DESIGN AND IMPLEMENTATION OF ADVANCED SECURITY SYSTEM BASED ON ONE-TIME PASSWORD FOR HIGHLY SECURE ZONES

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ABSTRACT

Now-a-days the security becomes a major issue in all the facets of human life. Security and safety are the most considered objectives in today’s world. To secure the property against theft, crime, fire, etc. a powerful security system is required not only to detect but also pre-empt hazards. This project is aimed at developing an advanced security alert system to detect and allow only the authorized persons into a high security zone like the vital defense establishments, nuclear installations and power plants, or in any smart environments. When a sensor is triggered by unwanted action, it first asks for One-time password (OTP) which will be sent to the authorized person’s mobile numbers as preferred by the owner of this instrument.

Keywords: GSM Modem, IR Sensor, Magnetic Sensor, Microcontroller, PIR Sensor, Vibration Sensor.

1. INTRODUCTION

Security and safety is one of the most talked of topics in almost every facet like surveillance, industrial applications, offices, and in general, in smart environments. To secure it against theft, crime, fire, etc. a powerful security system is required not only to detect but also pre-empt hazards. Conventional security systems use cameras and process large amounts of data to extract features with high cost and hence require significant infrastructures. This Paper proposes a PIR sensor based low cost security system in addition to IR, Vibration and Magnetic sensor for security applications in which Passive Infrared (PIR) sensor has been implemented to sense the motion of human through the detection of infrared radiated from that human body. PIR device does not emit an infrared beam but passively accepts incoming infrared radiation. PIR sensor detects the presence of human in the home and generates pulse which is read by the microcontroller.

Today's indoor security systems built with various sensors such as ultrasonic detectors, microwave detectors, photoelectric detectors, infrared detectors etc. Each of these systems has its own limitations. As an example, photo-electric beam systems detect the presence of an intruder by
transmitting visible or infrared light beams across an area, where these beams maybe obstructed. But
the drawback lies within it if the intruder is aware of the presence of this system. Despite of having
strong dependence on surrounding environmental status, pyro-electricity has become a widely used
detection parameter because of simplicity and privilege of interfacing to the digital systems.

Now, it is extensively used for intruder detection, smart environment sensing, and power
management applications. Several works have been conducted in various applications. Intelligent
fireproof and theft-proof alarm system, GSM network based home safeguard system, human tracking
system and intruder detection systems are some notable works done previously based on pyroelectric
sensing technique [2]. Our work introduces a low-cost security system solution. Utilization of
existing cellular network to alert and inform the system owner about the security breach is made to
cope up with ever increasing demand for cheap but reliable security system [3].

PIR is basically made of Pyro-electric sensors to develop an electric signal in response to a
change in the incident thermal radiation. Every living body emits some low level radiations and the
hotter the body, the more is emitted radiation. When the warm body leaves the sensing area, the
reverse happens, whereby the sensor generates a negative differential change. Use of multi-sensor
data fusion and complex algorithm can be used to increase the effective FOV for larger spaces. In
order to enhance the location accuracy and to enhance the method of processing the PIR sensor
signal, use of more advanced techniques such as probabilistic theories. According to the pulse
received by microcontroller, a call is established to mobile station through a GSM modem and thus
warns the presence of human in the home to owner-occupier. On the other hand, this security system
remains in idle position and performs nothing if no one is in the home [1].

2. HARDWARE IMPLEMENTATION

![Fig 2.1: Block diagram of the proposed system](image-url)
2.1 IR Sensor

IR transmitter emits IR radiation using IR LEDs. The transmitter and receiver are operated on the line of sight. Here the design of the IR transmitter depends upon the receiver (TSOP sensor). IR receiver module requires the incoming data to be modulated at a particular frequency. It is also immune to ambient IR light, so one can easily use these sensors in outdoors. IR receivers are available for different carrier frequencies from 32 kHz to 42 kHz. Mostly available TSOP’s in the market are with a carrier frequency 38 kHz. Here in this project we used the TSOP with 38 kHz (TSOP 1738). In the number TSOP 1738 last two digits indicates the carrier frequency [7].

