MOTION DETECTOR

The present invention relates to a motion detector for a security system and methods of operating the passive motion detector. In particular, the present invention relates to passive infrared detectors.

Security systems may comprise one or more motion detectors to determine the presence of an intruder in a protected area. The motion detectors are mounted on the surfaces of a building (e.g. walls and ceilings) and are operable to detect movement within a field of view. If an object moves across the field of view of the motion detector, an alarm condition may be generated to signal the detection of a potential intruder.

Motion detectors may be of an active type, a passive type or may be a combination of active and passive detection types. One type of passive motion detector is a passive infrared detector (PIR). PIRs typically comprise an optical element and a sensing element. The optical element, which may be a Fresnel lens array or reflective mirror array, divides the field of view of the detector into a plurality of discrete sensitive detection zones, with each detection zone separated by a discrete non-sensitive neutral zone.

The sensing element is disposed at the focal point of the optical element such that infrared ("IR") radiation within each of the sensitive detection zones is focused onto the sensing element. As an intruder moves across the field of view, the intruder will enter and exit one or more of the sensitive detection zones causing IR energy emitted by his body to be focused onto the sensing element when in a detection zone and not focused on the sensing element when between or outside of detection zones.

The sensing element is typically a type of pyroelectric sensor that produces a small electrical signal in response to changes in incident IR. This small electrical signal is typically amplified and filtered and an alarm condition generated if the signal is over a predetermined threshold.

Whilst PIRs are intended to detect human intruders, PIRs may also undesirably be susceptible to various false alarm sources. False alarm sources may include sunlight incident on the detector or falling within detection zones, moving air, heat sources (e.g. radiators or fan heaters), induced radio-frequency interference (RFI), and small animals or insects.

It is an object of the present invention to provide a motion detector which at least partially addresses one or more of the problems of the prior art, whether identified herein or elsewhere.

According to a first aspect of the invention, there is provided a method of generating an alarm condition for a motion detector, as set out in claim 1.

By generating an alarm condition based upon both the pulse count and the amplitude of the received signal, the sensitivity of a motion detector using the method of the first aspect of the invention may be dependent on the amplitude of the received signal. For example, a different sensitivity may be provided when the received signal is relatively high (e.g. above a threshold value) and when the received signal is relatively low (e.g. below the threshold value). This allows the sensitivity of the motion detector to be tuned to reduce the number of potential false alarms whilst minimising the effect on detection efficiency of the motion detector.

In some prior art methods, to reduce the number of false alarms, the sensitivity of the motion detector is increased by simply increasing the threshold on the pulse count for generating an alarm. However, this has the unwanted effect of increasing the pulse count required for detection of genuine intruders.

The inventors have realised that an intruder is more likely to generate a high amplitude signal, whilst a false alarm is more likely to generate a low amplitude signal. As such, the amplitude of the signal may be used to adjust the sensitivity of the motion detector in dependence on the amplitude of the received signal so as to reduce the number of false alarms whilst maintaining detection efficiency.

The motion detector may be a passive motion detector, an active motion detector or a combination of a passive and active motion detector. Where the motion detector comprises a passive motion detector, the sensor may be a passive infrared sensor.

The alarm condition may be transmitted to a control panel of a security system.

The pulse count ~~may be~~is indicative of a number of detection zone boundaries that have been triggered within a time period. For example, a timer of a specified duration may be started in response to the detection of a pulse in the pulse signal. The pulse count may be the number of pulses detected within the time period. Alternatively, counting may begin when a first pulse is detected and counting may stop when no further pulses are detected within a time period of the last detected pulse.

Generating an alarm condition further comprises: modifying the pulse count based upon the amplitude of the received signal; and generating the alarm condition if the modified pulse count exceeds a pulse count threshold.

By modifying the pulse count, a simple method is provided to tune the sensitivity of the motion detector.

