ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

Improvised PIR Sensor for Stationery and Motional Human Detection

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ABSTRACT:A cost effective and an efficient system to detect human presence in motion as well as in a stationery position. A 500BP Pyro Infrared Sensor is installed on the shaft of a tower pro SG90 Servomotor with their axes aligned. The motor is rotated 180 degrees clockwise and then 180 degrees anti-clockwise. This process keeps on repeating. As the motor's shaft rotates, so does the PIR sensor installed on it. This rotary movement of the sensor facilitates the detection of human beings in a standstill position. This method is cost-effective, efficient, and it overcomes the drawbacks present in using a PIR sensor only for motion detection. This system will prove to be very effective at high value places where the detection of a human being inside a room or even outdoors is very important.

KEYWORDS: Rotating Servomotor, PIR sensor, Human presence, Range of Sensing Elements.

I.INTRODUCTION

A PIR sensor is used for motion detection of human beings. This sensor consists of two sensing elements. When a human being passes through both the elements a signal is generated indicating the presence of a human being. Earlier versions of a PIR sensor had only one such element and hence the radiation generated by the sun was also being detected. This drawback was overcome using two sensing elements and reducing the range of wavelengths to be detected. A layer of Fresnel lenswhich consists of unprocessed silicon wafer or polyethylene covers the sensing elements. The radiation of human beings falls in the range which is detected by the sensor. But the cost of using two sensing elements was that stationery human detection was not possible. A human being had to pass through both the range of both elements in order to generate a signal. This drawback is overcome by rotating the sensor through 180 degrees clockwise and anti-clockwise. The result is that within the complete range of the sensor's radiation detection, a human being, whether he is standstill or moving, a signal will be generated by the sensor indicating the presence of a human being.

A servomotor is used to rotate the PIR sensor. Servomotors are easy to interface with a controller and are cheap. They are preferred when a controlled movement is desired. In this system a 180 degree movement was desired. Hence a servomotor was desirable.

The servomotor and the PIR sensor attached to it are both interfaced with a micro controller. This micro controller on a general purpose board is used to generate the appropriate pulses required for the rotation of the motor [1].

II.RELATED WORK

Detecting the presence of human can be done by different methods and techniques. One of the technique is using a PIR sensor to find the direction of movements by the concepts of polarization [5]. Another technique by using PIR sensors along with Symbolic Dynamic Filtering on seismic waves, from these seismic waves the features were extracted using SDF and checked if presence is of vehicle or animal/human. After classifying, it is further classified between human or animal along with their movement type (running, walking) [6]. There is a technique which focuses on use of PIR sensors to detect human beings. Once the result obtained, the features can be extracted using wavelet packet entropy (WPE), the features are classified using LS-SVM (Least Square-Support Vector Machine), which classified between human and nonhumans [7]. Detection of human beings is easy by detecting their movements with PIR sensor and by moving sensor we actually move human being according to sensor, so the detection of steady human being [4].

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III.APPARATUS

1) 500BP PIR Sensor Module: This sensor module is compact and one of the least expensive of all the PIR sensors.Its response time is sufficient for many applications. It has three wires- one is the supply, another is the ground wire and the third wire is the output signal wire which is used to send the signal whenever a human being is detected. It has two sensing elements each with a certain range within which if a radiating body is present, the body is detected. A signal is given by the sensor only when a body passes through both the sensing elements' range. The sensor is covered by a Fresnel lens to filter solar radiation and pass only 5-14 um IR emitted by human body.

2) Tower Pro SG90 servomotor: A small in size and light weight servomotor is used to rotate the PIR sensor. It is very easy to interface and control this motor. Appropriate pulses will set the servomotor into motion in whichever direction we want. Since the PIR sensor itself is very light in weight, the servomotor of higher ratings was not needed to rotate it. This servomotor consists of three wires- the first one is the supply wire, the second is the ground and the third is the control wire to sendappropriate pulses to the servomotor from the controller.

3) Atmega 16: This is the micro controller used to write the program to control the rotation of the servomotor with proper pulses. The micro controller is also interfaced with the PIR sensor to detect the presence of a human being. A general purpose board is used to connect the entire system. Port B is made output to control the motor. A high pulse is given to a LED which will glow whenever a human is detected by the PIR sensor.

