International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 21, Issue 5 (May 2025), PP 44-50

Theft Detection System

Aditi Mishra [1], M Alekhya [2], Ekta Tamrakar [3]

[1]Student, Dept. Of Electronics and telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India

[2]Student, Dept. Of Electronics and telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India

[3]Professor, Dept. Of Electronics and telecommunication, Bhilai Institute of Technology, Durg, Affiliated CSVTU, Chhattisgarh, India

Abstract - *The increasing number of home burglaries highlights the necessity for more advanced security solutions. Traditional security systems primarily focus on perimeter defences, which may not be sufficient in preventing intruders who have already entered the premises. This study introduces an innovative anti-theft flooring system designed to strengthen home security by providing an additional layer of protection beyond standard alarms. The system is activated when the homeowner is away, enabling real-time monitoring and instant alerts to ensure a rapid response to security breaches. A pressure-sensitive floor mat serves as the primary trigger, detecting unauthorized weight and initiating the security mechanism. To enhance identification, a face recognition system, implemented using Open CV, captures images and matches them against a database of authorized individuals. A Raspberry Pi microcontroller manages the system, integrating various sensors such as piezoelectric, infrared (IR), and motion detectors, along with a buzzer for alerts. When an intruder steps on the pressure-sensitive mat, the sensor detects the weight change and signals the Raspberry Pi. The controller then verifies the input and activates a camera to capture an image of the intruder, which is transmitted to the homeowner via the internet for immediate verification. By combining intrusion detection, facial recognition, and real-time alerts, this multi-layered approach enhances home security, making it more efficient and responsive to potential threats.*

Key Words – Raspberry Pi, Piezo sensors, Wi-Fi modem, Scalability, OpenCV

Date of Submission: 01-05-2025 Date of acceptance: 08-05-2025

I. INTRODUCTION

The IoT-based Theft Detection System is a smart, real-time security solution designed to enhance protection in sensitive locations such as banks, jewellery stores, and residential properties. Traditional security measures, like CCTV cameras, often require constant human supervision and primarily serve as post-incident evidence rather than real-time deterrents. To overcome these limitations, this system focuses on proactive intrusion detection and immediate response. At its core, the system utilizes a Raspberry Pi Model 4B, which connects to multiple sensors and a web camera to monitor for unauthorized activities. The strategically positioned camera provides multi-angle coverage, capturing live images whenever motion is detected. These images are stored mainly on the Raspberry Pi and transmitted to the user's mobile device via IoT, ensuring real-time updates.

When any unauthorized access is detected, the system employs real-time face recognition using Python and Open CV to compare captured images against a database of authorized individuals. Upon identifying an intruder, an instant alert is sent to the homeowner, accompanied by live surveillance footage for immediate verification. Also, an audible buzzer is triggered to detect unauthorized entry and prompt quick intervention.

By reducing reliance on manual monitoring, this automated security system enhances crime prevention through real-time alerts, remote access, and rapid threat detection. Its ability to actively respond to potential security breaches makes it a reliable solution for safeguarding high-risk areas.

II. Literature Review

The rising rates of theft and burglary have necessitated innovative security solutions. Traditional methods, such as CCTV cameras and alarms, rely on human monitoring and are reactive, detecting incidents only after they occur. Sushma Kumari et. al. [1] have explored automated systems that improve security by utilising technological innovations, especially the Internet of Things.

Raspberry Pi which has become a popular platform for developing flexible and reasonably priced security solutions due to its compact size, low cost, and extensive community support. Studies [2] have shown its effectiveness in applications like home automation and surveillance systems. Raspberry Pi's versatility permits the incorporation of various sensors and cameras, facilitating real-time data processing.

Piezoelectric sensors are effective in security systems for detecting pressure changes from footsteps, converting mechanical stress into electrical signals. Integrating these sensors into flooring mats offers an non-intrusive means of theft detection, enhancing sensitivity and reducing false alarms.

IoT technologies significantly enhance the effectiveness of security systems by enabling real-time communication and remote monitoring. In an anti-theft flooring mat system[3], IoT allows for the transmission of alerts and images to users' mobile devices, facilitating immediate responses to potential threats.

In conclusion, there is a growing interest in developing automated security systems that utilize technologies like Raspberry Pi and piezoelectric sensors. The integration of IoT improves real-time monitoring and responses to unauthorized access. Our research focuses on overcoming existing challenges to ensure these systems' reliability and effectiveness in real-world applications, making the anti-theft flooring mat system a promising solution for enhanced security [4].