The method may further comprise amplifying the received signal. The received signal may be in the microvolt range and thus it may be beneficial to amplify the received signal into the volt range. The sensor signal may be amplified based upon a desired detection range of the sensor. For example, the signal may be amplified such that an intruder close to the sensor produces a saturated signal whilst an intruder on the edge of the desired detection range may still be detectable.

According to a second aspect of the invention, there is provided a motion detector as set out in claim 3.

By providing a motion detector comprising an alarm condition generator operable to generate an alarm condition based upon both the pulse count and the amplitude of the sensor signal, the sensitivity of a motion detector in accordance with the second aspect of the invention may be dependent on the amplitude of the received signal. For example, a different sensitivity may be provided when the received signal is relatively high (e.g. above a threshold value) and when the received signal is relatively low (e.g. below the threshold value). This allows the sensitivity of the motion detector to be tuned to reduce the number of potential false alarms whilst minimising the effect on detection efficiency of the motion detector.

The motion detector may be a passive motion detector, an active motion detector or a combination of a passive and active motion detector. Where the motion detector comprises a passive motion detector, the sensor may be a passive infrared sensor.

The motion detector further comprises: a pulse count modifier operable to modify the pulse count based upon the amplitude of the sensor signal; and the alarm condition generator is further operable to generate an alarm condition if the modified pulse count exceeds a pulse count threshold.

Whilst the sensor, pulse signal generator, pulse counter, alarm generator, pulse count threshold generator and pulse count modifier have been described as separate components, it will be appreciated that any combination of such components may be combined in a single device or the functions of such components may be performed by a single device such as a processor. It will also be appreciated that components may be implemented through any suitable means, for example using analogue or digital circuitry. It will also be appreciated that the same applies for any further components described.

The motion detector may further comprise an amplifier operable to amplify the sensor signal.

The motion detector may further comprise a transmitter operable to transmit the generated alarm condition to a control panel of a security system.

The sensor may comprise a sensing element and an optical element. The sensor ~~may be~~is arranged to divide a field of view into a plurality of detection zones.

It will be appreciated that aspects of the invention can be implemented in any convenient form. For example, the invention may be implemented by appropriate computer programs which may be carried on appropriate carrier media which may be tangible carrier media (e.g. disks) or intangible carrier media (e.g. communications signals). Aspects of the invention may also be implemented using suitable apparatus which may take the form of programmable computers running computer programs arranged to implement the invention.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a passive motion detector in accordance with an embodiment of the present invention;

Figure 2 is a schematic illustration of a sensor of the passive motion detector shown in Figure 1;

Figure 3 is a schematic illustration of a passive motion detector (not forming part of the invention);

Figure 4 is a schematic illustration of an embodiment of the passive motion detector shown in Figure 1; and

Figure 5 is a flowchart showing processing carried out by the passive motion detector shown in Figure 1.

Figure 1 is a schematic illustration of a passive motion detector 100. The passive motion detector 100 comprises a sensor 101, a pulse signal generator 102, a pulse counter 103 and an alarm condition generator 104.

The sensor 101, shown schematically in more detail in Figure 2, is operable to detect infrared radiation within a field of view 201. As is known in the art, the sensor 101 may comprise an optical element 202 and a sensing element 203. The optical element 203 comprises an array of elements. For example, the optical element 203 may comprise an array of Fresnel lenses or an array of reflective mirrors. Each element of the array focuses a different discrete detection zone 204 onto the sensing element 203. In this way, the optical element 202 divides the field of view 201 into a plurality of discrete detection zones 204 from which infrared radiation is focused onto the sensing element 203. Each pair of adjacent discrete detection zones 204 is separated by a neutral zone 205; infrared radiation from the neutral zones 205 is not focused onto the sensing element 203. The field of view 201 may be defined by a solid angle subtended by the optical element 202. The field of view 201 may be defined by a numerical aperture of the optical element 202.

The sensing element 203 is operable to generate an output signal in response to infrared radiation incident on the sensing element 203. The sensing element 203 may comprise a pyroelectric material such that an electrical signal is output in response to a change in incident IR. For example, as an intruder moves across a boundary between a detection zone and a neutral zone, the amount of infrared energy emitted by the intruder and focused onto the sensing element 203 changes. The sensor 101 is operable to produce an output signal that is large where there is a change in infrared energy incident on the sensing element 203 and may be proportional to the size of the change in infrared energy incident on the sensing element 203.

