Hotel Room Remote Monitoring System

Mini-Project Report submitted in partial fulfillment of

the requirements for the Sem-6 of

Bachelor of Engineering

In

Information Technology

Under the guidance of

Prof. Prasad Padalkar

By

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Affiliated to University of Mumbai

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<u>DECLARATION</u>

This is to certify that Mini-Project Report entitled **'Hotel Room Remote Monitoring System'** submitted by us in the Semester 6 for the degree of **BACHELOR OF ENGINEERING in 'INFORMATION TECHNOLOGY'** to University of Mumbai comprises only our original work and due acknowledgement has been made in the text to all other material used.

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Kevin Dsouza:

Disha Sanil:

Approved by :

Prof. Prasad Padalkar
Internal Guide

Don Bosco Institute of Technology

Kurla, Mumbai.

<u>CERTIFICATE</u>

This is to certify that Project Report titled **'Hotel Room Remote Monitoring System'** submitted in partial fulfillment for the degree of **BACHELOR OF ENGINEERING in 'INFORMATION TECHNOLOGY'** to
University of Mumbai is a record of the candidates own work carried out by them under our supervision. The matter embodied in this report is original and has not been submitted for the award of any other degrees.

Date :

Project Team Members:

Roll No	Names
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Acknowledgement

Table of Contents

List of Figures

List of Tables

Abstract--Occupancy sensors such as PIR (Passive Infrared) have been in use since the late 1970's and were first applied in office spaces automatic sensing and lighting. Throughout that time the popularity of detection sensor (PIR, Door Contact, Ultrasonic) has only seen an unimpeded ascend. As people get to know more and imbibe this technology into their daily lives, it is not surprising that the intelligence sensing of occupancy of hotel rooms is becoming a market pleaser and can positively impacting a customer's opinion about a hotel. Industries such as Building Automation, Cost Management, Automobile automation and security have been the greatest users of these occupancy sensors. The Indian demand for occupancy sensors is estimated at approximately $500 million and is expected to expedite at a rate of approximately 20% across the next 5 years and therefore double by the year 2026. PIR sensors are the most popular type of sensors used in hospitality service, and ubiquitously too. In this project, we present an empirical study of human presence detection and alert using one PIR sensor in each room of the hotel. We have planned to deploy a single radial PIR sensor in the geometric center every room in the hotel. With the advancement of sensor and actuator technologies, indoor (and affinity) sensing and identifications is one of the cardinal technologies we use for providing activity-cognizant service, therefore, creating a 'smart' environment. A 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 the crystal, it generates an electrical charge. Thus, a PIR sensor can be used to detect presence of human beings within a range (adjustable using sensitivity screws) of 10-12 m. After sensing the PIR can have any operation i.e, turn on/off light, send alerts, turn on shower.

Keywords: Occupancy sensors, Passive Infrared sensor, industries, Indian demand, 2026, human movement detection; hospitality, activity-cognizant, 10-12m;

1. Introduction

A Pyroelectric Infrared (PIR) Sensor is an occupancy/heat sensing device that can sense infrared (IR) radiation changes within its set range. In layman terms, these sensors are sensitive to moving objects radiating IR light. A PIR sensor creates temporary electric potential whenever a change of IR radiation occurs on the viewing range of the sensor. The charge generated is miniscule in nature and won't be of any use unless amplified. Therefore, the charge generated must be amplified significantly using an amplifier. That is because PIR sensors cannot be deployed as stand-alone sensors, instead they become one of the cardinal components of a Passive Infrared Device (PID) where additional components are integrated along. The basic

structure of a PID contains four main structures: A Fresnel lens, a PIR sensor, an amplifier circuitry and the power supply with the transformer.

Movement detection and human presence using a PIR sensor can be used for numerous applications like home, hotel, mall, car security. This system though designed for hospitality can basically be used at any place where security related to motion presence is required. Security is needed by everyone in today's modular and burgeoning world by all people to protect their personal or confidential property, information from unauthorized and unwarranted access. In this project we are striving to integrate the hotel booking system with the PIR sensor security system in each room. The PIDs are low-cost, easy to use and widely available commercially. These practical features made them used in many indoor and outdoor applications including this security system. If any booking is done legitimately through the booking system, the PIR System in each room is switched off and the customer can enjoy an unmonitored and uninterrupted stay. But, if any booking is not done legitimately via the booking system, then the PIR Sensor system in each room remains active. Therefore, if anyone enters the room, the owner will receive a SMS. Each PIR sensor has an 1 hour window for the house-keeping and room service staff. The PIR is used along a Fresnel Lens, which increases the range of accessibility of the infrared radiation from the sensor.

Occupancy Sensing Systems (OSS) can also improve the guest experience and loyalty. Cost savings, Energy optimization, reduced maintenance and an amazing guest-delight sure does sounds like facile task. The reality is that if not strategically deployed, occupancy and energy management can often lead to a unsatisfactory guest experience. In order to properly execute the OSS strategy, it is necessary to create a plan of execution that considers the accuracy of the occupied and unoccupied hotel rooms data as a primary objective in order to enhance, not deteriorate, the comprehensive guest satisfaction.

