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HUMAN BODY DETECTOR

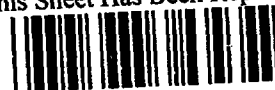
The present invention relates to a reflection type human body detector of an intermittent light projection system and, more particularly, to a human body detector which outputs a detection signal to, for example, a feed water control system so as to control the valve opening operation.

The conventional reflection type human body detector for outputting a detection signal to a feed water control system or the like which is disclosed in Japanese Patent Laid-Open No. 294032/1986 compares the photoelectric value received with a threshold value, and outputs a human body detection signal when the photoelectric value reaches the threshold value.

In a generally used reflection type human body detector, the photoelectric value received is integrated, the integrated value is compared with a threshold value, and when the integrated value reaches the threshold value, a human body detection signal is output.

In the reflection type human body detector which is disclosed in Japanese Patent Laid-Open No. 156686/1993, the

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photoelectric value received is integrated during the projection of light, the integrated value is compared with a threshold value, and when the integrated value reaches the threshold value, a human body detection signal is output.

However, these conventional reflection type human body detectors have the following problems.

In the first human body detector, since a human body detection signal is output when the photoelectric value reaches the threshold value, even if a man passes momentarily by the apparatus, a human body detection signal is output.

In the second human body detector, since a human body detection signal is output when the integrated photoelectric value reaches the threshold value, even if the integrated photoelectric value of disturbing light reaches the threshold value, a false human body detection signal is output.

In the third human body detector, since the photoelectric value received is integrated during the projection of light, and when the integrated value reaches the threshold value, a human body detection signal is output, even if disturbing light is received during the projection of light and the integrated photoelectric value of disturbing light reaches the threshold value, a false human body detection signal is output.

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Accordingly, it is an aim of the present invention to eliminate the above-described problems in the related art and to provide a reflection type human body detector of an intermittent light projection system which can exactly detect a human body by taking out a variation of the photoelectric value during the projection of light and storing it until the next light projection, updating the variation at the next projection, comparing the variation of the photoelectric value integrated in a predetermined time with a threshold value, and outputting a human body detection signal when the integrated value reaches the threshold value.

To achieve this aim, the present invention provides a reflection type human body detector having a light emitting element, a light receiving element and a light projection pulse generator for generating pulses for intermittently projecting light from the light emitting element onto an object of detection so as to detect the object of detection by processing a light reception signal output from the light receiving element when the light reflected from the object of detection is received by the light receiving element, the human body detector comprising: an output converter for outputting a variation of the light reception signal supplied from the light receiving element when the light projection is started by the light emitting element in

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synchronism with the intermittent light projection timing of the light projection pulse generator; an integrator for integrating the variation; and a judging means for judging whether or not the output value of the integrator is within a predetermined threshold value so as to output a detection signal of the object of detection when the output value reaches the threshold value.

According to the human body detector having the above-described structure, light projection is started in synchronism with the intermittent light projection timing, and when the light reflected from the object of detection is received by the light receiving element, the outputting converter outputs the variation of the light reception signal, so that the variation is a value with the influence of disturbing light or the like eliminated therefrom. In addition, since the variation is integrated by the integrator, when the output value reaches the predetermined threshold value, the judging means output a detection signal indicating the detection of the object.

The preferred embodiments of the present invention will be explained hereinunder by way of example only with reference to the accompanying drawings, in which;-

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Fig. 1 is a block diagram of the whole structure of a first embodiment of a human body detector according to the present invention;

Fig. 2 is a timing chart of human body detection;

Fig. 3 is a block diagram of a modification of the first embodiment shown in Fig. 1; and

Fig. 4 is a block diagram of the structure of the main part of a second embodiment of a human body detector according to the present invention.

Fig. 1 is a block diagram of the structure of a first embodiment of a reflection type human body detector according to the present invention for outputting a human body detection signal to a feed water control system. Fig. 2 is a timing chart of human body detection.