Where there is no change in incident IR detected by the sensing element 203, the output signal may be a quiescent signal. It will be appreciated that the output may be subject to noise and fluctuations and therefore the quiescent signal may therefore fluctuate around a quiescent value. The quiescent value may, for example, be calibrated based upon the incident IR at room temperature without the presence of any additional sources of IR within the field of view 201.

As an object moves across the field of view 201, the output signal may be generally sinusoidal. In particular, the signal may be an oscillating signal modulated at a frequency based upon a speed of movement of an object moving through the field of view 201 as it enters and exits the detection zones 204 of the sensor 101.

It will be appreciated that the sensing element 203 may comprise a plurality of sensing elements and in particular may be a pair of sensing elements. The sensor 101 may be a passive infrared sensor. The output signal of sensing element 203 provides an output of the sensor 101 and may be referred to as a sensor signal hereafter.

It will also be appreciated that the sensor 101 is not limited to the arrangement described above. In particular, there may be other arrangements of sensor which are arranged to divide a field of view into a plurality of discrete detection zones. For example, in an alternative embodiment the sensor may comprise a single lens arranged to focus the entire field of view onto an array of sensing elements.

The pulse signal generator 102 is operable to generate a pulse signal based upon the sensor signal. As explained above, the sensor signal may oscillate and a pulse may be generated if the sensor signal is above an upper threshold above the quiescent value or below a lower threshold below the quiescent value. The two thresholds therefore define a region around a quiescent value whereby it is considered that no movement has been detected and outside of this region, it is considered that movement has been detected. The region defined by the two thresholds may be referred to as the quiescent value region. A pulse may be generated each time the sensor signal is outside of the quiescent region, thereby providing an indication of a detection event. The upper and lower thresholds may be set based upon the operating characteristics of the sensor as deemed appropriate, for example, by an engineer or installer of the passive motion detector 100.

An exemplary pulse signal generator 102 may comprise two voltage comparators. Each voltage comparator has as an input the sensor signal. The first voltage comparator may output a non-zero signal (for example a positive voltage) if the sensor signal is above the upper threshold referred to above and a zero signal (for example a voltage of 0 V) if the sensor signal is below the upper threshold. The second voltage comparator may output a non-zero signal (for example a positive voltage) if the sensor signal is below the lower threshold referred to above and a zero signal (for example a voltage of 0 V) if the sensor signal is above the lower threshold. The output of the voltage comparators therefore provides a pulse signal with a pulse being generated for the duration of time that the corresponding voltage comparator is triggered to generate a non-zero output signal.

The duration of the pulse is therefore dependent on the length of time that the sensor signal is outside of the quiescent value region. This in turn is dependent on factors such as the speed of the object moving through the field of view 201 and the distance of the object from the sensor 101. Objects further away from the sensor 101 are likely to generate pulses of a longer duration than objects closer to the sensor 101.

As an example, a sinusoidal sensor signal may typically have a frequency in a range of 0.1 Hz to 10 Hz and may typically be 1 Hz. It will be appreciated that a generated pulse would have a duration of at most half a cycle for a sinusoidal signal. As such, for a sinusoid signal in the previous exemplary range, a pulse may have a duration in a range of 25 ms to 2.5 s and may typically be 250 ms for a 1 Hz sensor signal.

As previously explained, the pulse duration may be dependent on a number of factors. Therefore it will be appreciated that the ranges described for frequency and duration are merely exemplary and that other values may be used as appropriate. In particular, the pulse duration may be extended (for example by the pulse signal generator 102, the pulse counter 103 or an additional component of the passive motion detector 100) to enable the pulses to be counted more easily.