Given the broadness and depth of the field, the scope of this survey is restricted to use of sensor systems for hospitality management and alerts. Here, we try to provide a cheap and easy-to-use solution for remote monitoring of hotel room. The rest of this paper will be organized as follows. In Section 2, we provide a Review of Literature , Section 3 we discuss our Problem Statement, in

Section 4 we discuss the Scope, in Section 5 we discuss our Proposed System and objectives, in Section 6 we discuss the Hardware and Software required,, in Section 7 we form a Conclusion of the system and try discovering Future Scope, in Section 8 the Reference Research Papers and finally in Section 9 we give a Plagiarism Report.
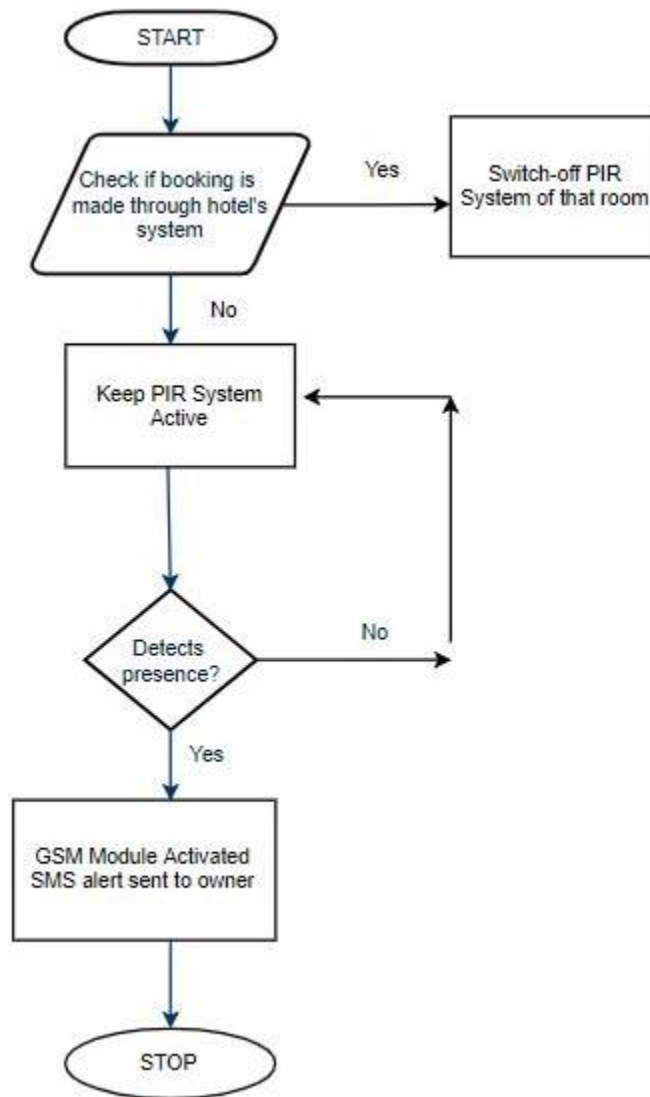
```
                    ┌─────────────┐
                    │    START    │
                    └─────────────┘
                           │
                           ▼
        ┌──────────────────────┐         ┌──────────────────┐
        │ Check if booking is  │  Yes    │  Switch-off PIR  │
        │ made through hotel's │────────▶│ System of that   │
        │       system         │         │      room        │
        └──────────────────────┘         └──────────────────┘
                           │ No
                           ▼
              ┌──────────────────────┐
              │  Keep PIR System     │◀──────────────┐
              │      Active          │               │
              └──────────────────────┘               │
                           │                          │
                           ▼                          │
                      ╱         ╲                     │
                    ╱   Detects   ╲       No          │
                   ╲   presence?   ╱ ───────────────▶ ┘
                     ╲           ╱
                           │ Yes
                           ▼
              ┌──────────────────────┐
              │ GSM Module Activated │
              │ SMS alert sent to    │
              │       owner          │
              └──────────────────────┘
                           │
                           ▼
                    ┌─────────────┐
                    │    STOP     │
                    └─────────────┘
```

Figure 1.1 Flowchart explanation of the system

2. Review of Literature

Definition: A literature review or narrative review is a type of review article. A literature review is a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and do not report new or original experimental work.

A literature review may consist of simply a summary of key sources, but in the social sciences, a literature review usually has an organizational pattern and combines both summary and synthesis, often within specific conceptual categories. A summary is a recap of the important information of the source, but a synthesis is a reorganization, or a reshuffling of that information in a way that informs how you are planning to investigate a research problem. The analytical features of a literature review might:

- Give a new interpretation of old material or combine new with old interpretations,
- Trace the intellectual progression of the field, including major debates,
- Depending on the situation, evaluate the sources and advise the reader on the most pertinent or relevant research, or
- Usually in the conclusion of a literature review, identify where gaps exist in how aproblem has been researched to date.