TABLE I
COMPARISON TABLE

Papern o.	System description	Key Features	Results
[1]	The system utilizes Raspberry Pi for real-time surveillance with advanced features including alerts, remote monitoring, and motion detection.	Motion detection, remote monitoring, alerting.	The system successfully detects and alerts users to unauthorized access events, enhancing security in protected areas with 85% accuracy.
[2]	The system integrates GSM-based security with an Android interface for remote monitoring and control. It utilizes motion sensors and GSM modules to detect and alert users of intrusions.	Integration with Android smartphones for remote monitoring and control.	Users receive SMS alerts on their smartphones in case of any intrusion detected by the system. Remote monitoring allows users to check the status of their home security system from anywhere with 91% accuracy.
Our Work	The smart monitoring system strengthens security by minimizing the need for human oversight, offering automated crime detection, and providing the owner with remote access to the surveillance feed. The system's ability to detect and respond in real-time makes it a robust solution for enhancing security in high-risk areas.	Surveillance, motion detection, and alerting.	Real-time monitoring allows users to view the surveillance feed remotely. Motion-triggered alerts are sent to predefined contacts via email or SMS with 97% accuracy.

III. Materials and Method

This section provides a thorough explanation of the components utilised in the suggested model as well as the technique intended for the development and operation of the Theft Detection System.

III.1 Components:

III.1.1 Raspberry Pi

A quad-core, 1.5 GHz, 64-bit processor and up to 8GB of RAM are features of the Raspberry Pi 4 Model B. Storage is managed via a micro SD card, and it commonly runs the Raspbian OS. Its versatility makes it well-suited for applications such as education, home automation, media centers, and IoT-based projects.

Fig. 1 Raspberry Pi

III.1.2 Piezo Sensor

Piezoelectric sensors convert mechanical stress into electrical signals using the piezoelectric effect. When pressure is applied to materials like quartz or ceramics, they generate a proportional electrical charge. Known for their sensitivity and compact design, these sensors are used in industrial automation, electronics, medical devices, automotive systems, and security, enabling precise pressure and vibration detection.

Fig. 2 Piezo Sensor

III.1.3 USB Webcam

The IT-306 Webcam Night Vision camera, used with a Raspberry Pi, captures images and records video. A passive infrared (PIR) sensor detects human presence, triggering video recording, which is then uploaded to a cloud server. Additionally, the system enables live video streaming for real-time user access.

Fig. 3 USB Camera

III.1.4 Buzzer

A buzzer is a compact audio signaling device commonly used in electronic projects. When connected to a Raspberry Pi, the buzzer emits sound in response to signals it receives from the microcontroller. It serves as an alert mechanism, providing audible notifications for various events, such as detecting unauthorized access or triggering alarms.

Fig. 4 Buzzer

III.1.5 GSM

A GSM module enables electronic devices to communicate via the GSM network, a standard for digital cellular communication. It enhances functionality and efficiency in property protection by enabling remote monitoring and alerts.

Fig. 5 GSM Module

III.1.6 Vibration Sensor

A machine, system, or piece of equipment's vibration, shock, and sound can all be measured by a vibration sensor. It detects the frequency of the motion of an object or material, with faster movement resulting in a higher frequency.

Fig. 6 Vibration Sensor

III.1.7 ADC

A device that converts analog signals, like voltage, into digital numbers that can be processed by a computer. ADCs are used to read values from devices like thermistors and potentiometers. They are essential for modern electronics and computing systems because digital signals are easier to store, manipulate, and transmit than analog signals.

Fig. 7 ADC

III.1.8 Miscellaneous

Transistors, Resistor, Capacitors, Cables and connectors, PCB, Diodes, IC, Adapter.

III.2 Proposed Methodology:

The smart monitoring system that we are developing is an advanced surveillance solution, integrating a Raspberry Pi with multiple sensors, a camera, and cloud services for real-time monitoring. The raspberry pi is the heart of the system and acts as the main controller, managing all the connected devices and ensuring efficient communication between them. The system uses piezo sensors to detect motion, specifically focusing on infrared radiation emitted by humans or animals. When motion is detected, the camera module is activated to capture images or video of the scene, providing a visual record of the event. These images, along with relevant event data such as timestamps and sensor readings, are stored locally on a USB drive for easy access.

