Smart Home Security System

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Abstract— The Passive infrared (PIR) sensors have been employed for human detection, tracking, and identification due to their low cost, small size, and operation stability under varying temperatures. The existing systems employ the passive PIR sensor that uses dual elements to form a differential measurement, so that it can detect the thermal change of the environment (rather than the absolute temperature). This configuration enables it to detect the moving thermal source, but also limits its application for static targets. PIR based security system saves the power consumption and memory space of the recording systems has been proposed. PIR (passive infrared radiation) sensors detect the change in infrared radiations of warm blooded moving objects in its detection range. According to the change in infrared radiations there is a change in the voltage generated which is then amplified and triggers the alarm through relay. Pyroelectric sensors are low-cost, low-power small components commonly used only to trigger alarm in presence of humans or moving objects. However, the use of an array of pyroelectric sensors can lead to extraction of more features such as direction of movements, speed, number of people and other characteristics. In this work a low-cost pyroelectric infrared sensor based wireless network is set up to be used for tracking people motion. A novel technique is proposed to distinguish the direction of movement and the number of people passing. The approach has low computational requirements, therefore it is well-suited to limited-resources devices such as wireless nodes. Tests performed gave promising results.

Key words: Passive Infrared Sensor (PIR), Pyroelectric Infrared Radiation, Differential Measurement, Wireless Nodes

I. INTRODUCTION

Human situation recognition systems have attracted much attention due to their applications in healthcare, intelligent control, smart houses, etc. The situation understanding can be achieved by using the information of locations and motions of the subjects[1]. Generally, situation recognition is different from motion recognition. The latter focuses on the individual's motions, while situation recognition is more concerned about the scenario context such as the size of the group, locations and postures of human subjects, and so on.

Pyroelectric infrared (PIR) sensors have been employed for human detection, tracking, and identification due to their low cost, small size, and operation stability under varying temperatures. The existing systems employ the passive PIR sensor that uses dual elements to form a differential measurement, so that it can detect the thermal change of the environment (rather than the absolute temperature). This configuration enables it to detect the moving thermal source, but also limits its application for static targets. In daily lives, many ordinary scenarios involve static humans. During the process of indoor scenario perception, one or several human subjects may not generate any detectable motions within a certain period. For example, people are sitting or reading books. Therefore, it is necessary to develop active sensing for PIR sensors. Active PIR sensors can detect the static human subjects by moving the sensor or the mask (attached in the front of the sensor) to actively generate thermal changes.

Human detection and motion tracking have always gathered much attention in fields as surveillance, industrial applications and, in general, in smart environments. Conventional tracking techniques use cameras and process large amounts of data to extract features such as number of people, position and direction. Even if these solutions are accurate, they have high cost and require significant infrastructure. Pyroelectric Infrared (PIR) detectors take advantage of pyro electricity to detect a body not at thermal equilibrium with the surrounding environment these sensors are typically used in commercial applications to detect presence of individuals to trigger alarms. PIR sensors are also used in much more complex applications such as thermal imaging radiometry thermometers and biometry high-end video surveillance systems benefit from the integration of PIR detectors within the video system.

In PIR sensors are used to distinguish a still person from the background, while in a PIR based wireless sensor network enhances a tracking system by solving some points of failure such as change in direction or in background. Several other works explore the usage of PIR sensor arrays to track people movement. Four PIR detectors are used to develop a system able to detect the path of a single person moving in an area, while in Shankar et al. allow cost sensor cluster is used to extract velocity as well as the path of a single person. Also in array of PIR is used to detect the number of people moving through a gate. Here a mechanical chopper is used to temporarily obstruct the PIR Field of View (FOV) and each sensor just gives a presence/absence indication. The data from the sensors is processed by a PC.

II. LITERATURE SURVEY

E Kritzinger and SH von Solms *et.al*.[7] proposed a home user security from thick security oriented home users to thin security oriented home users, in which they whowed that how a regulatory body, for example, an Internet Service Provider (ISP), could be involved to take over the majority of cyber security responsibilities for the home (end) user. This would transform a user from being a thick security-oriented user to being a thin security-oriented end user. Jin-Hee Han and YongSung Jeon *et.al.* described specifically the various security requirements of the components that make up the smart home system [8].

