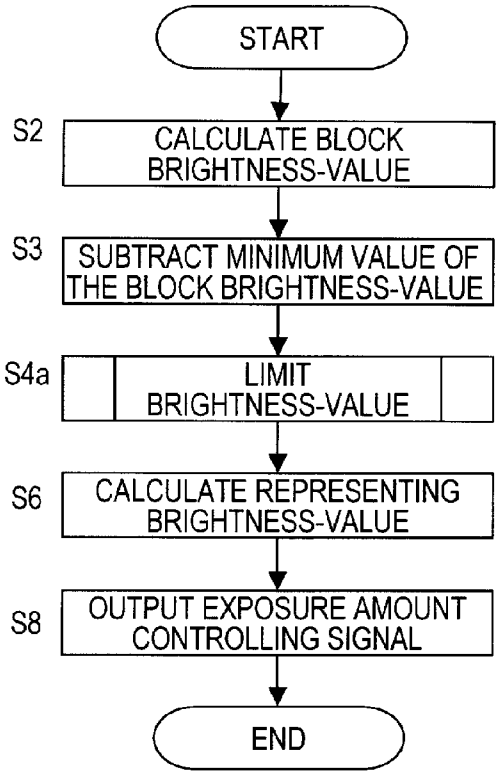
START
S2
CALCULATE BLOCK BRIGHTNESS-VALUE
S3
SUBTRACT MINIMUM VALUE OF THE BLOCK BRIGHTNESS-VALUE
S4a
LIMIT BRIGHTNESS-VALUE
S6
CALCULATE REPRESENTING BRIGHTNESS-VALUE
S8
OUTPUT EXPOSURE AMOUNT CONTROLLING SIGNAL
END

FIG. 7B

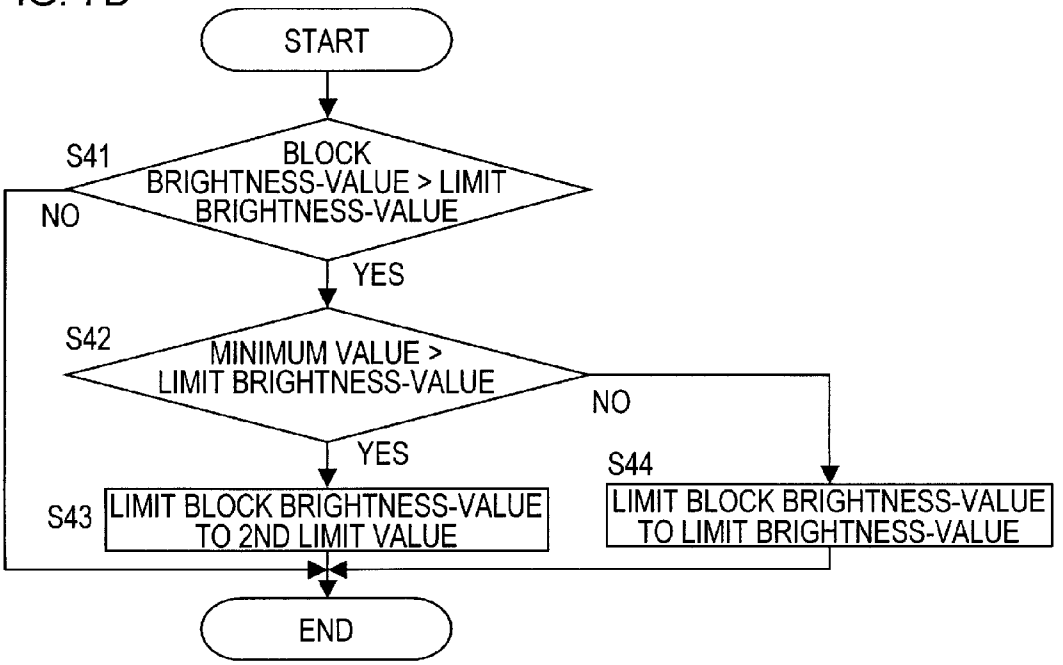
START
S41
BLOCK BRIGHTNESS-VALUE > LIMIT BRIGHTNESS-VALUE
NO
YES
S42
MINIMUM VALUE > LIMIT BRIGHTNESS-VALUE
NO
YES
S44
LIMIT BLOCK BRIGHTNESS-VALUE TO LIMIT BRIGHTNESS-VALUE
S43
LIMIT BLOCK BRIGHTNESS-VALUE TO 2ND LIMIT VALUE
END

FIG. 8A

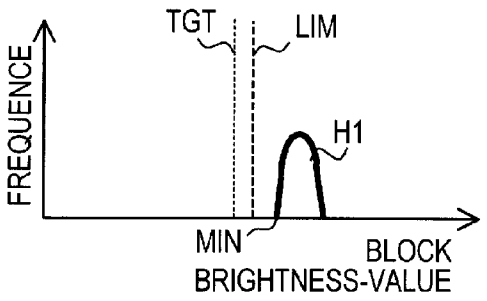

FIG. 8B

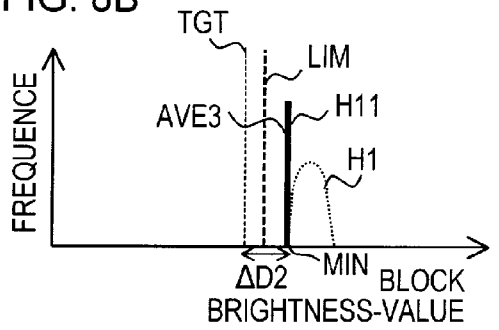

FIG. 8C

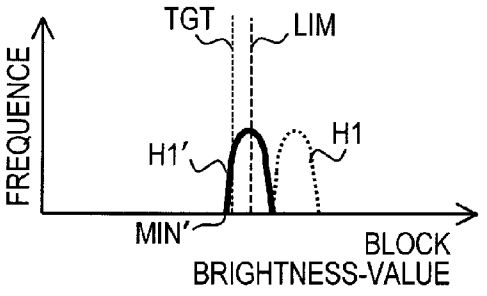

FIG. 8D

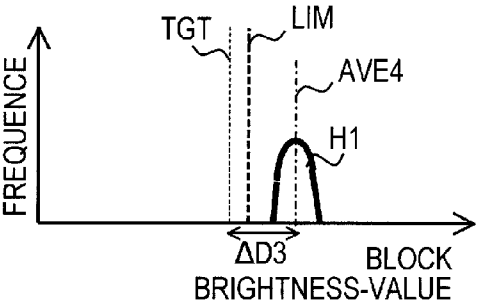

FIG. 9A

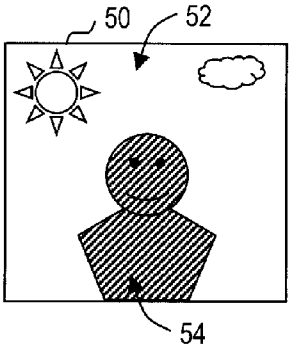

FIG. 9B

500	150	150	500
500	10	10	150
500	10	10	150
150	10	10	150

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 185

FIG. 9C

200	150	150	**200**
200	10	10	150
200	10	10	150
150	10	10	150

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 110

FIG. 9D

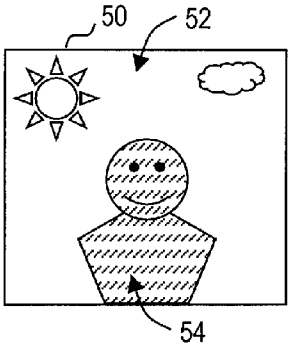

FIG. 9E

1000	300	300	1000
1000	20	20	300
1000	20	20	300
300	20	20	300

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 370

FIG. 9F

200	**200**	**200**	**200**
200	20	20	**200**
200	20	20	**200**
200	20	20	**200**