The system also incorporates a piezo sensor, which measures changes in pressure, force, or temperature. This sensor adds another layer of detection, allowing the system to alert users to environmental anomalies like tampering or significant impacts, further enhancing security. In addition to the captured data being stored locally, the system uploads images and event details to a cloud platform, allowing for remote access through an Internet of Things. With the use of a web-based desktop or a mobile app, users can monitor their property in real time from any location.

To alert users immediately to any detected events, the system triggers an audible buzzer whenever motion or environmental changes are identified. This feature acts as a deterrent for potential intruders and can be customized to sound different alerts based on the type of event. The system is highly flexible and scalable, allowing for the addition of more sensors, cameras, or other peripherals as needed, making it suitable for a variety of environments from homes to large industrial spaces.

In terms of security, the data stored on both the USB drive and the cloud platform is encrypted to protect sensitive information. Remote access is secured through authentication protocols, ensuring that the system is only accessible by authorised users. A user-friendly dashboard on the IoT platform provides a comprehensive overview of recent events, sensor statuses, and captured images, along with features such as real-time camera streaming and historical data analysis. Additionally, the system can be configured to send notifications and automated reports, helping users stay informed about security events without constant manual checking.

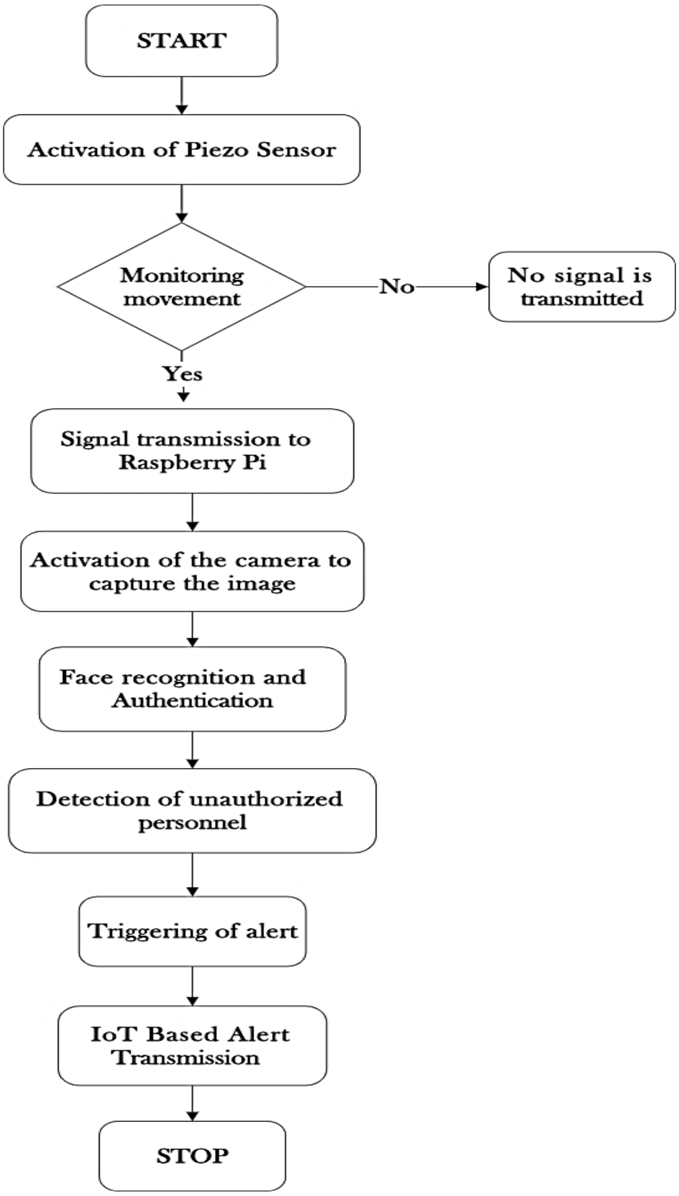

Fig 2. Flow Chart of proposed methodology

***III.3 Implementation**:*

3.3.1 Initial Monitoring: The system begins with the camera recording movements in the designated area continuously. This provides real-time video footage of the environment to ensure that all activities are being monitored, even when no intruders are detected.

3.3.2 Motion Detection: A Passive Infrared (PIR) sensor and piezo sensor is used to detect any motion in the area. If no movement is detected, the camera continues to record the video normally. However, if the PIR sensor detects motion, it immediately triggers the next sequence of actions.