2.1 Existing Systems

Before we can finally delve into our survey of human-sensing approaches but first must take a moment to make a few clarifications.

i) Clarification 1: Our goal in this section is to introduce, organize and review the existing systems similar to our systems, rather than to detail the exact algorithms that those systems employ. This is because common trends in the algorithmics of the reviewed solutions are currently rather limited across different sensing modalities.

ii) Clarification 2: The second clarification we must make is that since the authors of the solutions reviewed in this section often do not agree on common performance metrics or even experimental scenarios, we are forced to compare different approaches in rather qualitative terms. Thus, we use words such as "accuracy" and "precision" loosely to denote a measure of the average error and a measure of classification correctness

2.1.1 Inertial Sensors:

The process of inferring the path of a moving body from its inertial measurements (such as speed or acceleration) is known as dead-reckoning. The sensors that are most widely used for this

purpose are inertial measurement units (IMUs) containing accelerometers (acceleration sensors), gyroscopes (angular velocity sensors), and/or magnetometers (magnetic field sensors, used as a compass). The premise of dead-reckoning is that if a person's location at time t is known, then their location at t + δt can be found by simply integrating their known velocity, or

twice-integrating their acceleration, during the time interval δt. However, a number of sources of error accumulate during this integration, causing the location estimate to quickly diverge, often within a few seconds. The most prominent sources of error in dead-reckoning are calibration errors, quantization errors, and the effect of gravity on the accelerometer, the effect of external magnetic fields and metals on the compass.

2.1.2 PIR Sensor-Based Applications in Smart Environments:

PIR sensors are commonly integrated with a variety of other sensors in diverse applications for fabricating smart environments, security and privacy of houses, building and malls, automobile automation and various other commercial uses. Han *et al* presented a paper indoor occupancy sensing and detection methods based on a various type of sensors, including PIR sensors, CO2 sensors, Heat Sensor, ultrasonic sensors, pressure sensors. Tsai et al. illustrated a way of reducing the unused power consumption of lighting devices based on a PIR sensor, an automatic light sensor to optimize on time for the lights. Erickson et al. implemented a power-efficiency occupancy-based energy management system based on camera-based system integrated with PIR sensor and fashioning a HVAC system and increasing energy efficiency. This capability and diverse range of applications and domains gave us the motivation and ebullience to work and research on this topic of ours.

2.1.3 Human-Tracking systems using pyroelectric infrared detectors:

They design and develop a low-cost pyroelectric detector-based IR motion-tracking system. They study the characteristics of the detector and the Fresnel lenses that are used to modulate the visibility of the detectors. They build sensor clusters in different configurations and demonstrate their use for human motion tracking

2.1.4 Smart Surveillance System Using PIR Sensor Network and GSM

System surveillance is most important security systems in houses, hotels, malls and buildings. This security system is based on an integrated system along with GSM and sensor networks. The human movement is detected using the PIR sensors. In this time, the system triggers an alarm detecting the presence of person in a specific interval of time and parallelly sends the how many people were intruders using alert SMS via the GSM system used. When the PIR system detects a presence, it is activated and it in turn activates the CCTV camera. This is a quick response approach and has a very low computational requirement. Therefore, it is well suited for home surveillance system.

2.1.5 Real Time Intruder Detection Using Passive Infrared Sensors

In this paper, a PIR based security system which provides the power efficiency and saves the memory space of the recording system has been explained. Passive Infrared Radiation (PIR) is aware of the temperature of an empty room and an occupied room. Therefore, when a room is occupied the sensor understands the difference in temperature and produces different voltage. These voltages will be amplifying and used to activate/deactivate the webcam. When an intruder comes in the visibility range of the PIR sensor, it actuates the lighting system and the webcam. The software detects the webcam connection; it will activate the recording and save the video. Once the intruder leaves the range, the webcam along with the light is turned OFF. The software repeats the process. Thus, providing security and privacy along with efficient usage of energy.

2. 2 Comparison Chart

1	PARAMETERS	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 4	OUR SYSTEM
2	ILLUMINATION SENSING	YES	YES	YES	YES	NO
3	SPEED SENSING	YES(algorithm)	NO	NO	NO	NO
4	PRESENCE SENSING	YES	NO	NO	NO	YES
5	HEAT SENSOR	YES	NO	NO	NO	YES (PIR)
6	CO2 SENSOR	YES	NO	YES	NO	NO
7	LOCATION	YES	NO	NO	YES	YES(algorithm)
8	COUNT	YES	NO	YES(algorithm)	NO	NO
9	PRESSURE SENSING BEDS	NO	YES	NO	NO	NO
10	PRESSURE SENSING TILES	NO	YES	NO	NO	NO
11	ULTRASONIC SENSOR	YES	NO	NO	YES	NO

Table I: Comparison with other existing systems.

