

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN AND RELATING TO PHOTO-ELECTRIC RANGE FINDING

- (71) We, KARL VOCKENHUBER, of 118, Potzleinsdorfstrasse, Vienna 18, and RAIMUND HAUSER, of 2, Goldgasse, Vienna 4, both Austria, both Austrian citizens, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—
- 10 The invention refers to a method for range finding, in which two images of an object are drawn up and the relative displacement of these images is established by conversion of a plurality of image spots
- 15 of each image into electrical signals and by subsequent comparison of the intensity of the signals. A range finder using this type of method is described in our copending application No. 29497/72 (Serial No. 20 1389847).
- Such a method is the subject of a prior proposal in which two electrical signals derived from different images were compared with each other. This involved a
- 25 complicated comparison of the particular test data, so that the circuit construction was very expensive. For each pair of photodetectors there was provided a differential amplifier, so that the current consumption
- 30 of the circuit increased with increasing numbers of pairs of photodetectors.
- In accordance with the invention there is provided a method for range finding, in which two separate images of a scene
- 35 to be ranged are formed and the sequential conversion of a plurality of image spots of each image into electrical signals takes place for the subsequent comparison of signals corresponding to one image with
- 40 the signals corresponding to the other image, the image spots of one image being arranged to be identical to the image spots of the other image when the scene is correctly ranged.
- 45 The invention also includes a device for carrying out this method, including an optical system for producing two images to be compared with each other, two lines of photocells with each line being assigned to its respective image, the output of the
- 50 lines being connected to first control means which include means for sequentially connecting each photocell of a first line to a first input of a device for performing a logic function and simultaneously for connecting alternately a directly opposite
- 55 photocell of the second line or a photocell in a given direction from a given number of photocells away from the directly opposite photocell of the second line to a
- 60 second input of the logic device, the output of which is connected via an integrator to further control means.
- The image spots of each image are thus converted one after the other into electrical
- 65 signals and the cross relation between the signals assigned to the two images is determined. There results an especially uncomplicated construction for realizing this method. A relatively low cost circuit is
- 70 obtained, even with large lengths of photocell lines.
- The invention will now be described in more detail, by way of example only and with reference to the accompanying diagrammatic drawings, in which:
- 75 FIGURE 1 shows a photocell interrogation circuit; and
- FIGURES 2, 3a and 3b show various waveforms of the circuit of Figure 1.
- 80 In this circuit a pulse generator 15 produces a cadence signal A composed of interrogation pulses shown in Figure 2. A further pulse generator 16 produces a signal pulse B of much lower frequency determining the repetition frequency of the
- 85 scanning of the photodiode lines. The synchronization of the phase position between the cadence signal A and a starting pulse C or D furnished to the photo-diode lines
- 90

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n or n' , respectively, is carried out by a synchronizing circuit 17, which also determines the pulse length of the starting pulses C, D.

5 While however the line n receives its starting pulse C directly, the starting pulse D first passes an intermittently effective delay mechanism 18 controlled by a frequency divider 19. The frequency divider 19
10 divides the starting pulse B from the starting generator 16 in the ratio 1 : 2 as shown at E. The delay mechanism 18 thus delays only alternate starting pulses D, whereas the remaining starting pulses C are allowed
15 to pass undelayed (see Figure 2). The two diode lines n and n' are in one case read together and simultaneously when starting pulse C coincides with starting pulse D, whereas in the other case they are read
20 with a certain relative delay, caused by the interval between the starting pulses C and D, which simulates a deviation of the two partial images relative to each other. The successive interrogation of diode lines is
25 controlled by a circuit not shown and commences operation when a starting pulse is received.

The video signals received from the interrogation of the photocell lines n , n' are
30 amplified in amplifiers 20, 20', and passed through high-pass filters 21, 21', which suppress the effects of ambient light. The signals are further amplified in amplifier 22 or 22' to appropriate threshold values to
35 trigger electronic switches in the form of Schmitt-Triggers 23 and 23'. These Schmitt-Triggers digitize the video signals and so render possible their subsequent digital treatment.