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 132.5

FIG. 9G

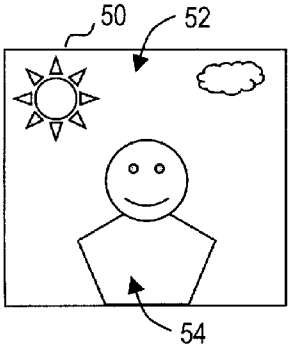

FIG. 9H

1023	1023	1023	1023
1023	160	160	1023
1023	160	160	1023
1023	160	160	1023

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 699.4

FIG. 9I

200	**200**	**200**	**200**
200	160	160	**200**
200	160	160	**200**
200	160	160	**200**

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 185

FIG. 10A

750	800	800	800
800	800	800	800
800	800	800	800
800	800	800	750

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 793.8

FIG. 10B

200	200	200	200
200	200	200	200
200	200	200	200
200	200	200	200

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 200

FIG. 10C

650	700	700	700
700	700	700	700
700	700	700	700
700	700	700	650

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 693.8

FIG. 10D

200	200	200	200
200	200	200	200
200	200	200	200
200	200	200	200

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 200

FIG. 11A

750	800	800	800
800	800	800	800
800	800	800	800
800	800	800	750

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 793.8

FIG. 11B

750	750	750	750
750	750	750	750
750	750	750	750
750	750	750	750

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 750

FIG. 11C

350	400	400	400
400	400	400	400
400	400	400	400
400	400	400	350

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 393.8

FIG. 11D

350	350	350	350
350	350	350	350
350	350	350	350
350	350	350	350

AVERAGE VALUE OF BLOCK BRIGHTNESS-VALUE: 350

IMAGING CONTROL UNIT, IMAGING APPARATUS, AND METHOD FOR CONTROLLING AN IMAGING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a divisional of U.S. application Ser. No. 13/211,745, filed on Aug. 17, 2011, and is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2010-263164, filed on Nov. 26, 2010, the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments discussed herein relate to an imaging control unit for outputting a controlling signal to control an exposure amount of an imaging unit, an imaging apparatus having an imaging control unit, and a method for controlling an imaging apparatus.

BACKGROUND

[0003] In an imaged image of a backlight scene, which is obtained by an imaging of an object being performed against the light source behind the object, the object has a lower brightness compared with the background. Therefore, for example, in case that an imaging apparatus such as a digital still camera and the like displays an imaged image as a finder image, it is difficult to identify a detailed contour of the object. For such a case, a method is proposed, for obtaining a preferable imaged image data which has an appropriate brightness by, for example, controlling the exposure amount. Or, another method is proposed for generating a preferable imaged image data by an image processing. Related descriptions are found in Japanese Laid-open Patent Publications No.H7-298131, No.2003-87646, and No.2009-49712.

[0004] In one example of generating an imaged image data by an image processing, by generating an image data in which the brightness of a part of the object is corrected and an image data in which the brightness of a part of the background is corrected from an imaged image data of one frame, and by combining those, an imaged image data, of which the object and the background each has an appropriate brightness, is generated. Or, in another example, by imaging a plurality of images having different exposure amounts, and by combining an image data, which is imaged with an exposure amount most appropriate to the object (referred to as the optimal exposure amount hereinafter), and an image data, which is imaged with an exposure amount most appropriate to the background, imaged image data, in which the object and the background each has an appropriate brightness, is generated.

[0005] However, for the imaging apparatus, in displaying the finder image and the like, a fast processing is desired. On the other hand, there is a demand for a low cost. Therefore, even for obtaining a preferable imaged image data, a process with a large lord is unpreferable.

SUMMARY

[0006] An imaging control unit in accordance with an embodiment includes: a calculating unit that obtains block brightness-values of a plurality of blocks from each pixel of an image data of a frame, the image data of a frame being divided into the plurality of blocks; a limiting unit that limits to a first limit brightness-value a block brightness-value which is larger than the first limit brightness-value among the plurality of block brightness-values; and a controlling unit that controls an exposure amount of an imaging unit so that a representing brightness-value of the plurality of the block brightness-values correspond to a target brightness-value which is less than first limit brightness-value.

[0007] The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

[0008] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. **1** is a drawing for illustrating an exemplary configuration of an imaging apparatus;

[0010] FIGS. **2**A and **2**B are flow-chart diagrams for illustrating steps of an exposure amount control process;

[0011] FIGS. **3**A and **3**B are drawings for illustrating an imaged image data in a backlight scene;

[0012] FIGS. **4**A-**4**F are drawings for illustrating a distribution state of a block brightness-value in the backlight scene;

[0013] FIGS. **5**A and **5**B are drawings for illustrating an imaged image data in a high-brightness scene;

[0014] FIGS. **6**A-**6**H are drawings for illustrating the distribution state of the block brightness-value in the high-brightness scene;

[0015] FIGS. **7**A and **7**B are flow-chart diagrams for illustrating steps of the exposure amount control process;

[0016] FIGS. **8**A-**8**D are drawings for illustrating the distribution state of the block brightness value;

[0017] FIGS. **9**A-**9**I are drawings for illustrating the exposure amount control process in case of the backlight scene;

[0018] FIGS. **10**A-**10**D are drawings for illustrating a normal exposure amount control process in the high-brightness scene; and

[0019] FIGS. **11**A-**11**D are drawings for illustrating the exposure amount control process in the high-brightness scene according to another embodiment.

DESCRIPTION OF EMBODIMENTS

[0020] Embodiments will be described hereinafter according to the drawings. However, it is noted that the technical scope is not limited to the embodiments described below, but covers the matters described in the claims and the equivalents thereof.

[0021] FIG. **1** is a drawing for illustrating an exemplary configuration of an imaging apparatus in accordance with one embodiment. The imaging apparatus **2** has an imaging unit **4** for imaging an object and for outputting the imaged image data, and an imaging control unit **7** for controlling an exposure amount of the imaging unit **4** according to the imaged image data. The imaging apparatus **2** is, for example, a digital still camera.

[0022] The imaging unit **4** converts a light from the object incoming through an imaging lens unit **3** into pixel value signals by an imaging sensor **5**, generates from the pixel value signals the imaged image data, and outputs it. The imaging lens unit **3** has, for example, a plurality of single focus lenses, and has a focal distance according to a combination thereof. The imaging lens unit **3** forms an object image, according to

the focal distance, on an acceptance surface of the imaging sensor **5**. The imaging sensor **5** converts the light accepted by 2-dimensionally arranged photoelectric conversion elements into the pixel value signals, and outputs the pixel value signals of one frame in order of raster scan. The imaging sensor **5** includes, for example, a CCD (Charge Coupled Device) sensor, or a CMOS (Complementary Metal Oxide Semiconductor) sensor. An A/D (Analog to Digital) converter **6** converts the pixel value signal output from the imaging sensor **5** into the imaged image data, by digitizing it. The imaged image data includes, for example, RGB (Red, Green, and Blue) gradation data for each pixel. The imaged image data is input into the imaging control unit **7**.