sensing modalities	signaling	presence	count	location	track	identity	ND
Uninstrumented							
Motion Sensors	either	o	·	·	·		2
Pressure Sensors	passive	◯	o	o	o	·	4
EF Sensors	active	◯	o	o	o		4
Vibration Sensors	passive	o	·	·	·	·	1
Scanning Range-Finders	active	o	o	◯	o	·	0
Doppler-Shift Sensors	active	o	o	o	o	·	0
General SDNs	active	◯	o	o	o		6
Camera SDNs	passive	◯	◯	◯	◯		4
Cameras	either	◯	◯	◯	◯	o	0
Thermal Imagers	passive	◯	◯	◯	o	·	0
Inertial Sensors	passive	o	·	·	·		3
Chemosensors	passive	·	—	—	—	—	?
Instrumented							
Wearable SS Device-to-Device Rangers	either	◯	◯	·	◯	◯	2
Wearable AA Device-to-Device Rangers	active	◯	◯	o	◯	◯	2
Wearable TOA/TDOA Dev.-to-Dev. Rang.	active	◯	◯	◯	◯	◯	2
Wearable Doppler-Shift Sensors	active	◯	◯	o	◯	◯	2
Wearable Environment Recognition	passive	⚡	⚡	⚡	⚡	⚡	×
Wearable Inertial Sensors	passive	⚡	⚡	⚡	⚡	⚡	×

◯ = good performance   o = medium performance   · = low performance
— = plausible, but no detailed literature   ? = unknown
⚡ = requires communications (i.e. depends on the addition of a radio)
× = does not apply since this solution is area-independent

Table II. Summary of the capabilities of each sensing modality

2.3 Need of The Proposed System

2.3.1 Commercial Use (Primary Use)

The main application of this system is for Hospitality Management. We are using this system in hotel chains where the owner cannot be physically present at all the times and cannot rely on the manager of the hotel. We can use this project in banks as well as other business organizations, since it has a sensor detector to detect any misconduct of persons in any premises and domains. And, most importantly the alert to be sent on the mobile is flexible and can be changed in a few minutes.

Figure 2.3.1. An example of pir sensor in a hotel room

2.3.2 Remote Indication

With the use of GSM technology owner of the house or industry get remote indication through SMS. So even if the user is away from home or industry, he/she will be informed of the presence of anyone within the house.

Figure 2.3.2. Detection of Human presence

2.3.3 Automation Use

The system is fully automated. So once this system is installed inside home or industry, then it does not require any human interaction to operate.

2.3.4 Security Use

This project has its main application in security system. This project can be used in houses and cars as GSM based domestic security system. It can be used in our house for theft detection at night time. It can also be used for farm monitoring and automatic animal prevention.
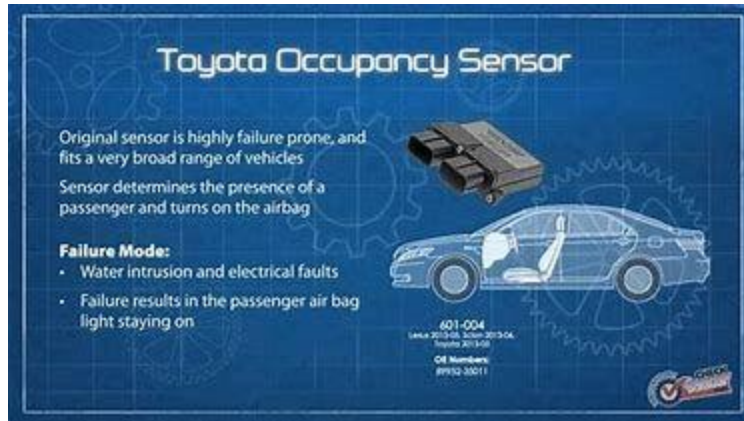
Figure 2.3.3. Toyota occupancy sensor

Various parameters monitored in this project like theft detection and are also applicable for industrial purpose as well. So this system can also be used in industries as a GSM based industrial security system.
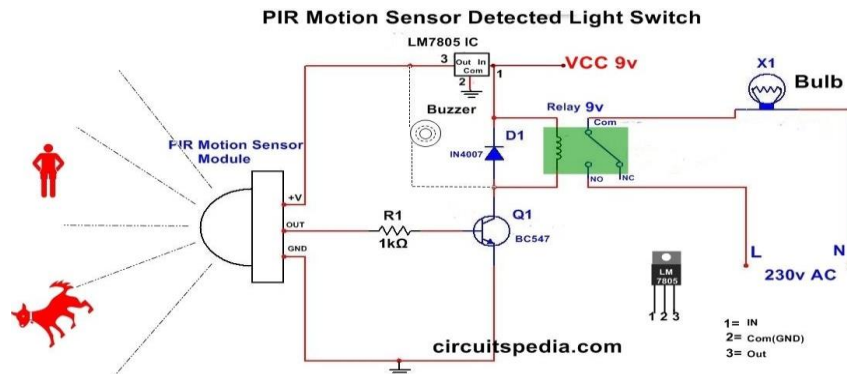
Figure 2.3.4: Use of PIR for auto Lighting in offices.

3. Problem Statement

The problem that this project aims to solve is resolving corruption in local hotel chains and providing cost-efficiency and energy-efficiency. Many hotel owners have not one but a chain of 2-3 hotels. So it is practically impossible for the owner to be physically present at all hotels. Some of the managers can take advantage of this fact and lend the room to someone for a lower price (cash transaction) and not bill it. In this transaction, all the money exchanged goes directly

into the manager's pocket. sometime. Therefore, we try to make a room occupancy detection system, to notify the owner if an un-booked room is occupied. So, the issues we aim at solving are:

 I) Corrupt managers

 II) Wastage of Energy and Loss of Money.

