SMART ALARM SYSTEM FOR RECORD ROOMS USING IC 555 AND PIR SENSOR

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Abstract:
Record rooms often contain confidential and critical data that require secure, tamper-proof environments. Traditional alarm systems lack the ability to automatically deactivate after a fixed time interval, leading to unnecessary power usage and alert fatigue. This project presents a smart alarm system utilizing a monostable timer circuit built around the IC 555. It integrates a PIR (Passive Infrared) sensor for motion detection and a relay-driven output mechanism that activates visual and audible alarms for a predetermined duration (11 seconds). The system ensures that unauthorized access is immediately detected and signaled without requiring manual reset.

Keywords: IC 555 Timer, PIR Sensor, Relay, Security System, Record Room Monitoring.

1. INTRODUCTION

In sensitive environments such as **record rooms**, which often house classified documents, legal papers, or archival records, **unauthorized access** or even unintentional intrusion can pose significant risks. Ensuring the security and integrity of these spaces requires more than just physical locks; **smart electronic monitoring systems** have become essential to detect, alert, and prevent tampering or unauthorized entry.

Conventional security alarm systems, while effective in motion detection, often lack intelligent control features. Typically, these systems activate an alarm continuously upon detecting motion and remain ON until they are manually deactivated. This design can lead to several operational inefficiencies, such as:

Continuous power consumption, even after the intruder has left.
Auditory fatigue for nearby personnel due to prolonged alarms.
Increased wear and tear on alarm components such as buzzers or LEDs.
User dependency, as it relies on manual reset or shutdown of the system.

To overcome these limitations, the proposed system introduces a **timer-based automatic alarm control mechanism** using the **IC 555** timer configured in **monostable mode**. This configuration ensures that once motion is detected through a **Passive Infrared (PIR) sensor**, the alarm system activates **only for a preset duration**—in this case, approximately 11 seconds—after which it **automatically deactivates**, even if the motion persists.

The core of this system's efficiency lies in its **integration of time-bound response and non-contact sensing**, making it ideal for enclosed and secure environments such as:

- Government record rooms
- Hospital document storage
- Educational institutional archives
- Corporate data repositories

2. LITERATURE REVIEW

The increasing demand for automated security solutions in sensitive environments such as record rooms, research facilities, and archival repositories has driven extensive research into low-cost, energy-efficient, and intelligent alarm systems. This literature review surveys the evolution of intrusion detection technologies, highlights recent advancements in smart sensing and control mechanisms, and identifies key limitations in existing systems that the current work aims to address.

[2.1] Conventional Alarm Systems and Limitations

Traditional alarm systems typically use magnetic switches, mechanical sensors, or basic IR sensors. These designs operate on simple logic: any breach triggers the alarm continuously until manually turned off. Several studies have noted that such systems, though inexpensive, suffer from:

- High false alarm rates
- Manual reset requirements
- Excessive energy consumption
- Poor adaptability to dynamic environments

Moreover, these systems often lack feedback control or contextual awareness, rendering them ineffective in scenarios requiring intelligent response modulation.

[2.2] Advancements in Motion Detection

The field of motion detection has transitioned from basic line-of-sight infrared systems to more advanced technologies, including:

- PIR (Passive Infrared) Sensors
- Ultrasonic Sensors
- Microwave Doppler Sensors
- Camera-based Computer Vision

Among these, PIR sensors have become a cornerstone in indoor intrusion detection due to their low power consumption, compactness, and reliable human motion sensing. Studies demonstrate that PIR sensors effectively detect variations in infrared radiation from moving human bodies, providing a reliable, non-invasive alternative to mechanical detectors.

Importantly, PIR sensors do not emit signals but passively detect environmental changes, which makes them ideal for low-interference and secure spaces like record rooms.

[2.3] Time-Controlled Logic with IC 555 Timer

A significant body of research has explored the use of the 555 timer IC in building cost-effective time-delay and pulse-generation circuits. In monostable mode, the 555 timer is triggered by a negative pulse and outputs a high signal for a predetermined duration, calculated by:

$$T = 1.1 \times R \times C$$

where R is resistance in ohms and C is capacitance in farads.