As explained above, the field of view 201 of the passive motion detector 100 comprises a plurality of detection zones 204 and, as an object passes into (and out of) one of the detection zones 204, the sensor signal output by the sensor 101 increases (or decreases). A detection event may therefore correspond to the detection of an object crossing an edge of a detection zone. Therefore, a pulse generated by the pulse signal generator 102 may indicate that an object has moved across a detection zone 204 of the field of view 201.

The pulse counter 103 is operable to determine a pulse count of the pulse signal generated by the pulse signal generator 102. The pulse count ~~may, for example, be~~is a count of the number of pulses in the pulse signal within a detection time period. The detection time period may begin upon receipt of a pulse. For example, the detection time period may begin upon receipt of a first pulse following a period of inactivity (i.e. and period within which no pulses have been received). Upon receipt of such a first pulse following a period of inactivity, the pulse count may be incremented from zero to one and a timer may be started. The pulse counter 103 may increment the pulse count by one for each additional pulse received during the detection time period. The timer may be arranged to time a specified time period (for example 10 seconds). The detection time period may end when the timer reaches the specified time period. The timer may be reset each time a pulse is received. Therefore, the detection time period may end if no further pulses are detected within the specified time period starting from the last received pulse.

For instance, when a pulse is detected by the pulse counter 103, following a period of inactivity (for example for 10 seconds) the pulse count may be incremented from zero to one. A timer may be started on detection of the pulse. If a further pulse is received within the specified time period of the timer, the pulse count is incremented to two and the timer is reset to begin a new specified time period. Further pulses received within the specified time period of the timer will increase the pulse count and reset the timer in a similar manner. The pulse count is reset to zero if no pulses are detected within the specified time period of the timer. The duration of the timer may, for example, be 10 seconds.

In an alternative embodiment, instead of resetting the timer upon detection of a pulse, multiple specified time periods may be operating concurrently, each specified time period having been started upon receipt of a different pulse. Each of the specified time periods may be counted by a different timer.

As noted above, a pulse may be generated if it is detected that an object has moved across one of the boundaries of the plurality of detection zones 204. Therefore, the pulse count may be considered to be the number of detection zone boundaries that an object has crossed in such cases. It will be appreciated that a boundary may be a boundary between a detection zone 204 and a neutral zone 205 or may be a boundary between the detection zone 204 and outside of the field of view 201. It will also be appreciated that the same boundary may be crossed more than once and that each crossing of the boundary may generate a pulse.

The alarm condition generator 104 is operable to generate an alarm condition based upon the pulse count and the amplitude of the sensor signal. The amplitude of the sensor signal may, for example, be the modulus of the instantaneous amplitude of the sensor signal minus the quiescent value.

In prior art passive motion detectors, an alarm condition may be generated if the pulse count is above a specified threshold. Prior art passive motion detectors may comprise a switch or jumper links that allow an installer to manually adjust the alarm condition threshold. A higher threshold requires a higher pulse count to trigger an alarm condition and therefore potentially reduces the number of false alarms. However, a higher threshold also reduces the detection efficiency as more pulses are required to trigger the alarm condition. Consequently, this provides an intruder the opportunity of evading detection should he be familiar with the operating characteristics of the passive motion detector.

By generating an alarm condition based upon the amplitude of the sensor signal in addition to the pulse count, the passive motion detector 100 according to an embodiment of the present invention provides an arrangement whereby the sensitivity of the passive motion detector 100 can be tuned without impacting on the detection efficiency, as now explained. It is more likely that a high amplitude sensor signal corresponds to an intruder, whilst a low amplitude sensor signal is more likely to correspond to a false alarm source. Therefore, the alarm condition generator 104 may be configured such that a lower pulse count generates an alarm condition if the amplitude of the sensor signal is relatively high and a higher pulse count generates an alarm condition if the amplitude of the sensor signal is relatively low. In this way, false alarms may be reduced whilst maintaining detection efficiency.

Generating an alarm condition based upon the pulse count and the amplitude of the sensor signal may be performed using a variety of different methods. Two such methods are now described with reference to Figures 3 and 4.