IV.CONNECTION DIAGRAM

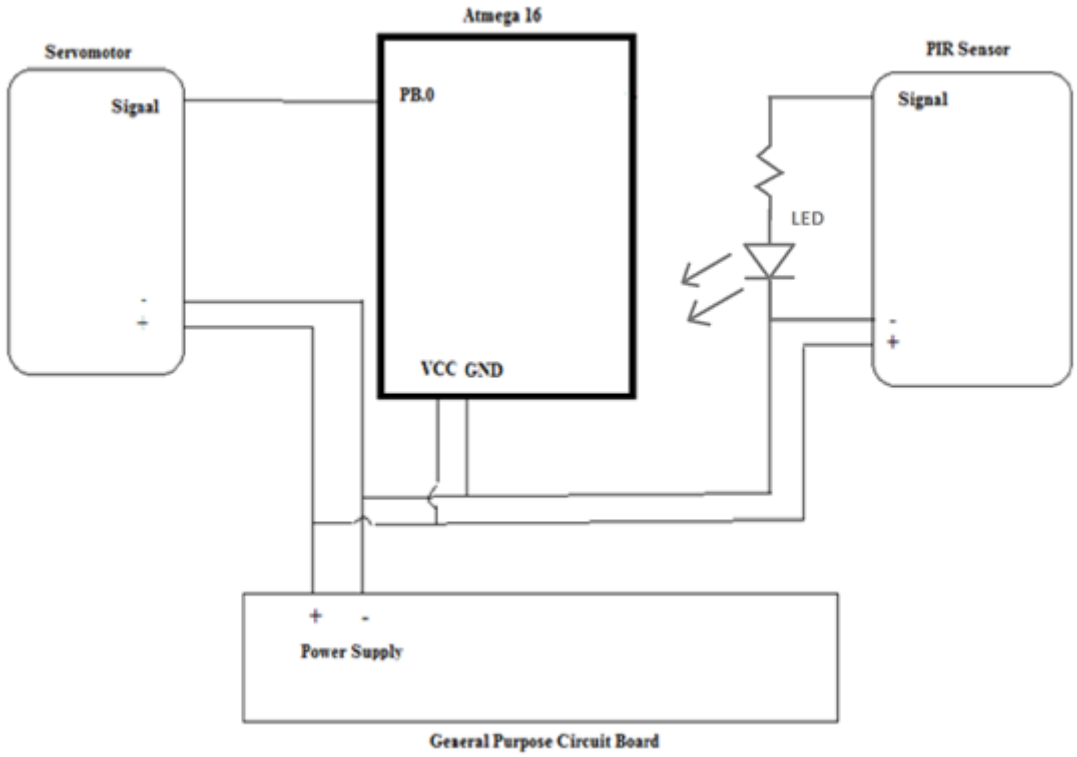

Fig. 1 Connection Diagram of sensor and motor interface with the controller

Fig. 1 shows the connections of the PIR sensor and the servomotor with the Atmega 16 micro controller. The port pin PB.0 is made output to control the servomotor and the supply to the servomotor and the micro controller is given

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through the general purpose circuit board[3]. The LED is used to get the signal for human detection[2]. This LED glows whenever a human being is detected. The supply to the sensor is given through the general purpose circuit board. The sensor can be connected to the microcontroller for any further use like generating an alarm when a human is detected.

V.WORKING AND METHODOLOGY

The PIR sensor is mounted on the shaft of the servomotor such that their axes are aligned. When the motor rotates, so does the sensor. The rotating sensor is tested for human detection in standstill position as well as in motion. In the program for rotating the servomotor, pulses of 0.5 microseconds and 2.5 microsecondsare provided for clockwise and anti-clockwise rotation respectively[1]. Since the micro controller does not do any other work, PWM is not needed. A software pulse and delay combination is used instead.

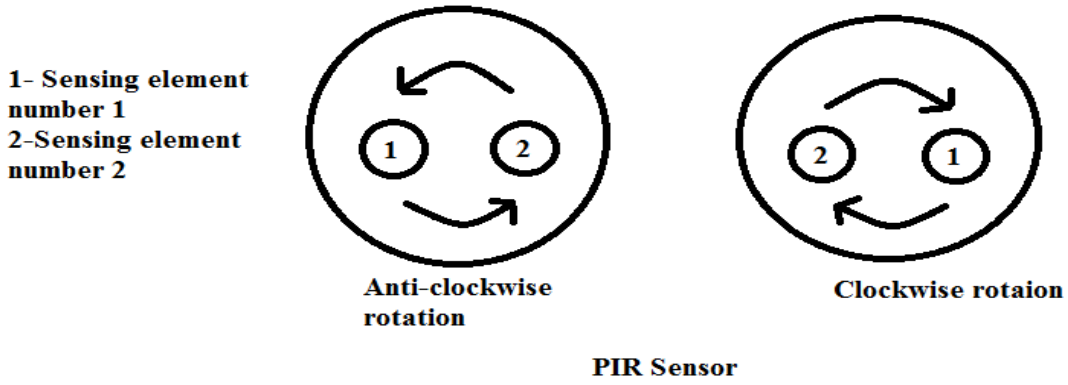

Fig.2 Position of the sensing elements of the PIR sensor.