[0023] The imaging control unit **7** is, for example, a system LSI including an image processing unit **8**, a CPU (Central Processing Unit) **10**, a brightness-value detecting unit **11**, a ROM (Read Only Memory) **12**, and a RAM (Random Access Memory) **14**, which are connected by a bus **28**. The imaging control unit **7** may further have, for example, an interface unit **18**, a medium controlling unit **22**, and a display controlling unit **24**. To the interface unit **18**, the medium controlling unit **22**, and the display controlling unit **24**, an operating unit **16**, a storage medium **20**, and a displaying unit **26** are connected.

[0024] The imaged image data **50** input from the imaging unit **4** is stored in the RAM **14**. The image processing unit **8** performs an image processing to the imaged image data **50** stored in the RAM **14**. The image processing includes, for example, a conversion process from an RGB data into a YCbCr (brightness/color difference) data, a correcting process of a color and a brightness, a denoising process, a contour enhancement process, a format conversion process for data compression, an image processing to minify a frame of the imaged image data **50** for generating an image data to be displayed in a finder, and the like. The brightness-value detecting unit **11** detects the brightness value of each pixel of the imaged image data **50**. The brightness-value is, for example, the Y value in YCbCr data.

[0025] The CPU (Central Processing Unit) **10** calculates a control amount of the exposure amount so that the brightness-value of the entire imaged image data **50** corresponds to the target brightness value, and outputs to the imaging unit **4** a exposure amount controlling signal **40** indicating such the control amount. From the imaged image data **50** of a pixel in a frame, for example, a block brightness-value of a plurality of blocks, which the frame is divided into is calculated. Then, the entire imaged image data **50** is obtained as the representative brightness-value of the block brightness value. This process will be explained in detail below.

[0026] The target brightness-value is, for example, a brightness-value, which is arbitrarily obtained by an experiment and the like and corresponds to the optimal exposure amount. For example, for a dynamic range of the brightness-value being 0% to 100% from the low-brightness side to the high-brightness side, the target brightness-value is set around 20%. In case that the brightness-value of the entire imaged image data **50** is greater than the target brightness value, the exposure amount of the imaging unit **4** is greater than the optimal exposure amount corresponding to the target brightness value. In that case, CPU **10** generates the exposure amount controlling signal **40** for decreasing the exposure amount to the optimal exposure amount, and outputs it to the imaging unit **4**. On the other hand, in case that the brightness-value of the entire imaged image data **50** is less than the optimal brightness value, the exposure amount of the imaging unit **4** is less than the optimal exposure amount. In that case, CPU **10** generates the exposure amount controlling signal **40** for increasing the exposure amount to the optimal exposure amount, and outputs it to the imaging unit **4**. Such the exposure amount control process is performed by each of the brightness-value calculating unit **30**, the brightness-value limiting unit **32**, the representing brightness-value calculating unit **34**, and the exposure amount-controlling unit **36**. The operation of each of these will be explained in detail below.

[0027] The brightness-value calculating unit **30**, the brightness-value limiting unit **32**, the representing brightness-value calculating unit **34**, and the exposure amount controlling unit **36** correspond to, for example, the CPU **10** performing processing programs corresponding to each process. The processing programs are stored, for example, in the ROM **12**. The CPU **10** stores the processing program and data in the RAM **14**, and performs each process.

[0028] The imaging unit **4**, being input the exposure amount controlling signal **40** according to the imaged image data **50** of the frame number n (n is a positive integer), in response thereto, adjusts the exposure amount of imaging at a frame number n+1 (or the frame number n+2 and after). The imaging unit **4** adjusts the exposure amount by a method, such as, for example, adjusting the shutter speed. The shutter of the imaging unit **4** may be either an electronic shutter or a mechanical shutter. In case of an electronic shutter, the shutter speed is controlled by controlling a storing time of an electrical charge by a photoelectric conversion element. Or, in case of a mechanical shutter, an open/close speed of the mechanically opening/closing shutter is controlled.

[0029] Further, the operating unit **16** receives an operation input by a user, and inputs the imaging control unit **7** a controlling signal corresponding to the operation. The operating unit **16** has, for example, various kinds of operating buttons and a control circuit thereof. The controlling signal from the operating unit **16** is transferred to the CPU **10** through the interface unit **18**. The CPU **10** controls, in response to this, according to the controlling program stored in the ROM **12**, operations of the imaging unit **4**, as well as of the display controlling unit **24**, the medium controlling unit **22**, and the like. Thereby, for example, the display controlling unit **24** displays the imaged image data **50** as a finder image at the displaying unit **26**. The displaying unit **26** includes, for example, an LCD (Liquid Crystal Display). Also, the medium controlling unit **22** stores the imaged image data **50** into the storage medium **20**, and reads out the imaged image data **50** stored in the storage medium **20**. The storage medium **20** includes, for example, a hard disk drive, or an attachable/detachable portable storage medium such as a memory card and the like.

[0030] Next, the exposure amount control process of the imaging control unit **7** will be explained. First, the exposure amount control process in case of a backlight scene, in which an imaging of the object is performed against the light source behind the object, will be explained. Then, the exposure amount control process in case of a high-brightness scene, in which no object is in backlight status, will be explained. The high-brightness scene corresponds to a case of imaging, for example, an extremely bright outdoor scenery such as sky, ocean, snowfield and the like on a clear weather.

The Exposure Amount Control Process of the Backlight Scene

[0031] FIGS. **2**A and **2**B are flowchart diagrams for illustrating example steps of the exposure amount control process. Steps S**2** to S**8** illustrated in FIG. **2**A are executed by the CPU **10**, for example, when the brightness-value detecting unit **11** finishes detections of the brightness-value of pixels in one frame. Also, subroutine steps of the step S**4** are illustrated in FIG. **2**B.

[0032] First, at the step S**2** of FIG. **2**A, the brightness-value calculating unit **30** divides the imaged image data **50** of one frame into a plurality of blocks, and calculates a block brightness-value of each block. In FIG. **3**A, a schematic imaged image data **50** in the backlight scene is illustrated. The imaged image data **50** includes a plurality of pixel data arranged in a matrix. This imaged image data **50** includes, for example, a background **52** including a light source **53** and an object **54** in a backlight condition receiving a light from the light source **53**. The background **52** has a relatively high brightness, and the object **54** has a relatively low brightness. Such the imaged image data **52** of one frame is divided, as illustrated in FIG. **3**B, into a plurality of blocks BLKs arranged in a matrix. That is, the pixel data of the imaged image data **50** are equally divided in a row direction and in a column direction.

[0033] The brightness-value calculating unit **30** accumulates, for example, the brightness-value of each pixel in the block BLK. This accumulated value is the block brightness value. Or, the brightness-value calculating unit **30** may calculate the average value of the brightness-value of pixels in the block BLK as the block brightness value. For example, in case that the brightness-value of each pixel is represented within a gradation range from 0 to 1023 by 10 bit resolution, and that the accumulated value is used as the block brightness value, a possible block brightness-value is in a range from 0 to 1023 multiplied by the number of the pixel in the block. Or, in case that the average value is used as the block brightness value, the possible block brightness-value is in a range from 0 to 1023.