Figure 3 is a schematic illustration of a passive motion detector 300 which is largely similar to the passive motion detector 100 of Figure 1. Elements of the passive motion detector 300 of Figure 3 which correspond to elements of the passive motion detector 100 of Figure 1 and which have been described above, have the same reference numerals and are not described in detail here. Passive motion detector 300 differs from the passive motion detector 100 of Figure 1 in that it comprises an additional pulse count threshold generator 304 which is operable to determine a pulse count threshold based upon the amplitude of the sensor signal.

The determination of the pulse count threshold by the pulse count threshold generator 304 is largely identical to that described above with reference to the alarm condition generator 104 of passive motion detector 100. That is, a lower pulse count threshold may be generated in response to a relatively high amplitude sensor signal and a higher pulse count threshold may be generated in response to a relatively low amplitude sensor signal. In this way, the sensitivity of the passive motion detector may be tuned based upon the amplitude of the sensor signal.

It will be appreciated that relatively high and relatively low may be defined by one or more threshold values. For example, a relatively high amplitude may be defined as any amplitude above a threshold value and relatively low may defined as any amplitude below the threshold. In this way, the threshold value divides the amplitude of the sensor signal into two amplitude levels. It will be appreciated that in other embodiments there may be a plurality of amplitude thresholds and, which may define more than two amplitude levels. There may also be a plurality of pulse count thresholds associated with each amplitude level.

The passive motion detector 100 may comprise a mechanism (e.g. a switch or jumper links) that allows a user to manually alter a sensitivity of the passive motion detector 100. For example, a user may have the option of choosing a first setting with value "1", defining a higher sensitivity or a second setting with value "2", defining a lower sensitivity. It will be appreciated that any number of sensitivity settings may be provided as appropriate.

A default pulse count threshold may be based upon this manual sensitivity setting and the pulse count threshold generator 304 may modify the default pulse count threshold based upon the amplitude of the sensor signal as shown in the Table below.

Sensor Signal Amplitude	Default Pulse Count Threshold	Modified Pulse Count Threshold
High Amplitude	1	1
High Amplitude	2	2
Low Amplitude	1	2
Low Amplitude	2	3

In the example shown in the Table, the default pulse count threshold corresponds to the manual sensitivity setting at which the switch or jumper links are set to. That is, a sensitivity setting of "1" results in a default pulse count threshold of 1 pulse and a sensitivity setting of "2" results in a default pulse count threshold of 2 pulses.

The example shown in the Table uses one threshold to define two amplitude levels of the sensor signal, a "High Amplitude" and a "Low Amplitude". For a high amplitude sensor signal (i.e. a sensor signal that has an amplitude above the threshold amplitude), the modified pulse count threshold is not changed from the default pulse count threshold. However, for a low amplitude signal (i.e. a sensor signal that has an amplitude below the threshold amplitude), the modified pulse count threshold is one greater than the default pulse count threshold. The larger modified pulse count threshold means that an additional pulse is required before an alarm condition is generated for such low amplitude signals, which are more likely to correspond to a false alarm. In this way, a pulse count threshold may be determined based upon the amplitude of the sensor signal.

It will be appreciated that the above example is exemplary and that the pulse count threshold may be determined based upon the amplitude of the sensor signal in other ways. For example, whilst in the above Table, the default pulse count threshold is the same value as the sensitivity setting, it is possible that the default pulse count threshold has a value other the sensitivity setting. As described above, the default pulse count threshold may be based upon the sensitivity setting. That is, the default pulse count threshold may have a lower relative value when the sensitivity setting is high and a higher relative value when the sensitivity setting is low.

In addition, whilst the above Table shows that the modified pulse count threshold is an increase over the default pulse count threshold for low amplitude sensor signals, it is possible to have an arrangement whereby the default pulse count threshold is decreased for high amplitude sensor signals. Furthermore, whilst the above Table also shows that the default pulse count threshold remains unchanged for high amplitude sensor signals, in other arrangements, the default pulse count threshold may be modified for both amplitude conditions as appropriate.