III) Improving customer satisfaction and uninterrupted stay.

Figure 3.1 Pictorial representation of the Problem statement

4. Scope

This work was highlighted into **Three** main objectives as follows:

I. Develop a system that is capable to identify an unauthorized guest and send information to hotel owner regarding the stay of an unauthorized guest at his hotel.

II. The necessities of the hotel security system should have low cost, easy installation, fast response, and low power consumption and a better way of security.

III. To improve hotel security systems and eliminate the degree of dependency of the owner on the individual hotel manager for handling the hotel chores/errands.

This system is aimed toward all the average hotel owners who wish to secure their hotel with a sensor that can be used to detect the presence of an unauthorized guest.

This reduces huge business losses, ensure corruption-free system.

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5. Proposed System

Our proposed system uses the concept of alert based human motion detection which is used to provide security along with provision of energy and cost efficiency for the owner. This is an automatic system and thus reduces man power and is considerably cheap. As we know human and animal bodies radiate heat energy in the form of Infrared radiations. This PIR sensor detects the human presence and movement by the change in the IR levels of surroundings and it sends a signal to the microcontroller.

The PIR sensor is aware of the temperature of the empty room in the hotel and an occupied room. Therefore, if the room is occupied a difference of temperature is generated and PIR senses it. This difference then generates a different voltage in the sensor which is amplified by the amplifier circuitry we have used. This system has been implemented in hotel rooms to enhance security and give the owner a sense of understanding of the activities in his hotel remotely. The sensor is installed at the center of room, this sensor stays on unless the room is booked. If there's an unknown presence and the room is not booked then a notification will be sent to the owner. And thus, necessary actions can be taken.
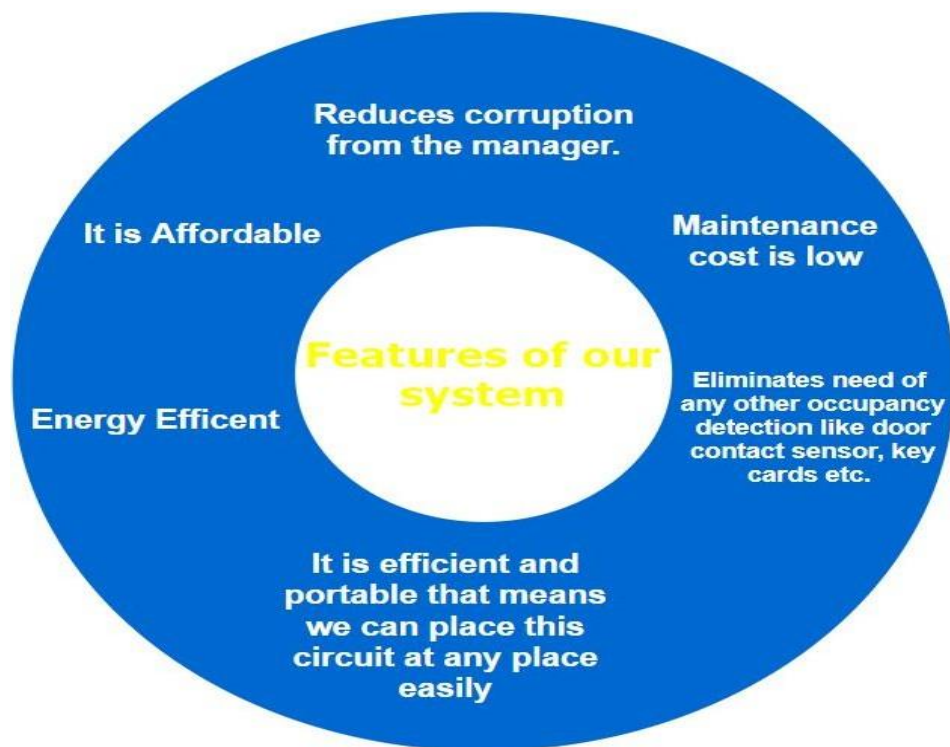
Figure 5.1 Features of the System

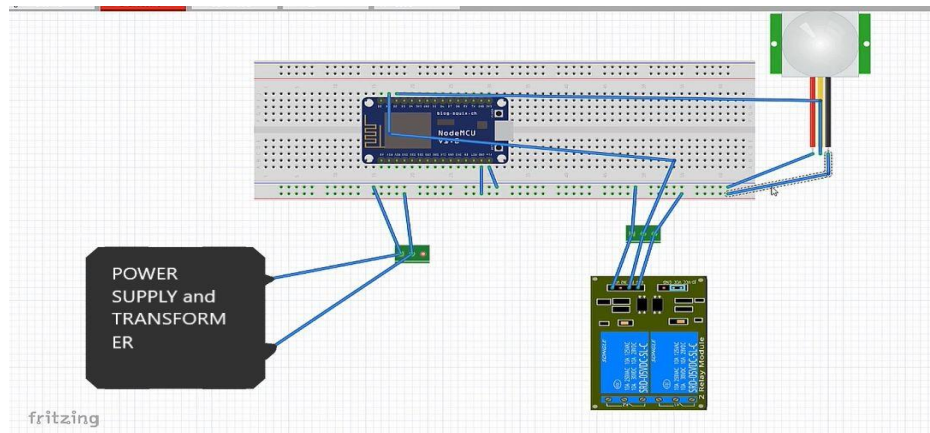# 6. Details of Software/Hardware Requirements