This feature has been widely used in systems such as:

- Automatic lighting control
- Alarm timing circuits
- Event-triggered notification systems

The deterministic nature of the monostable mode ensures repeatable and predictable output, which is vital in security applications where the alarm must sound for a defined duration regardless of continued motion detection. This mitigates false triggers and unnecessary energy consumption.

[2.4] Smart Alarm Systems in Recent Research

Modern smart alarm systems are increasingly incorporating embedded systems, IoT technologies, and wireless communication modules (e.g., GSM, Wi-Fi, Zigbee) to enable:

- Remote intrusion alerts
- Cloud-based event logging
- Real-time video streaming

- Integration with mobile applications

For instance, systems described in various studies use microcontrollers (e.g., Arduino or ESP32) to control GSM modules that send SMS alerts upon motion detection.

However, while such solutions offer advanced features, they introduce higher complexity, power consumption, and cost, limiting their use in basic setups or resource-constrained environments.

[2.5] Identified Research Gaps and Contribution of This Work

A survey of recent implementations reveals several gaps:

Table 1:- Comparison between Existing System and Proposed System

Aspect	Existing Systems	Proposed System
Alarm Control	Often continuous or manual	Time-bound via 555 Timer
Motion Detection	Often mechanical/contact-based	PIR sensor (non-contact)
Energy Usage	High due to constant ON state	Optimized via auto-off
Cost	High in IoT-based systems	Low-cost analog components
Scalability	Complex integration	Modular and expandable

Thus, this work contributes by designing a minimalistic, analog-driven solution that integrates the strengths of PIR sensing and monostable timing. The proposed system delivers energy-efficient, self-resetting alarm behavior suitable for applications where simplicity, cost-effectiveness, and reliability are paramount.

3. ABBREVIATIONS AND ACRONYMS

PIR Motion Sensor (Passive Infrared Motion sensor), IC (Integrated Circuits), NO (Normally Opened), LED (Light Emitting Diode), R (Resistance), C (Capacitance)

4. EQUATIONS

The system here is designed in such a way to be in ON state for 11 seconds from the time of sense. The time of ON state can be varied by varying the RC value according to the formula below,

$T_{ON} = 1.1RC$ (seconds)

The above circuit represents the ON state timing of monostable multivibrator using IC 555.

5.   BLOCK DIAGRAM OF PROPOSED SYSTEM

The block diagram represents a motion-triggered alarm system designed to secure record rooms by detecting human presence and activating a timed alert. The system comprises multiple functional stages working in sequence to ensure precise and reliable detection and response.

a.   PIR Motion Sensor (Measurement Device):

The process begins with the **Passive Infrared (PIR) sensor**, which continuously monitors the surrounding area for motion. It detects infrared radiation emitted by moving bodies, such as humans, and outputs a **LOW logic signal** when motion is sensed. This sensor acts as the primary **measurement device** in the system.

b.   Error Detector (Trigger Validation):

The signal from the PIR sensor passes through an **Error Detector** block. This block acts as a **logical filter or comparator**, validating whether the received signal truly corresponds to a motion event or is just a noise spike or environmental fluctuation. Only a confirmed motion signal is allowed to trigger the next stage, ensuring **false triggering is minimized**.

c.   Monostable Multivibrator using IC 555 (Controller & Timer):

Once the error detector confirms a valid trigger, the signal is sent to the **IC 555 timer** configured in **monostable mode**. In this configuration, the IC produces a **single HIGH pulse** on its output for a predefined duration (about **11 seconds**), regardless of how long the input trigger lasts.

This timing is set using a **1 MΩ resistor** and a **10 µF capacitor**, based on the formula:

T{ON} = 1.1 X R X C

  The IC 555 here functions as the **controller and timer** that govern how long the alarm stays active.

d.   Relay Module (Actuator):

The HIGH output from the IC 555 timer is used to **energize a relay coil**, turning it ON for the same 11-second duration. The relay serves as an **electromechanical switch** that safely connects or disconnects the output devices from the power source. This provides isolation between the control circuit and high-power output loads.

e.   LED and Buzzer (Output Devices):

Connected to the **Normally Open (NO)** terminal of the relay, an **LED** and **buzzer** act as the final **output devices**.