40 It is essential that the signal paths behind the diode lines n and n' are matched so that they show equal amplification, equal frequency characteristics and equal threshold values.

45 The amplifier 20 furnishes a control voltage for the control of the repetition frequency of the starting pulses and in that way also controls the sensitivity of the diode line. A low repetition frequency
50 results in a higher integration period of the photodiodes and consequently in a higher sensitivity. Time sharing means 24 ensure operation of the amplifiers 20, 20' only during the periods that they are receiving video signals.
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The outputs of the schmitt trigger switches 23, 23' are fed to an EXCLUSIVE-OR gate 25. An output signal at this gate
60 25 therefore occurs only when the input signals are unequal. If the interrogated signals from the photodiode lines n, n' are the same when simultaneously interrogated with an undelayed starting pulse D, the output of the gate 25 is a minimum. An
65 integrator 26 is provided to receive the sig-

nal from the gate 25. The output H of the integrator 26 comprises a signal consisting of unidirectional pulses, the period between adjacent pulses being equal to half of the period of the signal E. For any given adjustment of the range-finder, alternate pulses of the output H have equal amplitude. If
70 the range-finder is adjusted so as to correspond to focussing in front of the correct adjustment, the signal H is as shown in Figure 3a whereas, if the range-finder is
75 adjusted so as to correspond to focussing behind the correct adjustment, the signal H is as shown in Figure 3b. When the range-finder is adjusted so as to correspond to correct focussing, the signal H comprises
80 a string of pulses of equal magnitude. This latter adjustment corresponds to the partial images being displaced from their correctly adjusted position by an amount corresponding
85 to half the displacement corresponding to the delay introduced by the delay circuit 18 in response to the signal E, i.e. the displacement of one of the split images with respect to the other split image as
90 detected by vertically adjacent photodiodes when signals C and D coincide is equal and opposite to the displacement of the one split image with respect to the other split image as detected by the photodiodes when
95 signal D is delayed with respect to signal C.

In a reading amplifier 27 a modulation signal I is obtained from the signal H (see Figures 3a, 3b). The reading amplifier 27
100 is controlled in similar manner to the amplifiers 20, 20' by a monostable trigger stage 28, which generates a gating signal G to ensure operation of the amplifier 27 only
105 when signals requiring amplification are received. The modulation signal I issued by the reading amplifier 27 is reduced to zero when the correct range is found and at which the camera will naturally be in sharp focus. If however the modulation
110 signal I is not equal to zero, the magnitude and polarity is indicative of the deviation of the set range from the correct range.

A measure of the range error may, for example, be obtained by lamps 29, 30, if
115 the modulation signal I is led through a high-pass filter 31 to two bistable trigger stages 32, 33, this arrangement forming a phase-sensitive detector. The trigger stage 32 is set to 1 when signal E and signal K
120 are simultaneously 1, and the trigger stage 33 is set to 1 when signal E is 0 and signal K is 1. Both trigger stages are reset to 0 for signal combinations other than those described above. At correct distance
125 setting the lamps 29, 30 then give no signal, whereas in the case of deviation in one direction the lamp 29 flashes in time with the signal L (Figure 3a) and in the case of
130 deviations in the other direction, the lamp

30 flashes in time with the signal M (see Figure 3b). Of course it is also feasible and useful to lead the signals L, M to a focusing motor for automatic focussing of, for instance, a camera objective, instead of to the pilot lamps 29,30.

If required, data storage means may be provided for storing signals based on the output of the photocell lines and connected, for instance, to the output of the gate 25.

WHAT WE CLAIM IS:—

1. A method for range finding, in which two separate images of a scene to be ranged are formed and the sequential conversion of a plurality of image spots of each image into electrical signals takes place for the subsequent comparison of signals corresponding to one image with the signals corresponding to the other image, the image spots of one image being arranged to be identical to the image spots of the other image when the scene is correctly ranged.