[0034] Next, at the step S**4** of FIG. **2**A, the brightness-value limiting unit **32** limits the block brightness-values to a prescribed limit brightness value. For example, the steps illustrated in FIG. **2**B are executed for the block brightness-value of the each block BLK. For example, when the block brightness-value is greater than the limit brightness-value (YES at the step S**41**), the brightness-value limiting unit **32** limits the block brightness-value to the limit brightness-value (S**44**), and, when the block brightness-value is equal to or less than the limit brightness-value (NO at the step S**41**), execution of the steps in FIG. **2**B is finished.

[0035] Distribution states at this time of the block brightness-value of the imaged image data **50** are exemplarily illustrated in FIGS. **4**A-AF. In FIGS. **4**A-**4**F, the distribution state of the block brightness-values of the imaged image data **50** is schematically illustrated, with the horizontal axis representing the block brightness value, and the vertical axis representing the frequence (degree of frequency).

[0036] In FIG. **4**A, an example of the imaged image data **50** of the 1st frame is illustrated. As for the imaged image data **50** in the backlight scene, a high-brightness block brightness-value distribution H**1** corresponding to the background **52**, and the low-brightness block brightness-value distribution H**2** corresponding to the object **54** are formed. The limit brightness-value LIM is set at a value, which is greater to some extent than the target brightness-value TGT. For example, in case that the brightness-value of the each pixel is represented in a gradation range from 0 to 1023 by 10 bit resolution, the target brightness-value TGT corresponding to the optimal exposure amount is around 180 in a range from 0 to 1023, for example, at "184". Then, the limit brightness-value LIM is set, for example at "200" and the like, a greater value than the target brightness-value TGT by the amount of a few percent to less than 20 percent.

[0037] Here, the block brightness-value distribution H**1**, which is greater than the limit brightness-value LIM, is limited to the limit brightness-value LIM. Then, the distribution of the block brightness-value becomes as illustrated in FIG. **4**B. In FIG. **4**B, the frequence of the block brightness-value distribution H**1** of the high-brightness is accumulated as the frequence of the limit brightness-value LIM, and a block brightness-value distribution H**10** of the limit brightness-value LIM is formed.

[0038] Next, at the step S**6** of FIG. **2**A, the representing brightness-value calculating unit **34** calculates the representing brightness-value of the block brightness-value of one frame. The representing brightness-value is, for example, the average value of the block brightness-values of one frame. Or, it may be the median value. Hereinafter, an explanation will be made with the average value of the block brightness-values being the representing brightness value. In an example of FIG. **4**B, by limiting the block brightness-value distribution H**1** of the high-brightness to the limit brightness-value LIM, an average value AVE of the block brightness-value distribution H**10** and the block brightness-value distribution H**2** is calculated.

[0039] Next, at the step S**8**, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** indicating the control amount of the exposure amount so that the average value AVE of the block brightness-value corresponds to the target brightness-value TGT, and outputs it to the imaging unit **4**. In an example of FIG. **4**B, the average value AVE is less than the target brightness-value TGT by the difference ΔD. Therefore, such the exposure amount controlling signal **40** is generated that the exposure amount corresponding to the difference ΔD is increased. The control amount of the exposure amount corresponding to required increment/decrement of the average value AVE is obtained by the exposure amount controlling unit **36** on the basis of a formula or a map data obtained by an experiment or the like. Such a formula or a map data is/are, for example, previously stored as a part of the processing program in the ROM **12**. When imaging is performed according to such the exposure amount controlling signal **40**, an image of higher brightness as a whole than that of the 1st frame is imaged at the 2nd frame.

[0040] The distribution state of the block brightness-value of the imaged image data **50** of the 2nd frame is as illustrated in FIG. **4**C. Block brightness-value distributions H**1'** and H**2'** respectively correspond to the block brightness-value distributions H**1** and H**2** of the 1st frame shifted to the high-brightness side according to the increment of the exposure amount. Further, an example, in which a part of the block brightness-value distribution H**1** of the high-brightness is saturated, is illustrated.

[0041] For the 2nd frame, in the same manner as the 1st frame, the steps S**2** to S**8** in FIG. **2**A are executed. For the 2nd frame, at the step S**4**, the brightness-value limiting unit **32** limits the block brightness-value H**1'**, which is greater than the limit brightness-value LIM, to the limit brightness-value

LIM. The state at this time is illustrated in FIG. **4**D. By accumulating the frequence of the block brightness-value distribution H**1**' to the frequence of the limit brightness-value LIM, a block brightness-value distribution H**10**' of the limit brightness-value LIM is formed. Then, at the step S**6**, the representing brightness-value calculating unit **34** calculates the average value AVE' of the block brightness-value. Here, the average value AVE' is the average value of the block brightness-value distribution H**2**' and the block brightness-value distribution H**10**'.

[0042] Then, the exposure amount controlling unit **36** generates such the exposure amount controlling signal **40** that the average value AVE' corresponds to the target brightness-value TGT, that is, the exposure amount corresponding to the difference ΔD' of the average value AVE' and the target brightness-value TGT is increased, and outputs it to the imaging unit **4**. Further, at the 2nd frame, the block brightness-value distribution H**2**' is shifted towards the higher-brightness side than the block brightness-value distribution H**2** of the 1st frame. Therefore, the average value AVE' is greater than the average value AVE of the 1st frame. Therefore, the difference ΔD' is decreased from the difference ΔD of the 1st frame. Therefore, by that extent, the increment of the exposure amount decreases. When an imaging according to the exposure amount controlling signal **40** is performed, higher-brightness image, to some extent, than that of the 2nd frame, is imaged at the 3rd frame.

[0043] The distribution state of the block brightness-value of the imaged image data **50** of the 3rd frame is as illustrated in FIG. **4**E. Block brightness-value distributions H**1**" and H**2**" respectively correspond to the block brightness-value distributions H**1**' and H**2**' of the 2nd frame, which are shifted to the higher-brightness side according to the increment of the exposure amount. Further, the state that the entire high-brightness block brightness-value distribution H**1**" is saturated is illustrated.

[0044] At the 3rd frame, as in the similar manner as the 1st and the 2nd frames, the steps S**2** to S**8** in FIG. **2**A are executed. At the 3rd frame, at the step S**4**, the brightness-value limiting unit **32** limits the block brightness-value H**1**", which is greater than the limit brightness-value LIM, to the limit brightness-value LIM. The state at this time is illustrated in FIG. **4**F. By the frequence of the block brightness-value distribution H**1**" being accumulated to the frequence of the limit brightness-value LIM, a block brightness-value distribution H**10**" of the limit brightness-value LIM is formed. Then, at the step S**6**, the representing brightness-value calculating unit **34** calculates the average value AVE" of the block brightness-value. Here, the average value AVE" is the average value of the block brightness-value distribution H**2**" and the block brightness-value distribution H**10**".

[0045] Then, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** such that the average value AVE" corresponds to the target brightness-value TGT, that is, the exposure amount corresponding to the difference ΔD" between the average value AVE" and the target brightness-value TGT is increased, and outputs it to the imaging unit **4**. Further, at the 3rd frame, the block brightness-value distribution H**2**" is shifted towards the higher-brightness side than the block brightness-value distribution H**2**' of the 2nd frame. Therefore, the average value AVE" is greater than the average value AVE' of the 2nd frame. Therefore, the difference ΔD" is decreased from the difference ΔD' of the 2nd frame. Therefore, the increment of the exposure amount decreases. Then, when the imaging is performed at the next frame according to such the exposure amount controlling signal, an image of higher-brightness to some degree is imaged according to the exposure amount controlling signal **40**.