    The **LED** gives a **visual indication** that motion has been detected.
    The **buzzer** emits an **audible alert** to notify nearby personnel.
    Both remain active during the timer's ON period and automatically turn OFF afterward.

This process ensures that any unauthorized movement within the record room is immediately responded to, with a clear alarm that self-resets after a fixed time. The inclusion of the error detector enhances system reliability, while the use of IC 555 ensures **time-controlled operation** with minimal power consumption and no manual intervention.

Fig 1: Block Diagram
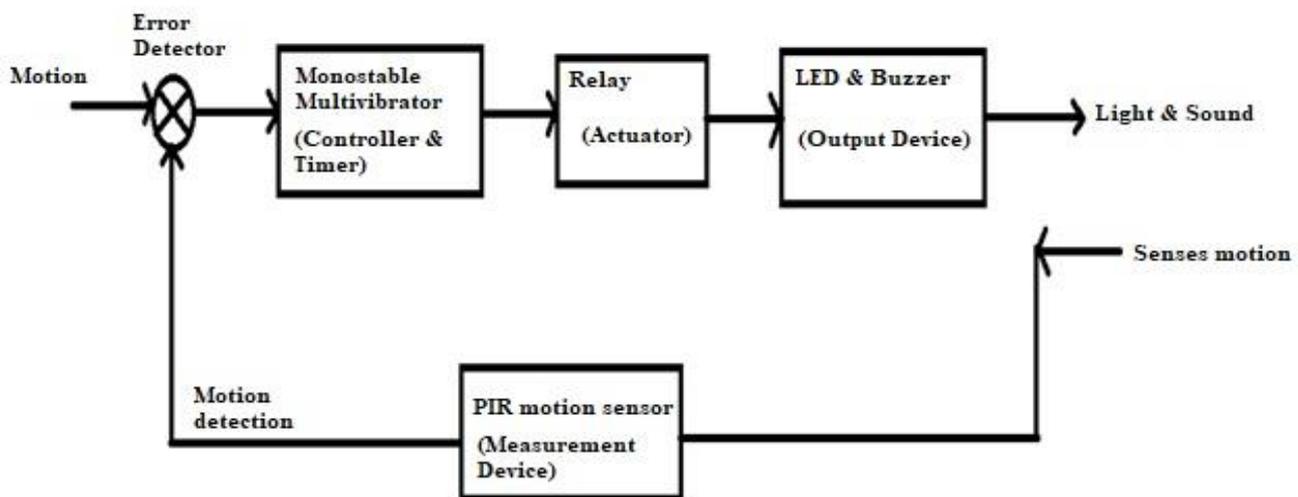
6.   CIRCUIT DIAGRAM OF THE PROPOSED SYSTEM

The circuit diagram represents a motion-based alarm system designed using the IC 555 timer in monostable mode, a PIR sensor module for motion detection, and a relay-controlled output stage with a buzzer and LED. The circuit is powered using a dual-voltage power supply: a +5V DC supply is used to operate the control circuitry (IC 555, PIR sensor, and relay module logic), while a +9V DC supply is dedicated to powering the buzzer, which typically requires a higher voltage for audible operation.

All the ground terminals from both power supplies are tied together to maintain a common reference point throughout the system.

The process begins with the PIR sensor continuously monitoring the designated area for human motion. When the sensor detects movement, it sends a LOW signal from its output pin to pin 2 of the IC 555 timer.

This acts as the trigger input for the IC 555, which is configured in monostable mode. Upon receiving this trigger, the IC generates a HIGH output pulse at pin 3, lasting for a fixed duration determined by the external resistor and capacitor connected to the timer circuit.

Specifically, a 1 MΩ resistor is connected between pins 8 and 7, and a 10 µF capacitor is connected between pin 6 and ground. Pins 6 and 7 are also internally shorted. According to the formula TON = $1.1 \times R \times C$, the output pulse duration is approximately 11 seconds.