2. A method as claimed in claim 1, in which each signal from each image spot of one image is compared alternately with the signal from a directly opposite image spot of the other image and with the signal from an image spot having a fixed displacement from the directly opposite image spot of the other image.

3. A method for range finding according to claim 1 and substantially as herein described.

4. A device for carrying out the method as claimed in any of claims 1 to 3, including an optical system for producing two images to be compared with each other, two lines of photocells with each line being assigned to its respective image, the output of the lines being connected to first control means which includes means for sequentially connecting each photocell of a first line to a first input of a device for perform-

ing a logic function and simultaneously for connecting alternately a directly opposite photocell of the second line or a photocell in a given direction from and a given number of photocells away from the directly opposite photocell of the second line to a second input of the logic device, the output of which is connected *via* an integrator to further control means.

5. A device as claimed in claim 4, in which a threshold value switch is connected to each photocell line for digitizing the signals and the logic device comprises an EXCLUSIVE-OR gate.

6. A device as claimed in claim 5, in which a high pass filter is connected in series with the input of each threshold value switch.

7. A device as claimed in any of claims 4 to 6, in which the first control means is arranged to supply photocell output enabling pulses directly to one photocell line and *via* a variable delay device to the other photocell line, the further control means being provided with a phase detector.

8. A device as claimed in claim 7, in which the first control means is arranged to supply delay control pulses to the variable delay device for switching the delay in and out, and a data storage means is arranged to receive and store signals based on the output of the photocell lines.

9. A device as claimed in claim 8, in which the data storage means is connected to the output of the logic device.

10. A device as claimed in claim 8 or 9, in which the phase detector is arranged to receive the delay control pulses.

11. A range finding device according to claim 4 and substantially as herein described with reference to the accompanying drawings.

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30 flashes in time with the signal M (see Figure 3b). Of course it is also feasible and useful to lead the signals L, M to a focusing motor for automatic focussing of, for instance, a camera objective, instead of to the pilot lamps 29,30.

If required, data storage means may be provided for storing signals based on the output of the photocell lines and connected, for instance, to the output of the gate 25.

WHAT WE CLAIM IS:—

1. A method for range finding, in which two separate images of a scene to be ranged are formed and the sequential conversion of a plurality of image spots of each image into electrical signals takes place for the subsequent comparison of signals corresponding to one image with the signals corresponding to the other image, the image spots of one image being arranged to be identical to the image spots of the other image when the scene is correctly ranged.

2. A method as claimed in claim 1, in which each signal from each image spot of one image is compared alternately with the signal from a directly opposite image spot of the other image and with the signal from an image spot having a fixed displacement from the directly opposite image spot of the other image.

3. A method for range finding according to claim 1 and substantially as herein described.

4. A device for carrying out the method as claimed in any of claims 1 to 3, including an optical system for producing two images to be compared with each other, two lines of photocells with each line being assigned to its respective image, the output of the lines being connected to first control means which includes means for sequentially connecting each photocell of a first line to a first input of a device for perform-

ing a logic function and simultaneously for connecting alternately a directly opposite photocell of the second line or a photocell in a given direction from and a given number of photocells away from the directly opposite photocell of the second line to a second input of the logic device, the output of which is connected *via* an integrator to further control means.

5. A device as claimed in claim 4, in which a threshold value switch is connected to each photocell line for digitizing the signals and the logic device comprises an EXCLUSIVE-OR gate.

6. A device as claimed in claim 5, in which a high pass filter is connected in series with the input of each threshold value switch.

7. A device as claimed in any of claims 4 to 6, in which the first control means is arranged to supply photocell output enabling pulses directly to one photocell line and *via* a variable delay device to the other photocell line, the further control means being provided with a phase detector.

8. A device as claimed in claim 7, in which the first control means is arranged to supply delay control pulses to the variable delay device for switching the delay in and out, and a data storage means is arranged to receive and store signals based on the output of the photocell lines.

9. A device as claimed in claim 8, in which the data storage means is connected to the output of the logic device.

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11. A range finding device according to claim 4 and substantially as herein described with reference to the accompanying drawings.

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