[0046] By executing the above exposure amount control process in each frame, the difference from the average value and the target brightness-value TGT of the block brightness-value is gradually decreased. Then, according to this, the control amount of the exposure amount is gradually decreased. Then, conclusively, the exposure amount for the object converges with the optimal exposure amount. Therefore, in case of the backlight scene, such the imaged image data **50** is generated that the object **54** has the target brightness-value TGT.

The Exposure Amount Control Process in Case of High-Brightness Scene

[0047] Then, the exposure amount control process in case of high-brightness scene will be explained. Here, according to the flow-chart in FIG. **2**A, FIGS. **5**A and **5**B and FIGS. **6**A-**6**H will be occasionally refereed to.

[0048] First, at the step S**2** of FIG. **2**A, the brightness-value calculating unit **30** divides the imaged image data of one frame into a plurality of blocks, and accumulates the brightness value of each block to calculate the block brightness-value of the each block. In FIG. **5**A, a schematic imaged image data **50** in a high-brightness scene is illustrated. This imaged image data **50** has the background **52** including the light source **53**. On the other hand, the imaged image data **50** does not have an object in backlight state by receiving a light from the light source **53**. Therefore, the background **52** entirely has a high-brightness. In this case, the high-brightness corresponds to, for example, a range which is greater than the target brightness-value in the dynamic range of the brightness value. Also, a state that such the imaged image data **50** of one frame is divided into a plurality of blocks BLKs arranged in a matrix is exemplarily illustrated in FIG. **5**B.

[0049] Next, at the step S**4** of FIG. **2**A, the brightness-value limiting unit **32** limits, the block brightness-value which is greater than the limit brightness-value LIM to the limit brightness-value LIM. The distribution state at this time of the block brightness-value of the imaged image data **50** is exemplarily illustrated in FIGS. **6**A-**6**H.

[0050] In FIGS. **6**A-**6**H, the horizontal axis representing the block brightness-value and the vertical axis representing frequence (degree of frequence), schematic distribution states of the block brightness-value of the imaged image data **50** is illustrated. In FIG. **6**A, an example of the imaged image data **50** of the 1st frame is illustrated. At the imaged image data **50** in the high-brightness scene, a block brightness-value distribution H**1** of the high-brightness corresponding to the background **52** is formed. Then, the block brightness-value H**1**, which is greater than the limit brightness-value LIM, is limited to the limit brightness-value LIM. Then, distributions of the block brightness-value is as illustrated in FIG. **6**B. In FIG. **6**B, the frequence of the block brightness-value distribution H**1** of the high-brightness is accumulated as the frequence of the limit brightness-value LIM. Therefore, a block brightness-value distribution H**10** of the limit brightness-value LIM is formed.

[0051] Next, at the step S**6** of FIG. **2**A, the representing brightness-value calculating unit **34** calculates the average value of the block brightness-values of one frame. In an

example in FIG. **6**B, by limiting the block brightness-value distribution H**1** of the high-brightness to the limit brightness-value LIM, the average value AVE**2** coinciding with the limit brightness-value LIM is calculated.

[0052] Next, at the step S**8** of FIG. **2**A, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** indicating the control amount of the exposure amount such that the average value AVE**2** of the block brightness-value corresponds to the target brightness-value TGT, and outputs it to the imaging unit **4**. In an example of FIG. **6**B, the average value AVE**2** is greater than the target brightness-value TGT by the difference ΔD**1**. Therefore, the exposure amount controlling signal **40** for decreasing the exposure amount corresponding to the difference ΔD**1** is generated. When an imaging according to such the exposure amount controlling signal **40** is performed, an image which has a lower-brightness to some extent as a whole than that of the 1st frame is imaged at the 2nd frame.

[0053] A distribution state of the block brightness-value of the imaged image data **50** of the 2nd frame is as illustrated in FIG. **6**C. The block brightness-value distribution H**1**' corresponds to the block brightness-value distribution H**1** of the 1st frame shifted to the low-brightness side according to decrement of the exposure amount.

[0054] At the 2nd frame, as in the similar manner to the 1st frame, the steps S**2** to S**8** of FIG. **2**A are executed. At the **2**nd frame, at the step S**4**, the brightness-value limiting unit **32** limits a block brightness-value H**1**' which is greater than the limit brightness-value LIM to the limit brightness-value LIM. The state at this time is illustrated in FIG. **6**D. By the frequence of the block brightness-value distribution H**1**' being accumulated to the frequence of the limit brightness-value LIM, a block brightness-value distribution H**10**' of the limit brightness-value LIM is formed. Then, at the step S**6**, the representing brightness-value calculating unit **34** calculates the average value AVE**2**' of the block brightness-value. By limiting the block brightness-value H**1**' to the limit brightness-value LIM, the average value AVE**2**' coinciding with the limit brightness-value LIM is calculated.

[0055] Then, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** such that the average value AVE**2**' corresponds to the target brightness-value TGT, that is, the exposure amount is decreased, and outputs it to the imaging unit **4**. Further, at the 2nd frame, the block brightness-value distribution H**1**' is shifted to the lower-brightness side than the block brightness-value distribution H**1** of the 1st frame, but still is greater than the limit brightness-value LIM, and thus being limited to the limit brightness-value LIM as in the similar manner to the 1st frame. Therefore, the average value AVE**2**' corresponds to the same value as the average value AVE**2** of the 1st frame, that is, the limit brightness-value LIM. Therefore, the difference ΔD**1**' between the average value AVE**2**' and the target brightness-value TGT is equivalent to the difference ΔD**1** of the 1st frame. Therefore, the decrement of the exposure amount corresponding to the difference ΔD**1**' is equivalent to the decrement of the exposure amount corresponding to the difference ΔD**1**. Then, when an imaging is performed according to such the exposure amount controlling signal **40**, a lower-brightness image as a whole to some extent than the 2nd frame is imaged at the 3rd frame.

[0056] A distribution state of the block brightness-value of the imaged image data **50** of the 3rd frame is as illustrated in FIG. **6**E. A block brightness-value distribution H**1**" corresponds to the block brightness-value distribution H**1**' of the 2nd frame shifted to low-brightness side according to the decrement of the exposure amount.

[0057] At the 3rd frame, as in the similar manner to the 1st and the 2nd frames, the steps S**2** to S**8** of FIG. **2**A are executed. At the 3rd frame, at the step S**4**, the brightness-value limiting unit **32** limits to the limit brightness-value LIM a part of the block brightness-value H**1**" which is greater than the limit brightness-value LIM. The state at this time is illustrated in FIG. **6**F. By the frequence of the part of the block brightness-value distribution H**1**" which is greater than the limit brightness-value LIM being accumulated to the frequence of the limit brightness-value LIM, a block brightness-value distribution H**10**" of the limit brightness-value LIM is formed. Then, at the step S**6**, the representing brightness-value calculating unit **34** calculates the average value AVE**2**" of the block brightness-value. The average value AVE**2**" corresponds to the average value of a part of the block brightness-value distribution H**1**", which is less than the limit brightness-value LIM, and the block brightness-value distribution H**10**".