Michael Schiefer *et.al*. introduces a smart home definition and security threats in which they were define Smart Home for ourselves and additionally provided a way to categorize the big mass of products into smaller groups [9]. Teddy Mantoro and Yosep Lazuardi *et.al.* proposed an approach on development of SMS based home appliance

security which securely used while the user is on move, away from their home. Firstly, the message was scramble using ROT13 and secondly it was encypted using RSA or RC4 algorithms. The length of the message after encryption process were compared along with the encryption and decryption time processing. Both aproaches show a satisfactory result based on the secure design specifications for the SMS based home security[10].Md. Azmi Bin Karnain and Zahriladha Bin Zakaria *et.al.* were provided a review on ZigBee networks technology and security requirements which were already embedded within the protocol. They additionally provide the essential data on the different threats and attacks in ZigBee networks technology. Finally, they investigate the three approaches used by different researchers to enhance the resilience of ZigBee networks in handling network attacks. It was believed that the information presented in this paper would benefit other researchers in enhancing the security level of ZigBee networks especially in supporting Smart Home application [11].

An intelligent surveillance with cloud storage for home security was provided by Dhiraj Sunehra and Ayesha Bano *et.al.* [12]. They presented the design and implementation of a home security system to detected an intruder at home when nobody was present. This low-cost security system uses a small Pyroelectric Infrared (PIR) module and a Infrared (IR) sensor, and is built around ARM7 microcontroller. Presence of individual is detected when the system senses the signal generated by many sensors. The system sent a message to the user through GSM modem after detecting the presence of unauthorized person. The user then monitors the intrusion from anywhere, on an Internet enabled device by using IP address of the installed IP webcam of mobile in home, and alerts the neighbors and police. The user could also save the images and record the videos, which could be stored in a public cloud for later use. Preparatory experiments had shown encouraging results.

Punit Gupta and Jasmeet Chhabra *et.al.* were proposed outcome of the project aimed as multiple benefits of saving on electricity bills of the home as well as keep the users updated about their home security with an option of controlling the switching of the devices by using their voice or simple toggle touch on their smartphone, and last but most importantly, monitor the usage in order to conserve the precious natural resources by reducing electrical energy consumption [13].

III. METHODOLOGY USED

A. Detailed Working of PIR

PIR (Passive Infrared Radial) The sensor is basically a pyroelectric device. When the device is exposed to infrared radiation, it generates an electric charge. The device is made of crystalline material. According to the change in the amount of infrared striking the element, there will be a change in the voltages generated, which is measured by an on-board amplifier. The infrared light explained here refers to the light radiating from all objects in its field of view.

The reason for not having a transmitter and receiver is that the device does not emit one, but only accepts the energy emitted from objects above absolute zero in the form of radiations. Thus the temperature will be different for a human working past a sensor, and that of a wall right in front of it. Thus the word "passive" is used in PIR to explain that it does not emit a radiation and receive it, but instead accepts the incoming infrared radiation passively. The block diagram and circuit diagram of the PIR based security system is given below.

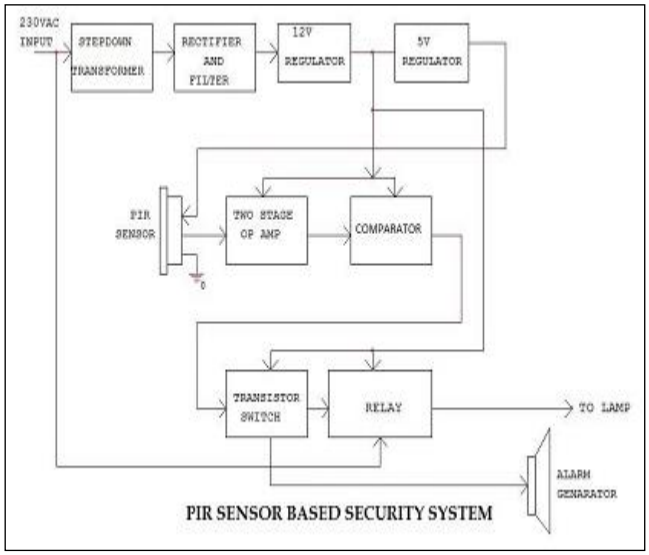

Fig. 1: PIR Sensor Circuit Diagram [1][3]