The above figure clarifies the movement of the PIR sensor:
Number 1 and 2 are the two sensing elements of the PIR Sensor. When the sensor rotates through 180 degrees, the sensing element 1 assumes the position of the sensing element 2. Again as the sensor rotates through 180 degrees in the opposite direction, the sensor assumes it original position. This process is repeated again and again. This movement of the PIR sensor occurs due to the servomotor on which the sensor is mounted[4]. The reason for providing two sensing elements is that it should not detect unnecessary radiation like solar radiation. Also the sensor is made such that it detects only 5-14micrometer wavelength and the radiation of the human body is around 9 micro meter[4]

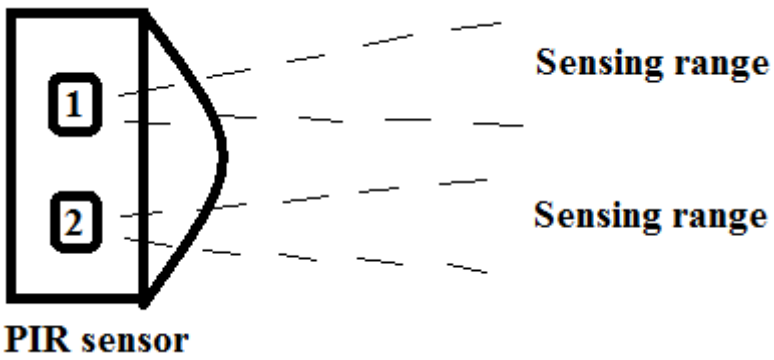

Fig.3 Range of the sensing elements.

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The above figure describes the range of the PIR sensor:
Sensing elements 1 and 2 have a certain range within which they detect radiation. Fig.2 shows the range of the sensing elements. If a body were to cross both these ranges, it would be detected in case of a stationery PIR sensor. But since the PIR sensor in this system rotates around its axis, according to sensor movement is happening even if the human is in steady state, so the human will be detected unconditionally.

VI. RESULT AND DISCUSSION

Fig. 1 shows the connection diagram of sensor and motor interface with the controller. PIR sensor is mounted on the servo motor, output of PIR sensor is connected to LED. As the sensor rotates according to Fig 2 and if a human being comes in a range of PIR sensor as shown in Fig 3, the presence of human being is detected and PIR sensor will send output signal which cause LED to glow indicating the human detection.
There are different conditions in which human can be detected, the following table shows some of its conditions,

.

Conditions for detection	Status
1) Human walking in the range of the sensing elements and crossing both the elements' range	Detected
2) Human walking in the range of the sensing elements and staying stationery within the range of the sensing elements	Detected
3) Human just entering the range of the sensing elements and only crosses the range of one of the elements	Detected

Table.1 Human detection for various states.

The above table shows the three basic conditions in which human detection is possible with rotating PIR sensor. These conditions are elaborated below.

Condition 1: Human walking in the range of the sensing elements and crossing both the elements' range:

When a person walks and passes through the range of both the sensing elements, the sensor sends a signal to indicate the presence of a human. This state is similar to the working of a PIR sensor which is not rotating around its axis. As the human passes through the range of the sensor, the relative motion between the human and the sensor's sensing elements generates a signal. As the sensor is rotating through 180 degrees, the human is detected by both the elements. This shows that a PIR sensor rotating around its axis works like a regular motion detector.

Condition 2: Human walking in the range of the sensing elements and staying stationery within the range of the sensing elements:

When a human walks in the range of the sensing elements he is detected by the PIR sensor. But when he stops walking and remains stationery, he is still detected. For as long as he stays in that state, the sensor sends the signal indicating the time for which the person was in the range of the sensing elements. There are two cases here- One while he was walking passes would pass both the elements' range and the other while he was walking would pass through a single element's range. If the sensor were stationery, the human would have been detected in only the first case. But as the sensor rotates, a relative motion is generated which leads in the person crossing the ranges of both the elements of the sensor.

Condition 3: Human just entering the range of the sensing elements and only crosses the range of one of the elements: When a human crosses only one sensing element, in a stationery PIR sensor, a signal of human detection is not generated. But when the sensor itself rotates and the human just comes within the range of only one of the element and stays there, the human is detected by both the elements.
It is also observed that solar radiation is not detected due to the motion of the sensor

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VII. DRAWBACK

PWM is not used to control the motion of the servomotor which is the better option. In any future applications, if the controller has to perform multiple functions, then PWM should be used. Since this is a prototype and the micro controller does not perform any other functions, a software delay was sufficient.

VIII. FUTURE PROSPECTS

This system is predicted to have tremendous applications in almost every industry and commercial projects. This system is suitable for applications like security of valuable items, keeping humans away from hazardous places etc. As it is compact and cost-effective, anyone will be able to install it. This system is also easy to interface with any existing system. This easy to interface nature makes it a very flexible and highly effective system.

IX.CONCLUSION

We can conclude that a rotating PIR sensor detects human radiation when a person comes in the range of the sensing elements regardless of its state. Be a person in motion or stationery, the sensor will give a signal indicating the presence of a human being. This is a cheap, simple and an efficient system to detect human beings which can have tremendous applications in various fields. The system being compact can be installed anywhere and effective in all environments.

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