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Table 2.1: Available types of different TSOP carrier frequencies

For such IR receiving sensor (TSOP), at the transmitter side we need to modulate the message signal with a carrier frequency. The Astable-multivibrator built around the popular IC 555 generates output pulses with a frequency of 38 KHz. In this application we generated a 38 kHz rectangular wave as a carrier and 1 kHz rectangular wave as a message (with a duty cycle less than 50% i.e., less TON period than TOFF period of the signal).

2.1.1 Generation of 38 kHz signal using 555 Timer

To generate 38 kHz rectangular wave, we need to operate the 555 timer in astable mode. Frequency of oscillation of 555 timer in astable mode is given as,
TON = 0.693*(RA+RB)*C = 21.83usec ....(1)

TOFF = 0.693*RB*C = 1.04usec ....(2)

Frequency of output =f0=1/T=1/(TON+TOFF)=1/0.693(RA+2RB)C ....(3)

To get fo = 38KHz, assume RB = 1KΩ, C = 1.5nF (always assume a fixed value capacitor because variable capacitor is difficult to find). Substitute these values in the equation (3), we get,

RA = 17.32KΩ.

Practically, these resistor values may not generate exact 38 kHz signal. Hence for RA we use a POT (potentiometer or variable resistor). Use an oscilloscope to observe the signal at output pin3. Adjust the POT (variable resistor) until the signal at output is a 38 kHz.

2.1.2 Design of IR Receiver

The TSOP17xx Series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal can directly be decoded by a microprocessor. TSOP17xx is the standard IR remote control receiver series, supporting all major transmission codes.

When a disturbance signal is applied to the TSOP1738 it can still receive the data signal. However the sensitivity is reduced to that level that no unexpected pulses will occur. Some examples for such disturbance signals which are suppressed by the TSOP1738 are:

- DC light (e.g. from tungsten bulb or sunlight)
- Continuous signal at 38kHz or at any other frequency
- Signals from fluorescent lamps with electronic ballast.

2.2 Magnetic sensor

![Magnetic Reed sensor diagram](image)

Fig 2.3: a) Magnetic Reed sensor   b) Working principle of magnetic Reed sensor

A permanent magnet and magnetic reed sensor are used as Magnetic Sensor. In magnetic reed sensor, there will be a two reed blades and gap between them. Inert gas is filled in the glass capsule as shown in fig 2.3(a). There will be a contact gap between two reed blades. We can use magnetic sensor in DC load or AC load. We are using a +5V DC regulated supply in our project, so we go for magnetic sensor in DC load.
Magnetic reed sensors are actuated by the presence of a permanent magnet. They detect changes or disturbances in magnetic fields that have been created or modified by objects or events. Due to the presence of a permanent magnetic bar near the magnetic reed sensor, the current passes through the reed sensor. When the permanent magnetic bar is kept away from the magnetic reed sensor then no current passes through the reed sensor as shown in fig 2.3(b). The performance of this magnetic sensor is steady and easy to weld.

2.3 Vibration sensor

The piezo-electric property is a reversible phenomenon. Whenever an electric excitation (voltage) is applied across the opposite faces of a quartz crystal, it starts to vibrate and hence produces mechanical oscillations. Whenever mechanical vibrations are applied to the crystal, it produces electric potential across opposite faces of the crystal. Thus a crystal can be used for the construction of vibration sensor. The frequency of oscillations depends on the physical size and the shape of the crystal. Generally, smaller dimensions of crystals produce higher frequencies and bigger crystals produce lower frequencies.

The mechanical vibrations are applied to a thin diaphragm. The diaphragm vibrates in accordance with the applied mechanical vibrations and applies pressure to the crystal. The crystal generates a voltage in accordance with the vibrations. These voltages are of very low amplitude. Hence these signals are fed to an op-amp amplifier. The amplified signals are fed to a monostable multivibrator for producing pulses of fixed duration. The microcontroller routinely checks the outputs of the monostable multivibrator.

![Vibration sensor circuit diagram](image.png)

**Fig 2.4: Design vibration sensor circuit**

When the piezo element is disturbed, it discharges the stored charge. This alters the voltage the voltage level at the inputs and the output momentarily swings high as indicated by led. This high output is used to trigger switching transistor T1, which triggers monostable multivibrator built using NE555 IC. The circuit is as shown in fig 2.4.
2.4 PIR sensor

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors [5].