Figure 6.1. Basic Circuit Diagram

6.1 Hardware:

6.1.1   PIR Sensor: The PIR sensor is the core part of the system. Our proposed system revolves mainly around infrared radiation, which is emitted from human body. PIR sensor is widely used to detect the motion of human in the security system. Infrared (IR) light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers. We, Humans are the source of infrared radiation. It was found that the normal human body temperature radiate IR at wavelengths of 10 to 12 micrometers. Infrared Radiation of human body PIR sensors are passive electronic devices which detect motion by sensing infrared fluctuations. After it detects IR radiation difference, a high is sent to the signal pin. PIR sensor is made up of crystalline material that generates a surface electric charge when exposed to heat in the form of IR. This change in radiation striking the crystalline surface gives to change in charge. The sensor elements are sensitive to radiation of wide range but due to the use of filter window that limits the sensitiveness to the range 8 to 14 micrometers which is most suitable to human body radiation.
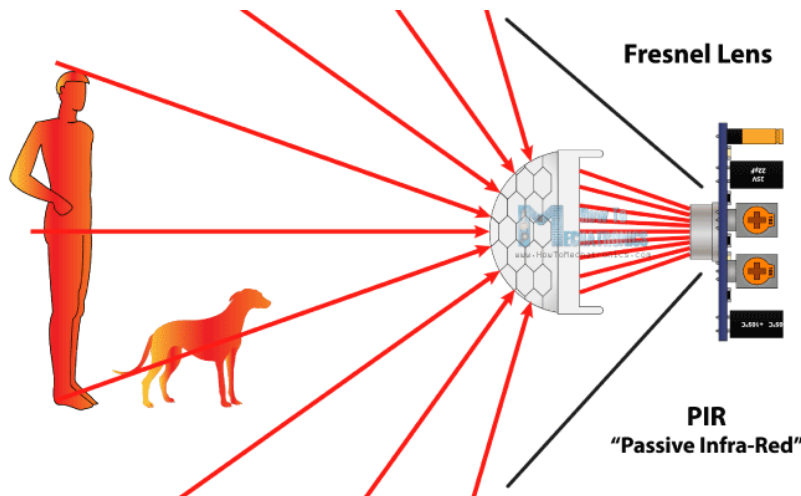
Figure 6.1.1. PIR sensor

6.1.2 Power supply: The power supply circuit involves the conversion of 230 volts, 50Hz AC into 16 volts DC. This is achieved by using step down 16-0-16 centre tapped transformer full wave rectifiers. The AC ripples are eliminated using the passive filter i.e. capacitor.

Figure 6.1.2. power supply

6.1.3 GSM module: It is a type of modem which accepts Subscriber Identification Model (SIM) card, and operates over mobile operators. After connecting the GSM modem to the system, there is communication over the mobile network. These GSM modems are most often used to provide internet connectivity but can also be used for sending and receiving SMS and MMS messages. This device receives and processes GSM signals from all GSM bands. GSM module will send MEssage to the user and also receive instruction from the user cell phone for reprogramming the phone number. Mechanical motion detection can also be used but it can be defeated by simply "cutting the wire".

Figure 6.1.3. GSM module

6.1.4 Fresnel Lens: A Fresnel lens is a Plano convex lens that has been collapsed on itself as to form a flat lens that retains its optical characteristics but is much smaller in thickness and therefore has less absorption loss.
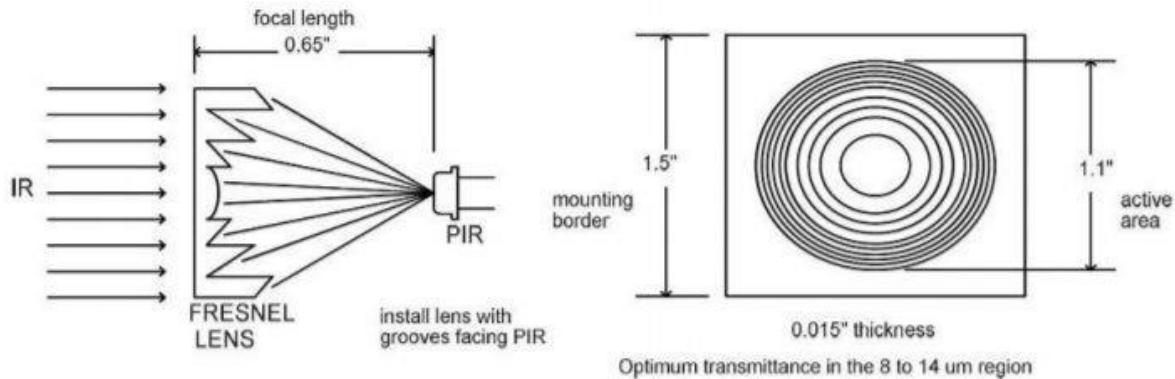
Figure 6.1.4. Fresnel lens

The Fresnel lens comprises of an infrared transmitting material that has an IR transmission ranging from 8µm to 14µm that is most sensitive to human body radiation. The grooves of Fresnel lens are designed to be facing the IR sensing element so that smooth surface is presented to subject side of the lens which is outside of an enclosure that protects the sensor.