It will be further appreciated that any number of amplitude thresholds and amplitude levels may be defined as appropriate.

The alarm condition generator 305 is operable to generate an alarm condition if the pulse count determined by the pulse counter 103 exceeds the determined pulse count threshold determined by the pulse count threshold generator 304. As the pulse count threshold is determined based upon the amplitude of the sensor signal, the alarm condition generator 305 generates an alarm condition based upon the pulse count and the amplitude of the sensor signal.

It will be appreciated that although the pulse count threshold generator 304 and the alarm condition generator 305 are shown as separate elements in Figure 3, in practice, the pulse count threshold generator 304 and the alarm condition generator 305 may be provided by a single processor or the like. For such embodiments, the pulse count threshold generator 304 may be considered to be a component of the alarm condition generator 305 similar to that of the embodiment shown in Figure 1 in which only an alarm condition generator 104 is depicted.

Referring now to Figure 4, a second method of generating an alarm condition based upon the pulse count and the amplitude of the received signal is described. Figure 4 is a schematic illustration of a passive motion detector 400 which is largely similar to the passive motion detector 100 of Figure 1. Elements of the passive motion detector 400 of Figure 4 which correspond to elements of the passive motion detector 100 of Figure 1 and which have been described above, have the same reference numerals and are not described in detail here.

Passive motion detector 400 differs from the passive motion detector 100 of Figure 1 in that it comprises an additional pulse count modifier 404 operable to modify a pulse count based upon the amplitude of the sensor signal. The alarm condition generator 405 is operable to generate an alarm condition if the modified pulse count exceeds a pre-determined threshold.

An exemplary modification scheme employed by the pulse count modifier 404 may be to increment the pulse count determined by pulse counter 403 by one if the amplitude of the sensor signal is low (i.e. a sensor signal that has an amplitude above a threshold amplitude) and to increment the pulse count by two if the amplitude of the sensor signal is high (i.e. a sensor signal that has an amplitude below the threshold amplitude). As a high amplitude signal is more likely to indicate the presence of an intruder, increasing the determined pulse count by a higher value may increase the likelihood of an alarm being triggered. As a low amplitude signal is less likely to indicate the presence of an intruder, incrementing the pulse count by a lower amount may reduce the likelihood of a false alarm.

In this way, the sensitivity of the passive motion detector 400 may be tuned to reduce the likelihood of the occurrence of a false alarm whilst maintaining detection efficiency. By including an additional pulse count modifier 404, existing alarm condition generators with fixed pulse count thresholds may be used without modification.

An exemplary pulse count modifier 404 may comprise two voltage comparators. One of the voltage comparators may have a first threshold voltage, whilst the other voltage comparator may have a second threshold voltage, the second threshold being lower than the first threshold. The sensor signal may be an input to both voltage comparators. The first and second threshold voltages define three amplitude levels, which may be referred to as low, medium and high amplitude levels respectively.

If the sensor signal is of low amplitude, none of the voltage comparators will output a signal as the amplitude is below both the low and high voltage thresholds. The pulse count therefore remains unchanged. If the sensor signal is of medium amplitude, only the low amplitude threshold voltage comparator will output a signal to increment the pulse count. The pulse count may then be incremented by one. If the sensor signal is of high amplitude, both the low amplitude threshold and high amplitude threshold voltage comparators will output a signal and thus the pulse count will be incremented by two.

As described above, the alarm condition generator 405 generates an alarm condition if the modified pulse count exceeds a pre-determined threshold. As the modified pulse count is modified based upon the amplitude of the sensor signal, an alarm condition is generated based upon the pulse count and the amplitude of the sensor signal.

It will be appreciated that although in the above examples, one threshold defining two amplitude~~s~~ levels and two thresholds defining three amplitude levels were described, any number of amplitude thresholds and amplitude levels may be defined as appropriate. In addition, it will be further appreciated that any modification scheme may be used that increments, decrements or leaves the pulse count unchanged, as appropriate, for each of the amplitude levels.