This HIGH signal at pin 3 energizes the relay module by applying voltage to its control input. When the relay is activated, its normally open (NO) contact closes, allowing current to flow from the +9V power supply to the output devices—namely the LED and buzzer. The anode of the LED is connected to the NO terminal of the relay, and its cathode is connected in series with a 1 KΩ resistor to ground. This resistor protects the LED from excessive current. The buzzer is connected in parallel with the LED and shares the same power path.

Thus, both the LED and the buzzer turn ON simultaneously, providing visual and audible alerts for the duration of the timer output.

After 11 seconds, the output of the IC 555 automatically returns to LOW, deactivating the relay. This breaks the connection at the NO contact, thereby turning OFF both the LED and the buzzer. The system then returns to its idle state, ready to detect the next motion event without any manual reset.

This design ensures a secure, efficient, and time-controlled alarm system well-suited for protecting sensitive areas such as record rooms.

Fig 2: Circuit Diagram
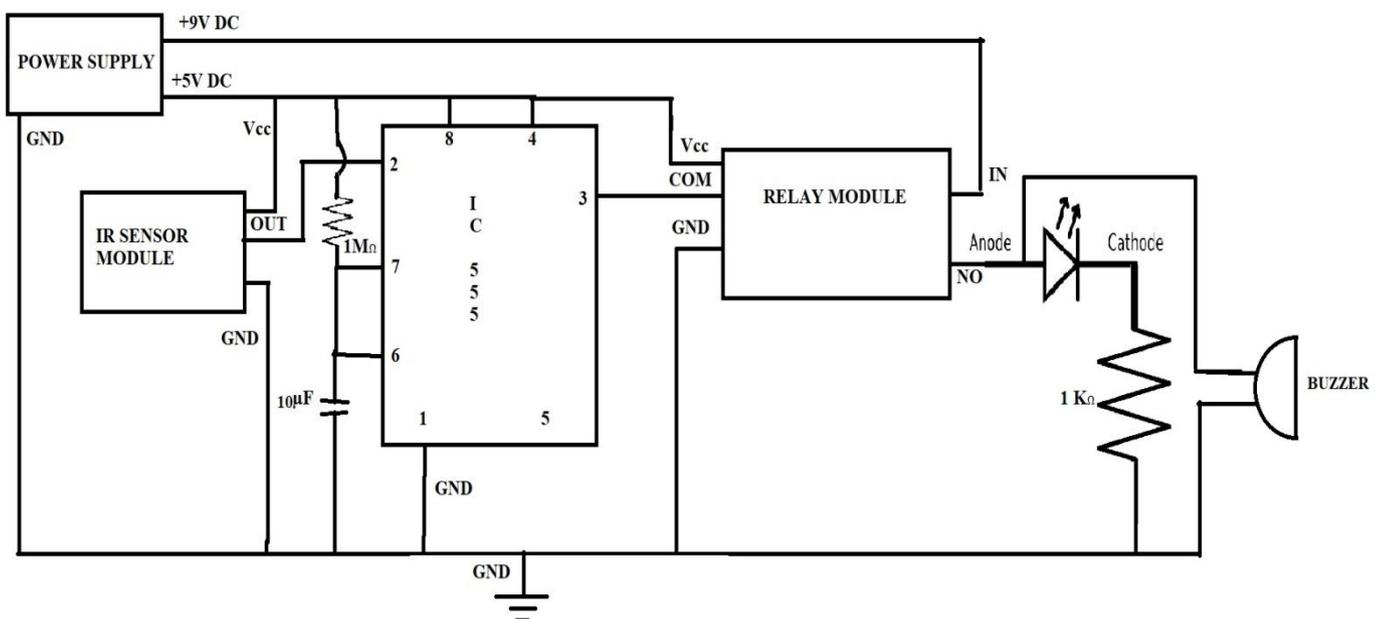
7. DESIGN OF POWER SUPPLY

The effectiveness and reliability of any electronic system are highly dependent on a clean and regulated power supply. In this project, a dual-stage regulated DC power supply is designed to provide both +9V and +5V outputs, essential for the stable operation of modules such as the IC 555 timer, relay, and PIR sensor. The power supply is engineered with a series of well-established components: a step-down transformer, bridge rectifier, filtering capacitors, and voltage regulator ICs (7809 and 7805).