6.1.5 Amplifier Circuit:

This circuit is used to amplify PIR sensor output, as it is very low. It is a 2-stage amplifier in which each stage has a gain of 100, corresponding to a total of 10,000. This 2 stage amplifier circuit comprises of two stages each of which perform amplification of the incident infrared signals and output finally obtained at the end of 2nd stage. Amplifiers having features of band-pass are used because there is a high gain.

6.1.6 PID Sensor Module Configuration:

As previously pointed, a typical PID sensor module is composed of four basic structures:
a) Fresnel lens,
b) PIR sensor
c) Amplifier Circuit
d) Step-down transformer

6.1.7 Relay circuit: Relays uses electromagnet to operate a pair of movable contacts from on open position to a closed position. It is an electromechanical device. It takes a relatively small amount of power to operate the relay coil. The relay itself can be used to operate the relay coil, but the relay itself can be used to control motors, heaters, lamps or AC circuits which themselves can draw a lot more electrical power.
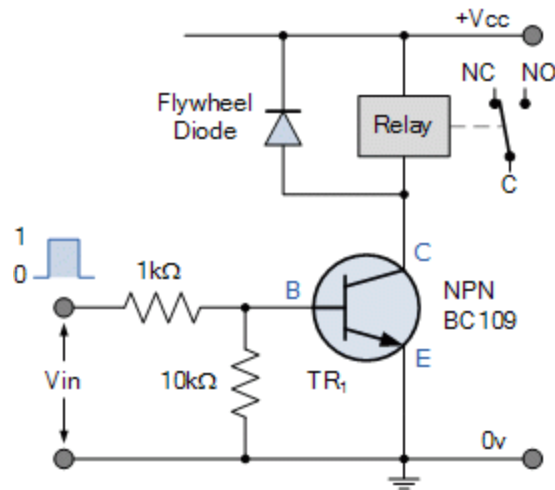
Figure 6.1.7 Relay Circuit Switch

6.2 Software

6.2.1 Blynk app: This app supports and controls Arduino, ESP8266, Node MCU, Particle Photon, Raspberry Pi and other microcomputers with the smartphones over the Internet. Used to create interfaces with widgets like buttons, knobs, graphs, displays and many more.

6.2.2 Hotel Booking System: for Hotel booking service.

6.2.3 Arduino IDE: Used to write, compile and upload code for the Node MCU

7. Future Scope

In this PIR Sensor integrated security system we have used low power consuming, affordable PIR sensor that are easy to be integrated with other sensors/switches/applications. By using this system we were able to make the security system energy-efficient, cost-efficient and fully automated. Considering all points mentioned above, followings are some additional functionalities we would like to add in our system:

7.1.1 Integration with a Web-Cam

As of now, we have not used a webcam/CCTV in our project which could capture any image or video of the intruder. We would like to integrate the system with a Webcam. Whenever an unauthorised person enters the room, the person's image will be captured/recorded and stored. This image will act as a proof for legal proceedings.

7.1.2 Detection of Precise Location and Path Trajectory

As a future work, the use of a PIR sensor arrays will be investigated to determine the approximate location and trajectory of objects in a room. It is our belief that PID sensors will play an important role in smart homes and hospitality. PID sensor arrays can observe their habitats, they can detect ⬜ames, and provide robust solutions for security applications. In this thesis, we have developed a project to just detect the presence of a person in the hotel room. The ideas beyond this work can be developed further to discover new application areas for PID.
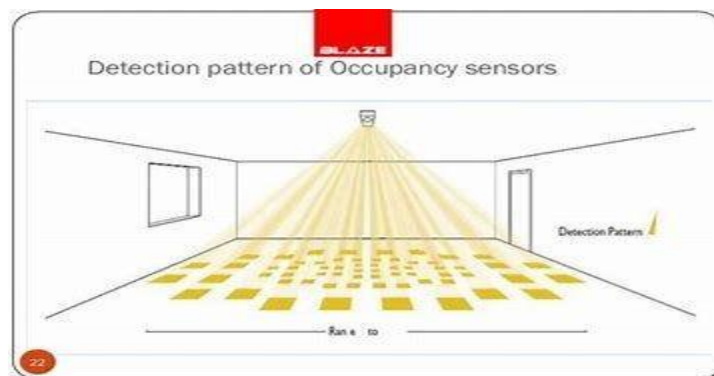

Figure 7.1.1. Detection pattern of occupancy sensor

7.1.3 Multiple Video Interfaces

 Work on a software to record videos from many webcams installed. The project has an aim to make a end-end security solution for houses, hospitality and buildings

7.1.4 Integrating System with Exclusive GUI for the Owner

The current system sends an SMS alert to the owner if the presence of an unauthorised person is detected. In the future, we would like to create a Web interface exclusively for the owner to check any room's occupancy at anytime from anywhere.