As shown in Fig. 1, a light injection pulse generator 2 for controlling the ON/OFF of a transistor Q in accordance with the instruction of a microcomputer 1 is provided. When the light injection pulse generator 2 receives the instruction for light emission from the microcomputer 1, as shown in Fig. 2(a), the light injection pulse generator 2 outputs a light injection pulse for switching ON the transistor Q at an interval of, for example, 2 seconds, so as to emit

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light from a light emitting element D1 which is composed of a light emitting diode or the like, as shown in Fig. 2(b). Since the transistor Q is switched ON every time the light projection pulse is input to the base of the transistor Q, a current is supplied from a power source VB to the light emitting element D1, so that the light emitting element D1 intermittently emits light at intervals of 2 seconds.

When the light emitted from the light emitting element D1 is reflected by a human body (not shown), the reflected light is received by a light receiving element D2 which is composed of a light receiving diode or the like. When the light receiving element D2 receives light, it outputs a light reception voltage at the timing shown in Fig. 2(c). The light reception voltage is applied to an amplifier A so as to be amplified. The amplified voltage is applied to a capacitor C1 which is connected to the output side of the amplifier A, and differentiated when the capacitor C1 is excited. In other words, the voltage corresponding to the variation of the light reception voltage received by the light receiving element D2 is output from the capacitor C1 as a light reception voltage.

Switches S1 and S2 which are turned ON and OFF by the light projection pulse generator 2 in synchronism with the ON/OFF timing of the light projection pulse are connected to the output side of the capacitor C1. The switch S1 is

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turned OFF for a very short time in synchronism with the ON of the light projection pulse, as shown in Fig. 2(d), while the switch S2 is turned ON for a very short time in synchronism with the ON of the light projection pulse, as shown in Fig. 2(e).

Since the switch S2 is turned ON for a very short time in synchronism with the ON of the light projection pulse, the light reception voltage output from the capacitor C1 is input to an integrator 3 which is composed of an operational amplifier OP1 and a capacitor C2 through a resistor R during the very short ON time. The integrator 3 integrates each light reception voltages input during the very short ON time of the switch S2 four times, as shown in Fig. 2(f).

The switch S1 is turned ON for a very short time in synchronism with the OFF of the light projection pulse from the light projection generator 2, and discharges the charges in the capacitor C1 in preparation for the next light reception.

A reset circuit 4 is connected to the output side of the integrator 3, and the integrated value from the integrator 3 is stored until the reset circuit 4 is operated. The integrator 3 outputs the integrated value to a comparator 5 which is composed of the operational amplifier OP2 and a threshold voltage source E1.

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The comparator 5 outputs a detection signal indicating the detection of a human body, as shown in Fig. 2(g), at the moment the integrated value reaches the voltage preset by the threshold voltage source E1. The detection signal is output to a feed water controller 2 so as to open a water valve 7 for a predetermined time.

In this embodiment, when noise N1 caused by disturbing light is output from the light receiving element D2, as shown in Fig. 2(c), the noise N1 is not integrated, because the switch S1 is ON (switch S2 is OFF). When noise N2 caused by another disturbing light beam is output, since the noise N2 is caused during the resetting operation of the reset circuit 4, the noise N2 is not integrated.

When noise N3 is caused, the noise N3 is not integrated, because the switch S1 is ON (switch S2 is OFF).

In this way, since almost no noise caused by unexpected disturbing light is integrated, the exact human body detection which is not influenced by disturbing light is enabled.

Fig. 3 is a block diagram of a modification of the embodiment shown in Fig. 1. In this modification, the integrator 3 and the comparator 5 are constituted by a microcomputer. Although the integrator 3 and the comparator 5 executes analog processing, this microcomputer is provided therewithin with an addition subtraction logic circuit 8 for digitally adding and subtracting the light reception voltage



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output from the switch S2, and a comparison logic circuit for outputting a human body detection signal when the sum or difference in a predetermined time t reaches a predetermined value. The other structure and operation are the same as in the embodiment shown in Fig. 1.