The system begins with an input from the standard 230V, 50Hz AC mains supply, which is fed into the primary winding of a 15-0-15V center-tapped step-down transformer. This transformer reduces the high-voltage AC to a safer and more manageable 15V AC across each secondary winding.

The AC output from the secondary side is then directed into a bridge rectifier, constructed using four 1N4007 diodes, which are arranged in a full-wave configuration. This bridge rectifier converts the alternating current (AC) into a pulsating direct current (DC).

To minimize voltage fluctuations and ripple in the rectified DC signal, the output is filtered using:

A 1000 µF electrolytic capacitor, which handles the bulk of the ripple filtering due to its high capacitance. A 0.1 µF ceramic capacitor, which filters out high-frequency noise and transients that may still be present in the signal.

The resulting filtered DC voltage is then fed to the input (pin 1) of the 7809 voltage regulator IC. This IC maintains a constant +9V DC output by automatically adjusting for input voltage fluctuations or load changes. The ground pin (pin 2) is connected to the system's common ground. To further improve stability and suppress transient voltage spikes:

A 0.1 µF capacitor is placed between the output pin (pin 3) of the 7809 and ground.

Another 1000 µF capacitor and 0.1 µF capacitor are used immediately after the 7809 output to ensure smooth, ripple-free DC voltage delivery.

Next, the clean +9V DC output from the 7809 regulator is passed as the input to the 7805 voltage regulator IC, which performs a similar regulation process to produce a stable +5V DC output—suitable for low-voltage digital components like the IC 555, PIR sensor, and relay module.

The 7805 regulator is also configured with:

Pin 1 receiving the input voltage (+09V DC),
Pin 2 grounded, and
Pin 3 delivering the regulated +5V DC.
    A 0.1 µF capacitor is again connected from pin 3 to ground to suppress any output transients.

By cascading two regulators (7809 followed by 7805), this design ensures:

- High voltage rejection at both stages
- Excellent ripple suppression
- Clean and consistent DC output even under varying load conditions

This dual-stage regulated power supply plays a vital role in ensuring the long-term reliability and stability of the alarm system, protecting sensitive components and supporting precise timer functionality.

Fig 3: Circuit Diagram of Power Supply
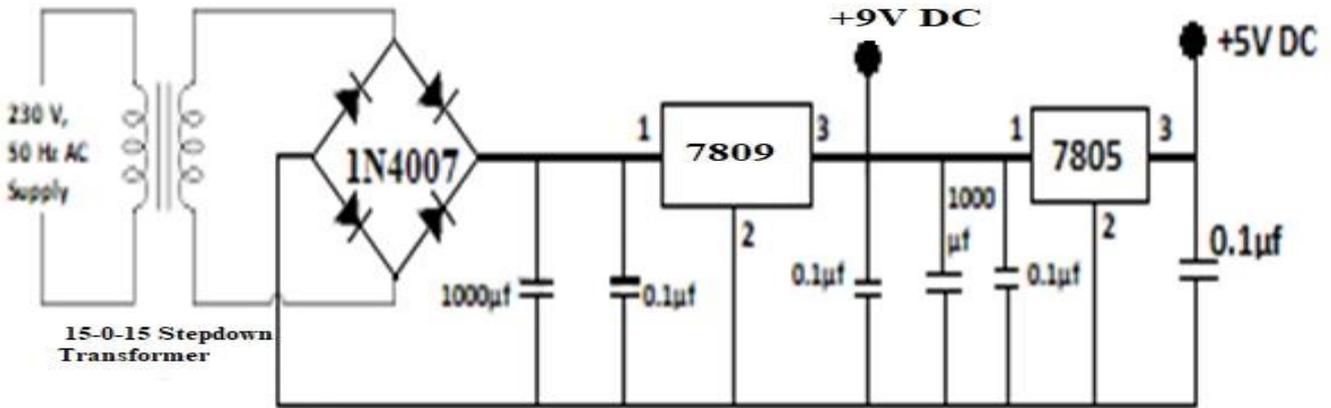
8.   SETUP AND OUTPUT