Referring back to the sensor signal output by the sensor 101, as described above, the sensor signal may be an electrical signal such as a voltage signal. The voltage signal output by the sensor 101 may be small, for example, in the microvolt range. The sensor signal may be amplified and filtered so that the sensor signal can be more easily processed. The pulse count signal may be generated based upon an amplified and filtered sensor signal. Amplifier circuits are commonly powered by low voltage, single rail DC power supplies, typically of 5V. With such an amplifier, an output voltage signal may be between 0V and 4V with a quiescent value of 2V.

The sensor signal may be amplified based upon a desired detection range of the sensor 101. The desired detection range may be the distance from the sensor 101 within which movement of an object (e.g. an intruder) generates an alarm condition. For example, a typical passive infrared sensor may have a desired detection range of ~~5~~ 15m. In order to detect intruders at the maximum range, the amplifier and filter circuit may be calibrated to amplify the sensor signal to have an amplitude of +/- 1V (i.e. 2V peak-peak). The amplified sensor signal is generally sinusoidal biased around the quiescent voltage. It will be appreciated that the polarity of the signal is arbitrary as the amplitude is measured as the modulus of the instantaneous amplitude minus the quiescent value.

It will also be appreciated that as the amplifier output is limited to its maximum output swing, any amplified signals with a theoretical magnitude of greater than +/- 2V would saturate the amplifier output resulting in signals clipped at, for example, the 0V and 4V limits. As is known in the art, the incident IR follows an inverse square law relationship between range and output voltage. That is to say, the amount of IR radiation incident on the sensing element 203 from an object is inversely proportional to the square of the distance between the object and the sensing element 203. Therefore, an amplified signal produced as a result of an intruder may be saturated throughout the majority of the coverage area, for example, within the field of view 201 with a range of 10m or less and may only start reducing for intruders beyond 10m. At the 15m range, the amplitude may have reduced to +/- 1V, which may just be sufficient to trigger an alarm condition. Beyond 15m, the amplitude may be less than +/- 1V and would not typically lead to an alarm activation.

A "high amplitude" signal in the 0m to 10m range may therefore have a greater probability of being produced by an intruder rather than a false alarm source and can therefore be processed with a lower pulse count threshold, as described above, in order to provide fast detection. A "lower amplitude" signal may be produced from an intruder between 10m and 15m, or could possibly be due to false alarm sources. The low amplitude signal may therefore be processed with a higher pulse count threshold, as described above, in order to improve false alarm immunity.

It will be appreciated that the above voltage values and ranges are exemplary only and the other values and ranges may be used as deemed appropriate by the person skilled in the art.

The passive motion detector 100 may further comprise a transmitter operable to transmit the alarm condition to a control panel of a security system. The control panel may, for example, trigger an audible alarm in response to receiving the alarm condition from the passive motion detector 100.

Whilst the passive motion detectors 100, 300, 400 of Figures 1, 3 and 4 have been described as being comprised of separate components, it will be appreciated that any combination of such components may be combined in a single device or the functions of such components may be performed by a single device such as a microcontroller.

For example, the sensor signal may be connected to an analogue to digital converter input on the microcontroller and the microcontroller may be configured to sample the sensor signal at specified time intervals and to analyse the amplitude of the sampled sensor signal. Based upon the amplitude of the sensor signal, the microcontroller may be configured to generate a pulse count threshold as described above.

The microcontroller may also receive the pulse signal from the pulse signal generator 102. The microcontroller may be further configured to determine a pulse count from the pulse signal in accordance with the operations of the pulse counter 103 described above. The microcontroller may compare the determined pulse count and pulse count threshold to generate an alarm condition if the pulse count exceeds the pulse count threshold.

Referring now to Figure 5, processing carried out to generate an alarm condition by the components of Figure 1 is described. At step S501, a sensor signal is received from the sensor 101. The received sensor signal may be the direct output from the sensor 101 or the received sensor signal may optionally be amplified and filtered, as described above.