The below diagram shows working of PIR sensor the term PIR is the short form of the Passive Infra-Red. The term "passive" indicates that the sensor does not actively take part in the process, which means, it does not emit the referred IR signals itself, rather passively detects the infrared radiations coming from the human body in the surrounding area. The detected radiations are converted into an electrical charge, which is proportional to the detected level of the radiation. Then this charge is further improved by a built in FET and fed to the output pin of the device which becomes applicable to an external circuit for further triggering and amplification of the alarm stages. The PIR sensor range is up to 10 meters at an angle of +15o or -15o.The below image shows a typical pin configuration of the PIR sensor, which is quite simple to understand the pinouts; and, one may easily arrange them into a working circuit.

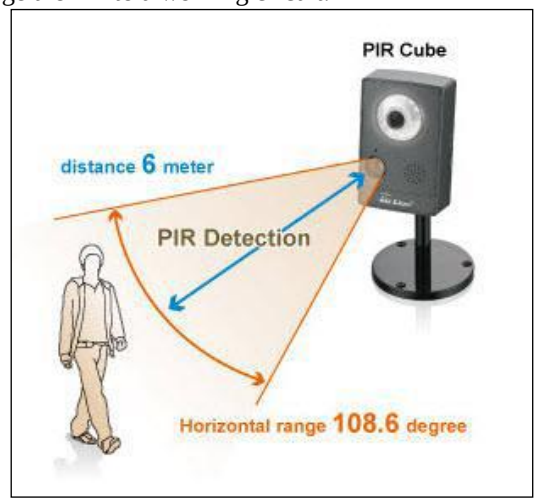

Fig. 2: Working of PIR Sensor[2]

B. Node MCU

Node MCU is an open source IoT Platform. It includes firmware which runs on the ESP8266 WiFi SOC from Espress if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the Eula project, and built on the Espress if Non-OS SDK for ESP8266. It uses many open source projects.

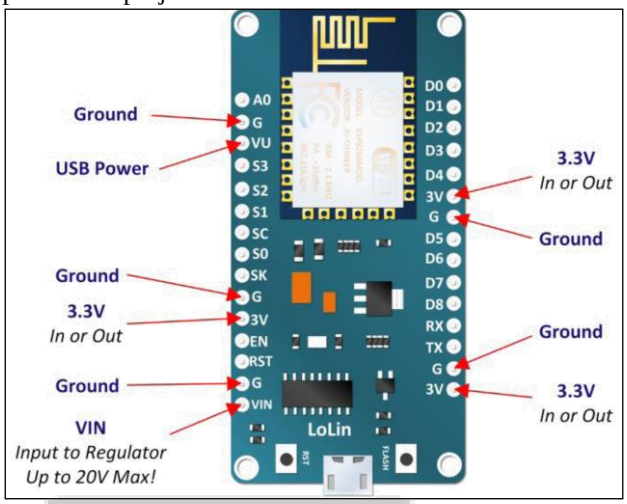

Fig. 3: Node MCU[4]

C. Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm, timers, and confirmation of user input such as a mouse click or keystroke.

Fig. 4: Buzzer

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

IV. WORKING OF A SYSTEM

When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. PIR sensor detects a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m.PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. For numerous projects or items that need to discover when an individual has left or entered the area. PIR sensors are incredible, they are flat control and minimal effort, have a wide lens range, and are simple to interface with PIR Sensor.