A second embodiment of the present invention will now be explained with reference to Fig. 4. A light emission system (not shown) which is similar to that in the first embodiment is provided in the second embodiment. A light injection pulse generator 2 for controlling the ON/OFF of a transistor Q in accordance with the instruction of a microcomputer 1 is provided. When the light injection pulse generator 2 receives the instruction for light emission from the microcomputer 1, the light injection pulse generator 2 outputs a light injection pulse for switching ON the transistor Q at an interval of, for example, 2 seconds. Since the transistor Q is switched ON every time the light projection pulse is input to the base of the transistor Q, a light emitting element D1 intermittently emits light at intervals of 2 seconds.

A semiconductor position detector PSD (Position Sensitive Photodetector) is used as a light receiving element for receiving the light intermittently emitted from the light emitting element D1 and reflected from a human body. The semiconductor position detector PSD is a sensor for

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measuring the distance between the PSD and a human body in accordance with the principle of triangulation.

To state this concretely, when light is received, the two voltages V_1 , V_2 , output from both terminals or the common terminal of the semiconductor position detector PSD are amplified by the respective amplifiers to the same amplification degree. The amplified light reception voltages are applied to capacitors C_1 which are connected to the output sides of the respective amplifiers A, and differentiated when the capacitors C_1 are excited. In other words, the voltage corresponding to the variation of the light received by the semiconductor position detector PSD is output from each capacitor C_1 as the light reception voltage.

Switches S_1 and S_2 which are turned ON and OFF by the light projection pulse generator 2 in synchronism with the ON/OFF timing of the light projection pulse are connected to the output side of each capacitor C_1 . The switches S_1 are turned OFF for a very short time in synchronism with the ON of the light projection pulse, while the switches S_2 are turned ON for a very short time in synchronism with the ON of the light projection pulse.

Since the two switches S_2 are turned on for a very short time in synchronism with the ON of the light projection pulse, the light reception voltage output from each

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capacitor C1 is input to the corresponding integrator 3 which is composed of an operational amplifier OP1 and a capacitor C2 through a resistor R during the very short ON time. Each integrator 3 integrates each light reception voltages input during the very short ON time of the switch S2.

A sample hold circuit S/H is connected to the output side of each integrator 3. Each sample hold circuit samples and holds the integrated value output from the corresponding integrator 3 and outputs the value to a comparison logic circuit 10 at the same time. The comparison logic circuit 10 may be replaced by a comparator constituted by an operational amplifier.

The comparison logic circuit 10 calculates the values (integrated values) output from the two sample hold circuits S/H so as to calculate the distance between the human body and the semiconductor position detector PSD. If the distance is not more than a predetermined value, a detection signal indicating the detection of a human body is output. The detection signal is output to a feed water controller 6 so as to open a water valve 7 for a predetermined time in the same way as in the first embodiment.

As described above, according to the present invention, light projection is started in synchronism with the intermittent light projection timing by the light projection generator, and when the light reflected from a human body is



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received by the light receiving element, the output converter outputs a variation of the light receiving signal. The variation is a value with influence of disturbing light or the like removed therefrom and the variation is integrated by the integrator. When the output value of the integrator reaches a preset threshold value, the judging means outputs a human body detection signal. In this way, the detection of a human body is ensured.

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CLAIMS:

1. A reflection type human body detector having a light emitting element, a light receiving element and a light projection pulse generator for generating pulses for intermittently projecting light from said light emitting element onto an object of detection so as to detect said object of detection by processing a light reception signal output from said light receiving element when the light reflected from said object of detection is received by said light receiving element, said human body detector comprising:

an output converter for outputting a variation of the light reception signal supplied from said receiving element when the light projection is started by said light emitting element in synchronism with the intermittent light projection timing of said light projection pulse generator;

an integrator for integrating said variation; and

a judging means for judging whether or not the output value of said integrator is within a predetermined threshold value so as to output a detection signal of said object of detection when said output value reaches said threshold value.

2. A reflection type human body detector according to claim 1, wherein





said light receiving element is a semiconductor position detector;

variations of the two light reception signals from said semiconductor position detector are integrated;

the distance between said object of detection and said semiconductor position detector is calculated on the basis of the two integrated values; and

a detection signal indicating the detection of said object is output when said difference is not more than a predetermined value.

3. A reflection type human body detector substantially as hereinbefore described with reference to Figures 1 to 3 and Figure 4 of the drawings.