[0058] Then, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** such that the average value AVE**2**" corresponds to the target brightness-value TGT, that is, the exposure amount is increased, and outputs it to the imaging unit **4**. At the 3rd frame, since a part of the block brightness-value distribution H**1**", which is less than the limit brightness-value LIM, is formed, the average value AVE**2**" becomes less than the average value AVE**2**' of the 2nd frame. Therefore, the difference ΔD**1**" between the average value AVE**2**" and the target brightness-value TGT is decreased from the difference ΔD**1**' of the 2nd frame. Therefore, decrement of the exposure amount is decreased. Then, when an imaging is performed according to such the exposure amount-controlling signal **40**, a lower-brightness image to some extent as whole than the 3rd frame is imaged at the 4th frame.

[0059] The distribution state of the block brightness-value of the imaged image data **50** of the 4th frame is as illustrated in FIG. **6**G. A block brightness-value distribution H**1**'" corresponds to the block brightness-value distribution H**1**" of the 3rd frame shifted to the low-brightness side according to decrement of the exposure amount.

[0060] At the 4th frame, as in the similar manner to the 1st frame to the 3rd frame, the steps S**2** to S**8** of FIG. **2**A are executed. At the 4th frame, at the step S**4**, the brightness-value limiting unit **32** limits a part of the block brightness-value H**1**'", which is greater than the limit brightness-value LIM, to the limit brightness-value LIM. The state at this time is illustrated in FIG. **6**H. By the frequence of a part of the block brightness-value distribution H**1**'", which is greater than the limit brightness-value LIM, being accumulated to the frequence of the limit brightness-value LIM, a block brightness-value distribution H**10**'" of the limit brightness-value LIM is formed. Then, at the step S**6**, the representing brightness-value calculating unit **34** calculates the average value AVE**2**'" of the block brightness-value. The average value AVE**2**'" corresponds to the average value of a part of the block brightness-value distribution H**1**'" less than the limit brightness-value LIM and the block brightness-value distribution H**10**'". Then, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** such that the average value AVE**2**'" corresponds to the target brightness-value TGT, that is, the exposure amount is decreased, and outputs it to imaging unit **4**. At the 4th frame, a part of the block brightness-

value distribution H1'", which is less than the limit brightness-value LIM, is formed, and the part is greater than the 3rd frame. Therefore, the average value AVE2'" is less than the average value AVE2" of the 3rd frame. Therefore, the difference ΔD'" between the average value AVE2'" and the target brightness-value TGT is decreased from the difference ΔD1" of the 3rd frame. Therefore, decrement of the exposure amount becomes smaller thereby. Then, when an imaging is performed according to such the exposure amount controlling signal **40**, a lower-brightness image to some extent as a whole is imaged at the next frame.

[0061] By the above exposure amount control process at each frame being performed, the difference between the average value of the block brightness-values and the target brightness-value TGT is gradually decreased, and, according to this, the control amount of the exposure amount is gradually decreased. Then, conclusively, the exposure amount for the background converges with the optimal exposure amount. Therefore, in case of the high-brightness scene, such the imaged image data **50** is generated that the background **52** has the target brightness-value TGT.

[0062] As above described, according to the present embodiment, in case of the backlight scene, an imaging is performed with the optimal exposure amount for the object, and thereby, a preferable imaged image is obtained. Adding to this, in case of the high-brightness scene, an imaging is performed with the optimal exposure amount for the background, and a preferable imaged image is obtained.

Variation Embodiment

[0063] Next, one of variation embodiments will be explained. Hereafter, above described exposure amount control process is referred to, for convenience sake, as a normal exposure amount control process, to be distinguished from that of the following variation embodiment. In this variation embodiment, when the minimum value of the block brightness-value is greater than a first limit brightness-value, which is the limit brightness-value LIM, the brightness-value limiting unit **32** limits the block brightness-value not to the limit brightness-value LIM, but to a second limit brightness-value which is greater than the limit brightness-value LIM. Such the second limit brightness-value is, for example, an arbitrary value which is greater than the limit brightness-value LIM, and is equal to or less than the minimum value of the block brightness-value. In the explanation below, the minimum value of the block brightness-value is explained as the second limit brightness-value. This variation embodiment is performed, for example, in case of a high-brightness scene, in which the minimum value of the block brightness-value is greater than the limit brightness-value LIM.

[0064] FIGS. **7**A and **7**B are flow-chart diagrams for illustrating steps of the exposure amount control process of the variation embodiment. The example steps in FIG. **7**A correspond to the steps of FIG. **2**A, with a step S**3** inserted after the step S**2**, and with the step S**4** being replaced with a step S**4***a*. Also, in FIG. **7**B, subroutine steps corresponding to the step S**4***a* are illustrated. The steps in FIG. **7**B correspond to the step in FIG. **2**B with the additional step S**42**, and S**43**.

[0065] The steps S**2** to S**8** illustrated in FIG. **7**A are executed by CPU **10** at each frame, for example, in the similar manner to the steps in FIG. **2**A, when the brightness-value detecting unit **11** finishes the detection of the brightness value of one frame. First, at the step S**2**, the brightness-value calculating unit **30** divides the imaged image data of one frame into a plurality of blocks, and, by accumulating the brightness value of the each block, calculates the block brightness-value of the each block. Next, at the step S**3**, the brightness-value limiting unit **32** subtracts, the minimum value of the block brightness-value of one frame.

[0066] Here, the distribution state of the block brightness-value of the imaged image data **50** in the high-brightness scene illustrated in FIG. **5**, is exemplarily illustrated in FIGS. **8**A-**8**D. In FIG. **8**A-**8**D, the horizontal axis representing the block brightness-value, and the vertical axis representing frequence (degree of frequence), distribution example of the block brightness-value of the imaged image data **50** is schematically illustrated. In FIG. **8**A, an example of the imaged image data **50** of the 1st frame is illustrated. In the imaged image data **50** of the high-brightness scene, a block brightness-value distribution H**1** of the high-brightness corresponding to the background **52** is formed. Then, the minimum value MIN of the block brightness-value distribution H**1** is subtracted. Here, the minimum value MIN is greater than the limit brightness-value LIM.

[0067] At the step S**4***a* in FIG. **7**A, the brightness-value limiting unit **32** limits the block brightness-value. At this time, the steps in FIG. **7**B are executed for the each block brightness-value. In case that the block brightness-value is greater than the limit brightness-value LIM (YES at the step S**41**), the brightness-value limiting unit **30** proceeds to the step S**42**. Then, in case that the minimum value MIN of the block brightness-value is equal to or less than the limit brightness-value LIM (NO at the step S**42**), the brightness-value limiting unit **32** limits the block brightness-value to the limit brightness-value LIM (the step S**44**). That is, a normal exposure amount control process is executed. On the other hand, in case that the minimum value MIN of the block brightness-value is greater than the limit brightness-value LIM (YES at the step S**42**), the block brightness-value is limited to a second limit brightness-value, for example, the minimum value MIN (the step S**43**). The state at this time is illustrated in FIG. **8**B. In FIG. **8**B, by the frequence of the block brightness-value distribution H**1** being accumulated to the frequence of the minimum value MIN, a block brightness-value distribution H**11** is formed.