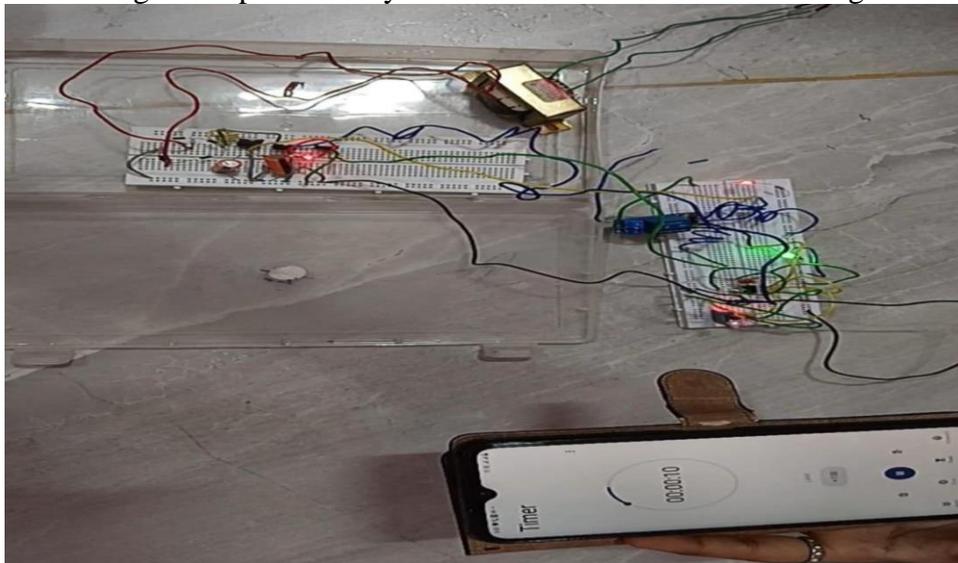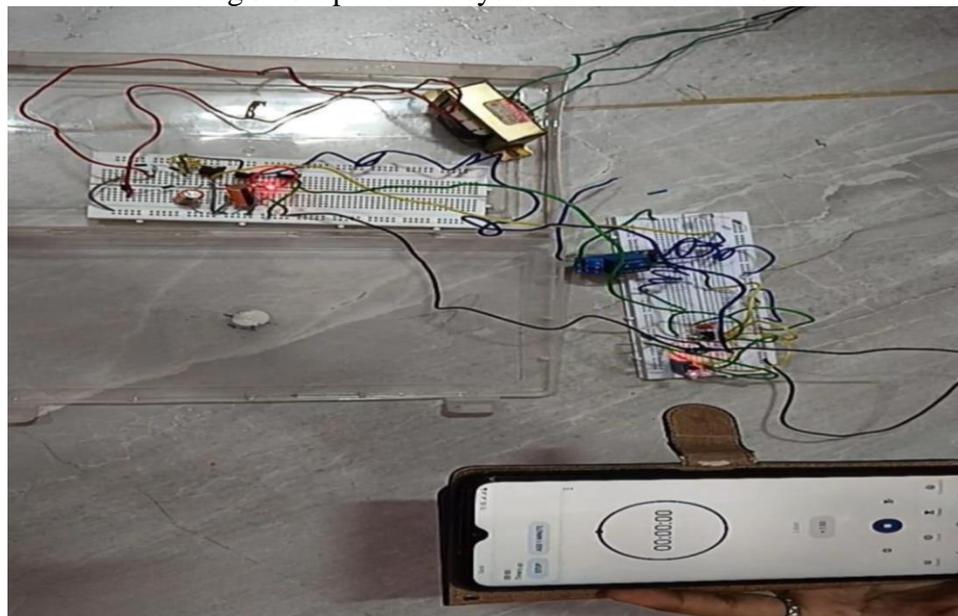Fig.4: Output of the system at the 10th second after sensing

Fig.5: Output of the system after 11 seconds

9. CONCLUSION

The design and implementation of the alarm system using the IC 555 timer in monostable mode successfully demonstrate an efficient and reliable method for enhancing security in sensitive environments such as record rooms. By integrating a PIR motion sensor for non-contact human detection and a time-controlled output using the IC 555, the system achieves precise control over alert duration. The use of a relay ensures safe and isolated switching of the output devices (buzzer and LED), while the dual-voltage configuration accommodates both logic-level control and higher voltage requirements for output signaling.