The PIR acts as a digital output so all you need to do is listening for the pin to flip high or low. The motion can be detected by checking for a high signal on a single I/O pin. Once the sensor warms up the output will remain low until there is motion, at which time the output will swing high for a couple of seconds, then return low. If motion continues the output will cycle in this manner until the sensors line of sight of still again. The PIR sensor needs a warm-up time with a specific end goal to capacity fittingly. This is because of the settling time included in studying nature's domain. This could be anyplace from 10-60 seconds. In presence of human IR radiations, the sensor detects the radiations and converts it directly to electrical pulses, which is fed to the inverter circuit. A PIR sensor can be used to detect presence of human beings in its proximity. The output can be used to device. PIR sensor detects the infrared light radiated by a warm object. It consists of pyro electric sensors which introduce changes in their temperature (due to incident infrared radiation) into electric signal. When infrared light strikes a crystal, it generates an electrical charge. Thus a PIR sensor can be used to detect presence of human beings within a detection area of approximately 14 meters.

The PIR acts as a digital output so all you need to do is operate the pin to flip high (detected) or low (not detected). Check out the images for more details. Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so check the pinout carefully! Power is usually 3-5v DC input. The circuit connections are made as follows:

- Vcc pin of the HC-SR501 is connected to +3v of the Node MCU.
- Output pin of the HC-SR501 is connected to Digital pin D7 of the Node MCU.
- GND pin of the HC-SR501 is connected to Ground pin (GND) of the Node MCU.
- We'll connect Anode pin of the LED to Digital pin D6 and Cathode pin to GND pin of Node MCU. After performing above steps we get below diagram as a result.

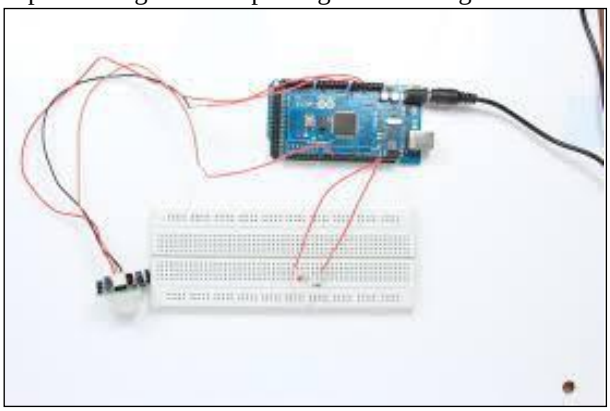

Fig. 5: Working of PIR Sensor with LED

After connecting all the equipment, we used this code in Arduino to implement it and use it in Node MCU.

```
sketch_apr06a§
int pirPin = 3;    //the digital pin connected to the PIR sensor's output
int ledPin = 13;

void setup(){
  Serial.begin(9600);
  pinMode(pirPin, INPUT);
  pinMode(ledPin, OUTPUT);
  digitalWrite(pirPin, LOW);

  //give the sensor some time to calibrate
  Serial.print("calibrating sensor ");
    for(int i = 0; i < calibrationTime; i++){
      Serial.print(".");
      delay(1000);
      }
    Serial.println(" done");
    Serial.println("SENSOR ACTIVE");
    delay(50);
  }

void loop(){

    if(digitalRead(pirPin) == HIGH){
      digitalWrite(ledPin, HIGH);   //the led visualizes the sensors output pin state
```

Fig. 6: Coding Snapshot

V. CONCLUSION

In this project, a PIR sensor based security system is proposed despite some delays taking place in recording the video captured, it was observed that the proposed system can save the memory space of the recording system as it starts recording when the webcam is turned ON. Also the power consumed by the lighting system at night can be reduced as the lighting system only gets turned ON only when PIR sensor gets activated. Both webcam and lighting system gets ON only when there is an intruder in the detection range of the PIR sensor.

VI. FUTURE SCOPE

In this PIR Sensor Based Security System, we have used low power, low cost PIR sensor that are easy to interface with other components. By using this system, we were able to reduce the power consumed and memory space of the system. Currently, we have used only one webcam in our project which could only capture the area facing to it. The system may not work if the intruders enter from other side. The software developed for the recording of the video captured by the webcam is experimented only with a webcam connected to the system also there was some delay in recording video captured by the webcam. Considering all above points, followings are our future works set to improve the system: Work on to reduce the delay time in recording the video captured by webcam. Use more than one webcam and integrating these webcams with the system. Work on the software to record videos from many webcams installed.

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