Therefore, the future implications of the project are very great considering the great variety of domains and field it can be applied and integrated in. This system can be used as a reference or a fundamental understanding point for realizing a scheme to be implemented in other projects of greater level of security, privacy, confidentiality and cognizance.

Figure 7.1.2. owner's dashboard preview

8. Conclusion

With an improved awareness and growing popularity of home, hotel, mall and building security, they have a necessity for an efficient and vigilant surveillance system which is affordable and portable. This design envelops all the key areas of the hotel security system. Detection of intrusion into any room in the hotel is executed strategically using passive infrared sensors. The sensor uses the infrared radiations(temperatures) differences as a result of human motion/presence detection within its range. When movement is detected, the PIR sensor activates the relay which in turn tells the GSM Module to send an alert Text Message to the owner. The system designed is energy efficient and can be deployed specifically in areas with lacking energy supply as a result of inadequate electricity supply. The method additionally offers flexibility and reliability. It enables the owner to be aware of the security situation at home provided he/she is connected to the internet.

Therefore, to conclude our project **"HOTEL ROOM REMOTE MONITORING SYSTEM",** we have presented a human presence detecting system based on pyroelectric infrared (PIR) sensors. We have used

this sensor to detect the human presence in the room thereby notifying the owner of any illegal booking, if any. It is an alert-based system.

9. Poster Presentation

Contents:

Name: Poster Competition - Hotel Room Remote Monitoring System
Date: 3rd April, 2019.
Venue: Mondini Hall, Don Bosco Institute of Technology, Mumbai.

Description: It was a poster making competition on our mini project topic i.e., Hotel Room Remote Monitoring System. It was assessed by our HoD, Prof. Prasad Padalkar, Project Supervisor, Mrs. Aruna Khubalkar, IIT Bombay HOD, Dr. Biswas and Father Agnel Computer Science HOD, Dr. Sunil Surve. Multiple questions about the system were asked and valuable feedback was provided. The competition was attended by several other faculties and students from the Information Technology Department of Don Bosco Institute of Technology, Mumbai
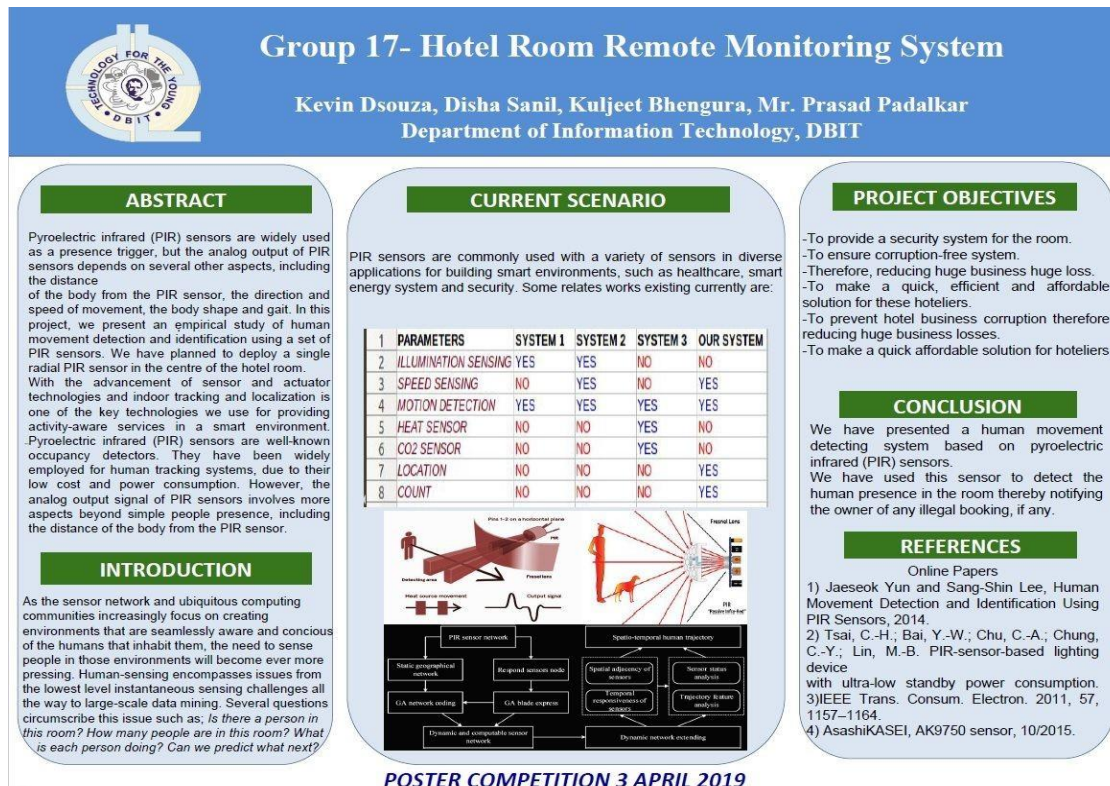
Figure 9.1 Presented poster of our project

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PIR Sensors, 2014.

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11. Plagiarism