The system is capable of autonomously detecting unauthorized motion and activating an alert mechanism for a specific time period (11 seconds), after which it resets automatically. This avoids issues such as continuous alarming, manual resets, and unnecessary power consumption. The modular nature of the system makes it easy to understand, cost-effective to build, and adaptable to various real-world applications beyond record room security, such as residential intruder alarms, automated lighting, and smart entry systems.

Overall, the project successfully meets its objective of providing a simple yet functional security alert mechanism. It effectively combines the core principles of sensor interfacing, timing circuits, and relay control in an integrated setup that ensures dependability and minimal maintenance.

10. FUTURE SCOPE

While the current system performs well for basic motion-triggered alerting, it can be further enhanced to support more intelligent, automated, and scalable security solutions. Some promising directions for future improvement include:

a. Integration with GSM or IoT Modules:

Incorporating a GSM module or IoT connectivity (e.g., via ESP8266 or NodeMCU) would allow the system to send real-time SMS or app-based notifications to concerned personnel when motion is detected.

b. Data Logging and Event History:

The system can be upgraded to log each motion detection event using EEPROM or cloud storage for auditing or pattern analysis purposes.

c. Camera Integration:

A camera module can be added to capture images or videos upon detection, providing visual confirmation and evidence for security monitoring.

d. Sensitivity Adjustment:

Adding adjustable sensitivity controls for the PIR sensor would allow fine-tuning the detection range based on room size or required coverage.

e. Multiple Sensor Inputs:

The design can be extended to include multiple PIR sensors to cover larger or multiple entry points in record rooms, with each sensor mapped to a timer or separate zone.

f. Battery Backup and Power Fail Alert:

Including a rechargeable battery backup would keep the system operational during power outages. A power failure alert could also be added for increased reliability.

g. Integration with Access Control Systems:

The alarm system can be connected with RFID or biometric access modules to trigger alerts only when unauthorized access is attempted, thus reducing false alarms.

With these advancements, the system can evolve from a standalone alarm unit to a part of a comprehensive smart security infrastructure. These future enhancements would not only increase functionality but also add

value in terms of remote access, automation, and real-time intelligence, making it suitable for modern-day smart security applications.

11.   AUTHORS' BIOGRAPHY

I am Sherley Suzane Tremot, pursuing my under-graduation in Electronics and Communication Engineering at Manakula Vinayagar Institute of Technology, Puducherry. I have completed my Diploma in Instrumentation and Control Engineering at Women's Polytechnic College, Karaikal with superlative distinction. I had completed my 10th standard (Brevet) in French medium of instruction at Collège d'Enseignement Secondaire, Karaikal.

REFERENCES:
1. A. Sharma and S. Rathi, "Design and Implementation of Low-Cost Intrusion Detection Alarm," International Journal of Security Engineering, vol. 7, no. 3, pp. 44–50, 2021.
2. S. K. Gupta et al., "Analysis of Conventional Burglar Alarm Systems: A Study," IEEE Access, vol. 9, pp. 112311–112318, 2021.
3. B. Patel and D. Shah, "PIR Based Human Detection System for Secure Spaces," Journal of Embedded Systems, vol. 4, no. 2, pp. 34–39, 2020.
4. R. K. Singh, "Low-Power PIR Sensors for Smart Security Applications," International Journal of Sensor Networks, vol. 15, no. 1, pp. 20–25, 2019.
5. K. Kumar, "Application of IC 555 Timer in Security and Control Circuits," Electronics and Communication Journal, vol. 6, pp. 40–46, 2018.
6. M. Jain et al., "Time-Controlled Security Alerts Using Monostable 555 Timer," IEEE International Conference on Circuit Design, 2022.
7. D. A. Reyes et al., "IoT-Based Smart Alarm System with Mobile App Integration," IEEE Internet of Things Journal, vol. 9, no. 5, pp. 1130–1138, 2023.
8. F. Liu and A. Banerjee, "GSM-Based Intrusion Detection System: Architecture and Implementation," International Conference on Embedded Security, 2021.