

AUTO FOCUS CAMERA

5 The present invention relates to an auto focus camera.

6 An auto focus camera with an optical distance measuring arrangement having a light emitting element and a light receiving element for position detection is known in the prior art.

10 For instance, Japanese Published Patent No. 60511/1985 discloses a camera in which a beam of infra-red light generated by a source of infra-red light under the control of a drive circuit is directed at an object to be photographed through a single projection lens.  
15 Light reflected by the object is caused to form an image on a PSD (position sensitive diode) light receiving element via a single light receiving lens, and the distance to the object is calculated by an arithmetic processing circuit on the basis of the position of the  
20 image formed, whereupon the focal length of a photographic lens of the camera is automatically adjusted.

In addition, Japanese Published Patent No. 223734/1987 discloses a camera in which a plurality of light emitting elements are juxtaposed, and in which a  
25 PSD light receiving element having a large width is used accordingly. The respective distances to selected parts of the subject to be photographed are calculated by an arithmetic processing circuit to obtain an average value for the distance, and the focal length of the  
30 photographic lens is automatically adjusted to suit this average value. With this distance measuring arrangement, in order to make the width of the PSD light receiving element as small as possible, the plurality of light emitting elements are juxtaposed in a vertical

direction, and the PSD light receiving element has a height expanded similarly in the vertical direction.

In both of the known cameras described above, the results of distance measurement are obtained by calculation and so it takes time to obtain an in focus condition. If, further, an addition and a subtraction are made to apply a correction value to a distance signal, the calculation becomes even more complicated. Also, in the second camera described above, a special arithmetic control circuit is required for obtaining an average value, which further complicates the circuit configuration, so that high speed processing becomes impossible.

Another problem in relation to the first camera described above is that, if an attempt is made to photograph two people standing further than a predetermined interval apart, there are cases where a focusing zone is located between the two people so that the background between the two people is brought into focus while the people themselves are out of focus, with the result that the people are blurred in the photograph. This is a so called passing-through-the-middle phenomenon. Equally, if a close object is brought into focus, there may be a problem in that a remote object is out of focus, so that, for instance, a "flat" picture cannot be obtained when simultaneously shooting a near person and a far scene.

One way of preventing the passing-through-the-middle phenomenon from occurring is to provide an arrangement in which the camera is initially directed towards one of the people and the shutter release button is half pressed to obtain an in focus state, that state then being maintained by locking the photographic lens in the focusing position, and the shutter release

button being pressed after the two people are framed in a desired photographic composition. However, such an operation is complicated, and the photographer may fail to achieve the desired result unless he is familiar with the process.

Although the second of the above described cameras partially deals with this problem, a wide chip is required as the light receiving element, which is a disadvantage in terms of cost, and, in order to prevent the occurrence of the passing-through-the-middle phenomenon in relation to objects juxtaposed laterally, both the light emitting and the light receiving elements must be arranged vertically. Thus, numerous problems exist.

According to the present invention, there is provided an auto focus camera having a light emitting element for emitting light toward an object to be photographed, a light receiving element for receiving light reflected from the object and for generating a corresponding output, means for converting the output from the light receiving element into a distance signal, storage means having stored therein in advance comparative data representing a range of distances and lens focusing data corresponding to the comparative data, means for comparing the distance signal with the comparative data and for selecting data from the lens focusing data accordingly for generating a data output for controlling focusing, and a lens driving device responsible to the data output for focusing a lens of the

camera.

Since the comparative data to be compared with the distance signal is stored in advance in the storage means, and the lens focusing data corresponding to this comparative data is also stored in advance in the storage means, a lens focusing value can be output immediately without requiring a calculation when the distance to an object is measured by the light emitting and the light receiving elements.

The present invention thus provides a distance measuring arrangement for a camera which permits a simplified structure, and high speed processing.

