

MULTIPLE FLASH RANGE FINDER

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5 The present invention relates to a multiple flash range finder for use in an auto-focus camera or other distance determining apparatus.

10 An auto-focus camera equipped with a range finder employing multiple flashes is known. The range finder comprises a plurality of light emitting devices for emitting light towards a subject, a light receiving device for receiving the light reflected from the subject, and an arithmetic processing unit arranged to receive output signals from the light receiving device and to calculate the distance to the subject based on such signal.

15 The light emitting devices are activated by a drive circuit so that each one emits a plurality of flashes during a respective period of time t_{11} , t_{12} , t_{13} , as shown in Figure 4. The light emitting devices may be LEDs, which emit infra-red radiation. Such light is passed through a single projector lens before falling on the subject. The reflected light is then focused onto the light receiving device, which may be a position sensitive photo-diode. The arithmetic processing unit computes the distance to the subject based on the position at which the reflected light focuses. The focal distance of the camera lens is subsequently adjusted automatically.

25 In the conventional multiple flash range finder, the sum of the periods during which the infra-red LEDs emit light, i.e. $t_{11} + t_{12} + t_{13}$, is long and so a long time is taken to measure the distance. In addition, the LEDs produce a large amount of heat and, therefore, the peak current available is limited.

Hence, a limitation is imposed on the light emission power. Consequently, the accuracy with which long distances can be measured is restricted.

5 The present invention seeks to provide a range finder having light emitting devices which produce a smaller quantity of heat and which can measure long distances with improved accuracy and in a shorter time by comparison with the conventional range finder described above.

10 According to the present invention, there is provided a range finder for a camera comprising a plurality of light emitting devices for emitting light towards a subject, a light receiving device for receiving light reflected from the subject and for
15 generating a corresponding output signal, and processing means arranged in response to the output signal to calculate the distance to the subject, the light emitting devices being arranged so as each to emit light momentarily successively one after the other.

20 Preferably, the sequence of light emissions is repeated several times.

25 The invention also features a method of driving a multiple flash range finder which is for use in a camera and comprises a plurality of light emitting means emitting light to a subject, a light receiving means receiving the light reflected from the subject, and an arithmetic processing unit that receives the output signal from the light receiving means and calculates
30 he distance to the subject, the

method consisting in causing the plural light emitting means to emit light successively and repeatedly in such a way that each light emitting means emits momentarily and that only one light emitting means emits at a time.

5 The invention is described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a diagram illustrating the operation of a range finder embodying the invention;

10 Figure 2 is a block diagram of circuitry within the range finder;

Figure 3 is a timing chart showing the relationship of respective light signals emitted by light emitting devices of the range finder; and

15 Figure 4 is a timing chart showing the relationship of respective signals emitted by light emitting devices of a conventional range finder.

Referring to Figure 1, three light emitting devices IR_1 , IR_2 , IR_3 and a light receiving device 1 are mounted on the front surface of a camera. The light emitting devices may comprise LEDs, for example, which are arranged to emit infra-red radiation towards a subject 0. The light receiving device 1 receives the light reflected from the subject and detects the position of such received light for determining the distance of the subject. The light receiving device 1 may, for example, comprise a position sensitive photo-detector, which is located at a certain distance from the light emitting devices IR_1 , IR_2 , and IR_3 . The three light emitting devices successively emit pulses of light such that only one device emits light at a time and each device only emits a single momentary flash of light. The light rays emanating from the light emitting devices IR_1 , IR_2 , and IR_3 pass through a

projecting condenser lens 2 and form light spots 0_1 , 0_2 , 0_3 , respectively, at the subject 0.

The light reflected from the subject 0 is concentrated by a condenser lens 3 and impinges on the light receiving device 1. Since the condenser lens 2 in the sending path is equivalent to the condenser lens 3 in the return path, the light is focused onto the light receiving device 1 at a single point.

In this way, the light reflected by the subject 0 is collimated into a fine pencil by the condenser lens 3 for receipt by the light receiving device 1, which converts the position of the light spot received thereby into an electrical signal representing the distance to the subject 0. An auto-focus control system is connected to the light receiving device 1 so as to receive the signal output from the light receiving device 1 for calculating the distance to the subject. As shown in Figure 2, this control system comprises a micro-computer 4, a drive circuit 5 for energising the light emitting devices IR_1 , IR_2 , IR_3 according to signals generated by the micro-computer 4, amplifier circuits 6, 7 for amplifying the output from the light receiving device 1, and an arithmetic processing unit 8 which receives the signal output by the light receiving device 1 via the amplifier circuits 6 and 7. A lens adjusting device 9 is connected to the processing unit 8.

The three light emitting devices IR_1 , IR_2 , and IR_3 are successively energised during periods of time $t_2 - t_1$, $t_3 - t_2$, $t_4 - t_3$, respectively, as shown in Figure 3, in such a manner that each such device emits a single momentary flash of light one after the other. This series of emissions is repeated several times.

More specifically, the light emitting device IR_1

emits light between the time t_1 and the time t_2 . At this point, the arithmetic processing unit 8 calculates the distance to the subject. Next, the light emitting device IR_2 emits light between the time t_2 and the time t_3 . The processing unit 8 computes the distance in a like manner. Then, the light emitting device IR_3 emits light between the time t_3 and the time t_4 . Once again, the processing unit 8 calculates the distance in a similar manner. After the light emitting device IR_3 emits, the light emitting device IR_1 is caused to emit light again, and the distance is once more computed. The series of emissions is thus repeated.

Thus, the light emitting device IR_1 does not operate between the time t_2 and the time t_4 . The light emitting device IR_2 is not activated between the time t_3 and the time t_1 . And the light emitting device IR_3 does not emit between the time t_4 and the time t_2 .

Accordingly, each individual light emitting device generates a single flash and is then inactive for a relatively long time. Hence, the amount of heat generated by the light emitting devices is diminished. This enables the peak current to be set to a relatively large value so as to increase the power of each light emission. Consequently, the accuracy with which long distances can be measured is enhanced. Furthermore, the total time taken to measure a distance can be shortened.

C L A I M S

1. A range finder for a camera comprising a plurality of light emitting devices for emitting light towards a subject, a light receiving device for receiving light reflected from the subject and for generating a corresponding output signal, and processing means arranged in response to the output signal to calculate the distance to the subject, the light emitting devices being arranged so as each to emit light momentarily successively one after the other.

2. A range finder as claimed in claim 1 wherein the light emitting devices are arranged so as to emit light repeatedly in succession.

3. A range finder as claimed in claim 1 or 2 wherein each light emitting device comprises a light emitting diode for emitting infra-red radiation.

4. A method of driving a multiple flash range finder which is for use in a camera and comprises a plurality of light emitting means emitting light to a subject, a light receiving means receiving the light reflected from the subject, and an arithmetic processing unit that receives the output signal from the light receiving means and calculates the distance to the subject, the method consisting in causing the plural light emitting means to emit light successively and repeatedly in such a way that each light emitting means emits momentarily and that only one light emitting means emits at a time.