[0068] Next, at the step S**6** of FIG. **7**A, the representing brightness-value calculating unit **34** calculates the average value of the block brightness-values of one frame. In an example in FIG. **8**B, by the block brightness-value distribution H**1** of the high-brightness being limited to the minimum value MIN, the average value AVE**3** coinciding with the minimum value MIN is calculated.

[0069] Next, at the step S**8**, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** indicating the control amount of the exposure amount such that the average value AVE**3** of the block brightness-values corresponds to the target brightness-value, and outputs it to the imaging unit **4**. In an example of FIG. **8**B, since the average value AVE**3** is greater than the target brightness-value TGT by the difference ΔD**2**, the exposure amount controlling signal **40** for decreasing the exposure amount by the amount corresponding to the difference ΔD**2** is generated. Here, as illustrated in FIG. **6**B, in comparison to a case that the block brightness distribution H**1** is limited to the limit brightness-value LIM, the difference ΔD**2** between the average value AVE**3** and the target brightness-value TGT is greater than the difference ΔD**1** between the average value AVE and the target brightness-value TGT. Therefore, the control

amount of the exposure amount according to the variation embodiment is greater than the control amount of the exposure amount according to the normal exposure amount control process. When an imaging is performed according to such the exposure amount controlling signal **40**, a lower-brightness image to a large degree as a whole than that of the **1**st frame is imaged at the 2nd frame.

[0070] The distribution state of the block brightness-value of the imaged image data **50** of the 2nd frame is as illustrated in FIG. **8**C. The block brightness-value distribution H**1**' corresponds to the block brightness-value distribution H**1** of the 1st frame, which is shifted to the low-brightness side according to the decrement of the exposure amount. Thereby, the minimum value MIN' of the block brightness-value distribution H**1**' is less than the limit brightness-value LIM. Therefore, at the 2nd frame, when the steps S**2** to S**8** of FIG. **7**A are executed, the result at the step S**42** in FIG. **7**B is "NO". Therefore, in the process thereafter, such a processes equivalent to the normal exposure amount control process in the high-brightness scene, as illustrated in FIGS. **2**A and **2**B, and FIGS. **6**A and **6**B, is executed.

[0071] According to this variation embodiment, at the exposure amount control process for the high-brightness scene, when the minimum value of the block brightness-value is greater than the limit brightness-value LIM, by the block brightness-value being limited to a second limit brightness-value greater than the limit brightness-value LIM, that is, the minimum value MIN, the exposure amount is decreased by the control amount which is greater than that of the normal exposure amount control process. Therefore, it is enabled to converge the exposure amount for the background with the optimal exposure amount, more promptly than the normal exposure amount control process.

[0072] Further, in another variation embodiment, the brightness-value limiting unit **36** may simply avoid limiting the block brightness-value to the limit brightness-value LIM, when the minimum value MIN of the block brightness-value is greater than the limit brightness-value LIM. For example, the step S**43** in FIG. **7**B may be omitted. In that case, the representing brightness-value calculating unit **34** calculates, as illustrated in FIG. **8**D, the average value AVE**4** of the block brightness-value distribution H**1** as the representing brightness-value. In this case, the difference ΔD**3** between the target brightness-value TGT and the average value AVE**4** is greater than the difference ΔD**2** in case of the block brightness-value being limited to the minimum value MIN. Therefore, the exposure amount controlling unit **36** generates the exposure amount controlling signal **40** for decreasing the exposure amount by the control amount which is greater than that of the case of the block brightness-value being limited to the minimum value MIN. Thereby, it is enabled to converge the exposure amount for the background with the optimal exposure amount more rapidly than the exposure amount control process of the above variation embodiment.

[0073] Next, another exemplary embodiment is illustrated by using an example of the block brightness-value.

Exemplary Embodiment in the Backlight Scene

[0074] FIGS. **9**A-**9**I are diagrams for illustrating an exemplary embodiment in case of the backlight scene. FIG. **9**A illustrates the imaged image data on starting the process. As illustrated in FIG. **9**A, in the imaged image data **50**, the background **52** has a relatively high-brightness, and, contrary to this, the object **54** has a relatively low-brightness. Further, hereafter, in FIGS. **9**A-**9**I, the low brightness of the object **54** is described by a thickness of hatching.

[0075] FIG. **9**B illustrates the block brightness-values of the imaged image data **50** in FIG. **9**A. Each cell represents a block, and each number therein represents the block brightness-value. In an explanation of the exemplary embodiment hereafter, for convenience sake, an example of 16 blocks in one frame is illustrated. Also, the block brightness-values are illustrated in a gradation scale from 0 to 1023. Then, the target brightness-value is assumed as "185". Then, blocks surrounded by double lines correspond to the object **54**, and the other blocks correspond to the background **52**. In blocks corresponding to the background **52**, the block brightness-values are as high as "150" or "500", but, contrary to this, in blocks corresponding to the object **54**, the block brightness-values are as low as "10". Also, at this time, the average value of the entire block brightness-values is a value of "185" coinciding with the target brightness-value. This indicates that, an image is imaged, as a whole, with the exposure amount suitable for the background **52**.

[0076] FIG. **9**C illustrates the state that the block brightness-values in FIG. **9**B are limited, as the limit brightness-value being "200". Among blocks corresponding to the background **52**, in blocks having the block brightness-values of "500", since the block brightness-values of "500" are greater than the limit brightness-value "200", the block brightness-values are limited to "200". As a result, the average value of the block brightness-values is "110". This average value is less than the target brightness-value "185" by "75". Therefore, by increasing the exposure amount corresponding to the difference, an imaging is performed.

[0077] FIG. **9**D illustrates the imaged image data **50** imaged when the exposure amount is increased. As illustrated in FIG. **9**D, in the imaged image data **50**, hatching of the object **54** is lighter than that of the imaged image data **50** in FIG. **9**A, which indicates that the brightness of the object **54** becomes high to some extent.

[0078] FIG. **9**E illustrates block brightness-values of the imaged image data **50** in FIG. **9**D. In comparison to FIG. **9**B, by increment of the exposure amount, in blocks corresponding to the background **52**, the block brightness-values increase to "300" or "1000". On the other hand, in blocks corresponding to the object **54**, the block brightness-values increase to "20". Also, at this time, the average value of the entire block brightness-values is "370", which is increased from the average value "185" at the time of FIG. **9**B.

[0079] FIG. **9**F illustrates the state that the block brightness-values in FIG. **9**E are limited. In blocks corresponding to the background **52**, which have block brightness-values "1000" and "300", since the block brightness-values are greater than the limit brightness-value "200", the block brightness-values are limited to "200". As a result, the average value of the block brightness-values is "132.5". This average value is still less than the target brightness-value "185" by "52.5", but is increased from the average value "110" at the time of FIG. **9**C, which indicates converging with the target brightness-value "185". In next frame, an imaging is performed by increasing the exposure amount by the amount corresponding to the difference "52.5".

[0080] FIG. **9**G illustrates the imaged image data **50** imaged when the exposure amount for the object **54** converges with the optimal exposure amount. As illustrated in FIG. **9**G, at the imaged image data **50**, the hatching of the

object **54** is lighter than that of the imaged image data **50** in FIG. **9**D, which indicates that the brightness of the object **54** becomes high to some extent.