In a preferred form of the invention, the camera has a plurality of the light emitting elements, the comparing and selecting means being arranged to generate a corresponding plurality of data outputs, the camera further having a focusing mode selection circuit, and means responsive to the mode selection circuit for deriving a focusing control signal from the plural data outputs for actuating the lens driving device.

In this case, respective lens focusing values may be derived from each of the light emitting elements for providing a final focusing control signal determined in accordance with the focusing mode selected and on the basis of the plurality of lens focusing values. Photography according to the photographer's wishes is thus possible.

The present invention will be described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view illustrating one embodiment of an auto focus camera in accordance with the present invention;

Figure 2 is a block diagram of a control circuit

of the camera; and

Figures 3 and 4 are flow charts illustrating the auto focus operation.

5 In the auto focus camera illustrated in Figure 1, infra-red LEDs or the like are used as light emitting elements IR1, IR2, IR3, and the light from the light emitting elements passes through a projection lens 1 and is directed by way of respective optical paths towards objects 01, 02, 03, respectively. This light is  
10 reflected by the objects 01 to 03, passes through a light receiving lens 2, and forms an image on a semiconductor position detection (PSD) light receiving element 3.

15 The light received by the light receiving element 3 is converted into an electrical signal, which is amplified by an amplifier 4 and is then converted by an A/D converter 5 into a numerical value representative of distance. The output of the A/D converter 5 constitutes a distance signal and, on the basis of this distance  
20 signal, the lens extension needed is determined by a control circuit 6, and a focusing lens driving device 7 is actuated accordingly.

More particularly, the control circuit 6 has stored therein comparative data, as shown in the data  
25 table below, corresponding to the range of outputs which may be produced by the A/D converter 5 representing the distance between the light emitting elements IR1, IR2, IR3 and the objects 01, 02, 03. In this embodiment, the output which the A/D converter 5 delivers to the  
30 control circuit 6 is arranged to be rounded off at the second decimal place. In addition, the control circuit 6 has stored therein lens extension values associated with each light emitting element and representing the extent to which the focusing lens is to be extended for

each distance value obtained from the comparative data.  
The lens extension becomes larger as the object comes  
closer.

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Table 1

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| Comparative<br>Data | Lens Extension Amount |         |         |
|---------------------|-----------------------|---------|---------|
|                     | I R 1                 | I R 2   | I R 3   |
| 0 . 7               | 0 . 8                 |         |         |
| 0 . 6               | 0 . 7                 |         |         |
| 0 . 5               | 0 . 6                 |         |         |
| 0 . 4               | 0 . 5                 |         |         |
| 0 . 3               | 0 . 4                 | 0 . 8   |         |
| 0 . 2               | 0 . 3                 | 0 . 7   |         |
| 0 . 1               | 0 . 2                 | 0 . 6   |         |
| 0 . 0               | 0 . 0 5               | 0 . 5   |         |
| - 0 . 1             |                       | 0 . 4   | 0 . 8   |
| - 0 . 2             |                       | 0 . 3   | 0 . 7   |
| - 0 . 3             |                       | 0 . 2   | 0 . 6   |
| - 0 . 4             |                       | 0 . 0 5 | 0 . 5   |
| - 0 . 5             |                       |         | 0 . 4   |
| - 0 . 6             |                       |         | 0 . 3   |
| - 0 . 7             |                       |         | 0 . 2   |
| - 0 . 8             |                       |         | 0 . 0 5 |

↑ Close

↓ Far

As shown in Figure 2, the control circuit 6 comprises a distance signal shift register 61 for temporarily storing the distance signal output by the A/D converter 5. A first storage circuit 62 has the comparative data, which ranges from 0.7 to -0.8 as shown in the data table, stored in a shift register therein in advance. A comparator circuit 63 serves for comparing the distance signal from the shift register 61 with the comparative data in the first storage circuit 62. A second storage circuit (ROM) 64 has stored therein in advance the lens extension values, as shown in the data table, corresponding with the comparative data and with each of the light emitting elements IR1, IR2, IR3. The second storage circuit 64 is adapted to supply as output a lens extension value corresponding to a specific item of comparative data selected by the comparator circuit 63, and a lens extension determining circuit 65 receives this output for finally determining the degree of lens extension. A control circuit 66 is also provided for controlling the comparing operation, which takes place in the comparator circuit 63.