![PIR Sensor module](image1)

![Circuit Diagram](image2)

**Fig 2.5: a) PIR Sensor module  b) Circuit Diagram to use PIR sensor.**

PIRs are basically made of a pyroelectric sensor (which you can see above as the round metal can with a rectangular crystal in the center) as shown in fig 2.5(a) which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low [6].

When warm bodies like a human or animal passes by the sensor, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These changes in pulses are what it detects [2]. The circuit is shown in fig 2.5(b).

3. RESULTS & DISCUSSION

In this project we have designed the power supply unit, IR transmitter and receiver, vibration sensor circuit. And with the available sensor parts we have implemented PIR and magnetic sensors. Fig 3.1 shows the practical output of power supply unit of 5V, 1A DC circuit is designed using transformer, rectifier (Bridge mode), capacitor filter and 7805 voltage regulator.
IR Transmitters and receivers are implemented in the line of sight, such that if there is any interruption of the invisible IR beam then it will trigger the microcontroller for necessary action. Fig 3.2 shows the working of IR transmitter and receiver. In this circuit we have designed IR sensor.

For IR sensor:
- Input: 9Volts for Transmitter
  5Volts for Receiver
- Output: High (5V) - when there is interruption on the IR beam.
  Low (0V) - when there is no interruption on the IR beam.

PIR sensor is installed inside the room, if any living being enters the room then the room temperature get changes slightly, in turn the PIR sensor will detect the change in IR radiation level or change in Room temperature, Because we know that every living bodies emits IR radiations in the form of heat. Once PIR sensor activated it then triggers the controller. Fig 3.3(a) and Fig 3.3(b) shows the practical implementation of PIR sensor.

For PIR sensor:
- Input: 5Volts
- Output: High (5V) - When there is change in temperature due to the presence of any living body
  Low (0V) - When there is a constant temperature inside the room.
Similar to PIR and IR we implemented Magnetic and Vibration sensors, whose results are as follows,

For Magnetic sensor:
- **Input**: 5Volts
- **Output**: High (5V) - When magnetic bar is in contact with reed Switch.
  - Low (0V) - When magnetic bar is not in contact with reed Switch.

For Vibration sensor:
- **Input**: 9 Volts
- **Output**: High (5V) – When doors or windows have been knocked (vibrations generated).
  - Low (0V) - When Magnetic bar is not in contact with reed Switch.

The overall project model has been implemented by assembling all the sensor units, keypad, buzzer, GSM modem and LCD etc. The software development of this complete project model is based on Round Robin principle, because the controller will test for the sensors status in the main loop, if any sensor gets activated then controller will display the sensor type on the LCD display as shown in fig 3.3(b). Then immediately it will send One-Time Password(OTP) to the authorized number.
Once the OTP is sent to authorized number the controller will ask for the OTP password as shown in fig 3.4(a), if the entered password is correct then the intruder is allowed into the premises as shown in fig 3.4(b).

If the entered password is wrong then the buzzer starts beeping, at the same time controller will send an alert SMS to the authorized number as shown in fig 3.5. The SMS includes the active sensor name with security alert.

![Image](image-url)

Fig 3.5: Access denied if invalid password entered

4. CONCLUSION & FUTURE SCOPE

In this paper we have discussed about developing an advanced security with the 3 levels of detection and security. This security system is implemented in a way that if an intruder overcomes the IR sensor at the first stage (i.e gate level), then he/she may be caught at the second stage of security (at the door or windows) where vibration and magnetic sensors are being implemented. Even if an intruder overcomes the second level of security then he/she will definitely be caught at third stage of security, because at this stage a smart PIR sensor is being installed. The PIR sensor detects the temperature change in the room by collecting IR radiations which are being emitted from the living bodies. As we know that every living bodies emits IR radiation in the form of heat. So PIR sensor is more important security part in our project because it plays dual role as 1. Motion sensor. 2. Fire sensor.

The main advantage is low cast, low power and pretty rugged and high security with several levels of detection. Conventional security systems were using high cost cameras and less secure sensors like IR, LASER etc. and implementation cost was more.

The future scope of this paper is to enhance security is to use Auto-Dial MMS security and to implement automatic door locking systems.

5. REFERENCES


[7]. “The 8051 microcontroller and the embedded system design” by Mazidi and Mazidi.