[0081] FIG. **9**H illustrates the block brightness-values of the imaged image data **50** in FIG. **9**G. In comparison to FIG. **9**E, by increment of the exposure amount, in blocks corresponding to the background **52**, the block brightness-values increase to "1023" (saturated state), and in blocks corresponding to the object **54**, the block brightness-values increase to "160". Also, at this time, the average value of the entire block brightness-values is "699.4", which illustrates further increment from the average value "370" in FIG. **9**E.

[0082] FIG. **9**I illustrates the state that the block brightness-values in FIG. **9**H are limited. In blocks corresponding to the background **52** of the block brightness-values of "1023", since the block brightness-values of "1023" are greater than the limit brightness-value "200", the block brightness-values are limited to "200". As a result, the average value of the block brightness-values is "185", thus coinciding with the target brightness-value. By repeating such the exposure amount control process, the exposure amount for the object **54** converges with the optimal exposure amount.

Exemplary Embodiment of the High-Brightness Scene According to Normal Exposure Amount Control Process

[0083] FIGS. **10**A-**10**D are drawings for illustrating an exemplary embodiment of the high-brightness scene according to the normal exposure amount control process. Each cell represents a block and each number therein represents the block brightness-value. In FIGS. **10**A-**10**D, in example of 16 blocks, the block brightness-values are illustrated in gradation range from 0 to 1023. FIG. **10**A illustrates the block brightness-values of the imaged image data at the starting of the process. In the high-brightness scene, the block brightness-values as a whole indicate as high value as "750" or "800". At this time, the average value of the entire block brightness-values is "793.8".

[0084] FIG. **10**B illustrates the state that the block brightness-values in FIG. **10**A are limited, for the limit brightness-value being "200". In all blocks having the block brightness-values "750" or "800", since the block brightness-values are greater than the limit brightness-value "200", the block brightness-values are limited to "200". As a result, the average value of the block brightness-values is "200". This average value is greater than the target brightness-value "185" by "15". Therefore, by decreasing the exposure amount by the amount corresponding to the difference, an imaging is performed.

[0085] FIG. **10**C illustrates the block brightness-value of the image data imaged by decreasing the exposure amount. In comparison to FIG. **10**A, by the decrement of the exposure amount, the block brightness-values are decreased to "650" or "700". At this time, the average value of the entire block brightness-values is "693.8", which is decreased from the average value "793.8" at the time of FIG. **10**A.

[0086] FIG. **10**D illustrates the state that the block brightness-value of FIG. **10**C is limited. In all blocks having the block brightness-value "650" or "700", since the block brightness-values are greater than the limit brightness-value "200", the block brightness-values are limited to "200". As a result, the average value of the block brightness-values is "200". Since this average value is greater than the target brightness-value "185" by "15", by decreasing the exposure amount by the amount corresponding to the difference, an imaging is performed. This average value is equal to the average value "200" at the time of FIG. **10**B. Therefore, in next frame, by decreasing the exposure amount by the amount corresponding to the difference "15", an imaging is performed.

Embodiment in the High-Brightness Scene According to the Variation Embodiment

[0087] FIGS. **11**A-**11**D are drawings for illustrating an embodiment of the exposure amount control process in the high-brightness scene according to the variation embodiment. Each cell represents the block, and the numbers therein represents the brightness value. FIG. **11**A illustrates the block brightness-values of the imaged image data at the starting of the process. FIG. **11**A is equivalent to FIG. **10**A.

[0088] FIG. **11**B illustrates an example of the block brightness-values of FIG. **11**A in a state that, when the minimum value of the block brightness-values is greater than the limit brightness-value "200", the block brightness-values are limited to the minimum value. Since the minimum value "750" of the block brightness-values is greater than the limit brightness-value "200", in all blocks having the block brightness-value "750" or "800", the block brightness-values are limited to the minimum value "750". As a result, the average value of the block brightness-values is "750". This average value is greater than the target brightness-value "185" by "565". Therefore, by decreasing the exposure amount by the amount corresponding to this difference, an imaging is performed. Here, it is illustrated that, by limiting the block brightness-values to the minimum value, the decrement of the exposure amount is greater than the decrement of the exposure amount of the normal exposure amount control process in accordance with the exemplary embodiment as illustrated in FIG. **10**B.

[0089] FIG. **11**C illustrates the block brightness-values of the image data imaged by decreasing the exposure amount. In comparison to FIG. **11**A, by the decrement of the exposure amount, the block brightness-values are decreased to "350" or "400". At this time, the average value of the entire block brightness-values is "393.8", which is decreased from the average value "793.8" at the time of FIG. **11**A.

[0090] FIG. **11**D illustrates the state that the block brightness-values of FIG. **11**C are limited. Since the minimum value "350" of the block brightness-values is greater than the limit brightness-value "200", in all the blocks having the block brightness-value "350" or "400", the block brightness-values are limited to the minimum value "350". As a result, the average value of the block brightness-values is "350". This average value is greater than the target brightness-value "185" by "165", and, by decreasing the exposure amount by the amount corresponding to this difference, an imaging is performed. Here, it is illustrated that, by limiting the block brightness-values to the minimum value, the decrement of the exposure amount is greater than the decrement of the exposure amount of the normal exposure amount control process in the exemplary embodiment as illustrated in FIG. **10**D.

[0091] Thereby, in the exposure amount control process according to the variation embodiment, in case of the high-brightness scene, when the minimum value of the block brightness-value is greater than the limit brightness-value, the exposure amount is controlled by the control amount greater than that of the normal exposure amount control process. Therefore, more rapid convergence with the optimal exposure amount is enabled.

[0092] In the above explanation, examples are described in which the exposure amount for the object converges with the optimal exposure amount in a series of frames (for example, 3 to 4 frames). However, the number of the frames taken for the convergence of the exposure amount is exemplarily described in each case, and an arbitrary number of frames may be taken.

[0093] As the above, according to the embodiments, the imaged image data having the optimal brightness is rapidly generated without such complex processes as detecting the position of the object, increasing the brightness value thereof, combining a plurality of the image data imaged by different exposure amounts, and the like. Therefore, the imaging control unit may be configured in a simpler configuration.

[0094] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the embodiments and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the embodiments. Although the embodiments have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. An imaging control unit comprising:

a calculating unit that obtains block brightness-values of a plurality of blocks from each pixel of an image data of a frame, the image data of a frame being divided into the plurality of blocks;

a limiting unit that limits to a first limit brightness-value a block brightness-value which is larger than the first limit brightness-value among the plurality of block brightness-values; and

a controlling unit that controls an exposure amount of an imaging unit so that a representing brightness-value of the plurality of the block brightness-values corresponds to a target brightness-value which is less than first limit brightness-value,

wherein the limiting unit does not limit, when the minimum value of the plurality of the block brightness-values is larger than the first limit brightness-value, the plurality of the block brightness-values to the first limit brightness-value.

2. An imaging control unit comprising:

a calculating unit that obtains block brightness-values of a plurality of blocks from each pixel of an image data of a frame, the image data of a frame being divided into the plurality of blocks;

a limiting unit that limits to a first limit brightness-value a block brightness-value which is larger than the first limit brightness-value among the plurality of block brightness-values; and

a controlling unit that controls an exposure amount of an imaging unit so that a representing brightness-value of the plurality of the block brightness-values corresponds to a target brightness-value which is less than first limit brightness-value,

wherein the representing brightness-value includes an average value or a median value of pixels included in each of the plurality of blocks.

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