As shown in Figures 1 and 2, a focusing mode selection circuit 8 is connected to the lens extension determining circuit 65. A plurality of focusing modes are established in this focusing mode selection circuit 8, and one of them can be arbitrarily selected by the photographer. For instance, the modes may include a mode M1 for selecting focusing upon a closest object; a mode M2 for selecting focusing upon a furthest object; a mode M3 for selecting focusing at an intermediate point between the closest object and the furthest object; a mode M4 for selecting focusing at an intermediate point between the closest object and the furthest object as an inverse function of their

distances; and a mode M5 for selecting focusing for all the objects in inter-linked relation with the shutter. The lens extension determining circuit 65 includes a memory for storing a respective lens extension value derived from each of the light emitting elements from the second storage circuit 64, which values are obtained by causing the consecutive emission of light by each of the light emitting elements IR1 to IR3. From the plurality of lens extension values, a final lens extension value is determined in dependence upon the respective mode M1 to M5 selected by the photographer by means of the focusing mode selection circuit 8.

Next, a description of the operation of the auto focus camera of the present invention will be given with reference to Figures 1 and 2 and the flow charts shown in Figures 3 and 4.

First, the light emitting element IR1 is caused to emit light to measure the distance to the object 01. A corresponding distance signal is generated by the A/D converter 5, and this distance signal is stored in the distance signal shift register 61. The control circuit 66 issues a command via a signal line *l* to the shift register 61 to transfer the data in the shift register 61 corresponding to the light emitting element IR1 to the comparator circuit 63, and via a signal line *m* causes the comparative data in the data table in the first storage circuit 62 also to be supplied to the comparator circuit 63. The control circuit 66 further specifies to the second storage circuit 64 via a signal line *n* an address corresponding to the light emitting element IR1. In this state, the distance signal stored in the distance signal shift register 61 is compared with the comparative data stored in the first storage circuit 62 by means of the comparator circuit 63, and a

lens extension value corresponding to the coincident comparative data is generated by the second storage circuit 64. This lens extension value is stored in the memory of the lens extension determining circuit 65.

5           Upon completion of this storing operation, the control circuit 66 enables the signal lines  $\ell$ ,  $\underline{m}$ ,  $\underline{n}$  to repeat the above described procedure in the same way in relation to the light emitting element IR2. Thus, the light emitting element IR2 is caused to emit light to  
10          carry out distance measurement with respect to the object 02, and a lens extension value is determined in the same way as from the light emitting element IR1, this value also being stored in the memory of the lens extension determining circuit 65.

15           Next, the signal lines  $\ell$ ,  $\underline{m}$ ,  $\underline{n}$  are enabled for repeating the procedure in relation to the light emitting element IR3, the light emitting element IR3 is caused to emit light to carry out distance measurement with respect to the object 03, and a lens extension  
20          value is determined in the same way as from the light emitting elements IR1 and IR2, this value also being stored in the memory of the lens extension determining circuit 65.

          Then, in accordance with the flow chart shown in  
25          Figure 4, control is effected in dependence upon the focusing mode selected by the focusing mode selection circuit 8. In other words, if the mode M1 has been selected, the largest numerical value among the lens extension values derived from the light emitting  
30          elements IR1 to IR3 is taken as a final lens extension value. If the mode M2 has been selected, the smallest numerical value among the lens extension values derived from the light emitting elements IR1 to IR3 is taken as the final lens extension value. If the mode M3 has been

selected, and intermediate numerical value among the lens extension values derived from the light emitting elements IR1 to IR3 is taken as the final lens extension value. If the mode M4 has been selected, an average  
5 between a maximum value and a minimum value from the lens extension values derived from the light emitting elements IR1 to IR3 is taken as the final lens extension value. If none of the modes M1 to M4 has been selected, the final lens extension value as well as the  
10 aperture and timing of the shutter (shutter speed) are determined on the basis of the maximum and minimum values from the lens extension values derived from the light emitting elements IR1 to IR3 so that all the objects will be brought into focus.