At step S502, a pulse signal is generated by the pulse signal generator 102 based upon the received signal. At step S503, a pulse count of the pulse signal generated at step S502 is determined by the pulse counter 103.

At step S504, an alarm condition is generated by the alarm condition generator 104 based upon the pulse count determined at step S503 and the amplitude of the sensor signal received at step S501.

As described above, generating an alarm condition may be performed in various ways. For example, generating an alarm condition may further comprise determining a pulse count threshold based upon the amplitude of the sensor signal received at step S501 and generating an alarm condition if the pulse count determined at step S503 exceeds the determined pulse count threshold. Determining a pulse count threshold may be performed by a pulse count threshold generator 304, described above with reference to Figure 3.

In another example, generating an alarm condition may comprise modifying the pulse count determined at step S503 based upon the amplitude of the sensor signal received at step S501 and generating an alarm condition if the modified pulse count exceeds a pre-determined threshold. Modifying the pulse count may be performed by a pulse count modifier 404 as described above with reference to Figure 4.

In any of the above, where a signal is received and processed, it will be appreciated that the signal may be continuously monitored, monitored periodically at specified time intervals, or polled on demand as appropriate.

Whilst the present invention has been described in the context of a passive motion detector, it will be appreciated that alternative embodiments may comprise an active motion detector. For example, the active motion detector may be a microwave based motion detector or an ultrasonic based motion detector. In addition, embodiments of the invention may comprise an active motion detector and a passive motion detector. For example, the motion detector may comprise a passive infrared motion detector and a microwave based motion detector with an alarm condition being generated if both the active and passive motion detectors are triggered.

Although specific embodiments of the invention have been described above, it will be appreciated that various modifications can be made to the described embodiments without departing from the spirit and scope of the present invention. That is, the described embodiments are to be considered in all respects exemplary and non-limiting. In particular, where a particular form has been described for particular processing, it will be appreciated that such processing may be carried out in any suitable form arranged to provide suitable output.

CLAIMS

1. A method of generating an alarm condition for a motion detector, the method comprising:

    receiving a signal from a sensor, wherein the sensor is arranged to divide a field of view into a plurality of detection zones;

    generating a pulse signal based upon the received signal, a pulse being generated if the received signal is above an upper threshold above a quiescent value or below a lower threshold below a quiescent value;

    determining a pulse count of the pulse signal, the pulse count being indicative of a number of detection zone boundaries that have been triggered within a time period; and

    generating an alarm condition based upon the pulse count and additionally based upon the amplitude of the received signal,

    wherein generating an alarm condition comprises:

        modifying the pulse count based upon the amplitude of the received signal; and

        generating the alarm condition if the modified pulse count exceeds a pulse count threshold.

2. The method of claim 1 further comprising:

    amplifying the received signal.

3. A motion detector comprising:

    A sensor operable to output a sensor signal, wherein the sensor is arranged to divide a field of view into a plurality of detection zones;

a pulse signal generator operable to generate a pulse signal based upon the sensor signal, the pulse signal generator generating a pulse if the sensor signal is above an upper threshold above a quiescent value or below a lower threshold below a quiescent value;

a pulse counter operable to determine a pulse count of the pulse signal, the pulse count being indicative of a number of detection zone boundaries that have been triggered within a time period;

an alarm condition generator operable to generate an alarm condition based upon the pulse count and additionally based upon the amplitude of the sensor signal,

the motion detector further comprising:

a pulse count modifier operable to modify the pulse count based upon the amplitude of the sensor signal,

wherein the alarm condition generator is operable to generate an alarm condition if the modified pulse count exceeds a pulse count threshold.

4. The motion detector of claim 3, further comprising:

an amplifier operable to amplify the sensor signal.

5. The motion detector of claim 3 or claim 4, further comprising:

a transmitter operable to transmit the generated alarm condition to a control panel of a security system.

6. The motion detector of any one of claims 3 to 5, wherein the sensor comprises a sensing element and an optical element.

~~7. The motion detector of any one of claims 3 to 6, wherein the sensor is arranged to divide a field of view into a plurality of detection zones.~~