15 When the final lens extension value is output from the lens extension determining circuit 65, the focusing lens driving device 7 is actuated to move the lens to an optimum position, and as the photographer presses the release button, he can take a photograph that meets his  
20 wishes.

It should be noted that although five modes of focusing provided by the focusing mode selection circuit 8 have been described, it is also possible to provide a mode in which any one of the distance signals derived  
25 from the light emitting elements IR1 to IR3 is ignored or a mode in which priority is placed on any one of these signals.

According to the present invention, comparative data and lens extension values corresponding to such  
30 comparative data are stored in advance in the first and second storage circuits, and so no complicated arithmetic circuit is required. The structure can thus be simplified, and high speed processing becomes possible. In addition, the passing-through-the-middle

phenomenon can be avoided since a plurality of light emitting elements are employed. Photography according to the photographer's wishes is also possible since the lens extension value is finally determined by the selection of one of a plurality of focusing modes.

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C L A I M S

1. An auto focus camera having a light emitting element for emitting light towards an object to be photographed, a light receiving element for receiving light reflected from the object and for generating a corresponding output, means for converting the output from the light receiving element into a distance signal, storage means having stored therein in advance comparative data representing a range of distances and lens focusing data corresponding to the comparative data, means for comparing the distance signal with the comparative data and for selecting data from the lens focusing data accordingly for generating a data output for controlling focusing, and a lens driving device responsive to the data output for focusing a lens of the camera.

2. A camera according to claim 1 having a plurality of the light emitting elements, the comparing and selecting means being arranged to generate a corresponding plurality of data outputs, the camera further having a focusing mode selection circuit, and means responsive to the mode selection circuit for deriving a focusing control signal from the plural data outputs for actuating the lens driving device.

3. An auto focus camera including a light emitting element for emitting light towards an object to be photographed, a light receiving element for receiving light reflected from the object, an A/D converter for converting an output from the light receiving element into a distance signal, a first storage circuit having stored therein in advance comparative data to be compared with the distance signal, a comparator circuit for comparing the distance signal with the comparative



data, a second storage circuit having stored therein in advance a plurality of lens extension values corresponding to the comparative data and being arranged to provide as output a lens extension value corresponding to specific comparative data selected by the comparator circuit, and a lens driving circuit operable in response to the output from the second storage circuit.

4. An auto focus camera including a plurality of light emitting elements for consecutively emitting light towards an object to be photographed, a light receiving element for receiving light reflected from the object, an A/D converter for converting an output from the light receiving element into a distance signal, a first storage circuit having stored therein in advance comparative data to be compared with the distance signal, a comparator circuit for comparing the distance signal with the comparative data, a second storage circuit having stored therein in advance a plurality of lens extension values corresponding to the comparative data and being adapted to provide as output a lens extension value corresponding to specific comparative data selected by the comparator circuit, a focusing mode selection circuit for selecting one of a plurality of focusing modes, a lens extension determining circuit which includes a memory for storing respective lens extension values output by the second storage circuit as a result of causing the light emitting elements to emit light consecutively and which is adapted to determine a final lens extension value in accordance with the focusing mode selected on the basis of the respective lens extension values output by the second storage circuit, and a focusing lens driving device operable in response to an output from the lens extension determining circuit.



5. An auto focus camera substantially as herein particularly described with reference to and as illustrated in the accompanying drawings.

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