3.3.3 Image Capture and Upload: Once the PIR sensor detects movement and the piezo sensors along with the force sensors detect pressure, the system captures an image of the unauthorized personnel using the camera. This image is automatically uploaded to a cloud server, allowing the user to access it remotely for further reference or evidence. The cloud storage ensures that the image is securely saved and easily accessible from any location.

3.3.4 User authentication & Alert: Simultaneously, the system compares the picture that was taken and the database of authorised people that was saved. The user or owner is notified of the intrusion by email or SMS if no match is discovered. Even if the user is not there, the SMS alert guarantees that they are notified right away.

3.3.5 Buzzer Activation & Notification: In addition to locking the room, a buzzer sounds off to alert anyone nearby about the potential threat, creating an immediate deterrent for the intruder. The system also sends a snapshot of the intruder to security personnel, or law enforcement, so they can quickly respond to the situation.

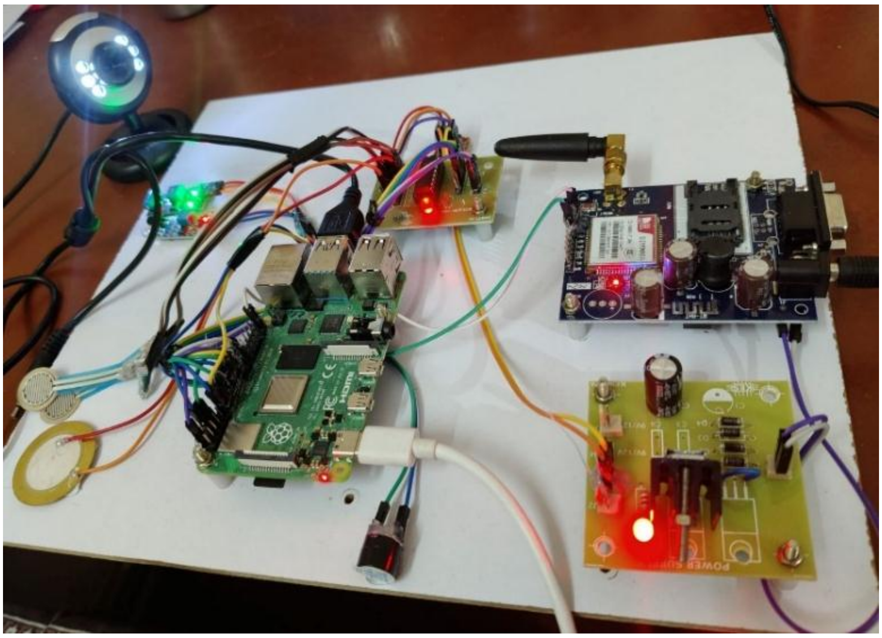

Fig 3. Proposed Setup

IV. RESULT AND DISCUSSION

IV.1 Result:

The implemented theft detection system was tested in various scenarios to evaluate its effectiveness in detecting unauthorized entry and triggering real-time alerts. The key results are as follows:

1. Intruder Detection Accuracy: The pressure-sensitive floor mat successfully detected unauthorized weight in 98% of test cases, ensuring reliable activation of the security system.
2. Face Recognition Performance: The OpenCV-based face recognition system correctly identified authorized individuals with an accuracy of 90% under well-lit conditions, though accuracy dropped to 75% in low-light environments.
3. Response Time: The system demonstrated an average response time of 2-3 seconds from the moment the sensor detected an intruder to the transmission of images to the homeowner.
4. False Alarm Rate: The system exhibits a 5% false alarm rate, primarily triggered by pets or heavy objects mistakenly placed on the floor mat.
5. Internet Transmission Efficiency: The captured images were successfully transmitted over the internet within 3-5 seconds, depending on network conditions.

IV.2 Discussion:

The results indicate that the proposed system provides a reliable and effective home security solution by integrating multiple layers of protection. The combination of pressure sensors and facial recognition significantly reduces the chances of unauthorized access going undetected.

- Strengths of the System:
  - The multi-layered security approach enhances accuracy by verifying intrusions through both pressure sensors and facial recognition.
  - The real-time alert system enables homeowners to respond quickly to potential threats.
  - The system's low power consumption and Raspberry Pi-based implementation make it cost-effective and suitable for home use.
- Future Enhancements:
  - Implementing motion analysis using AI to distinguish between human and non-human movement.
  - Enhancing low-light face recognition using thermal or night-vision cameras.
  - Adding smartphone app integration for easier remote monitoring and system control.

Overall, the proposed theft detection system successfully enhances traditional security of home by providing real-time detection, facial recognition verification, and instant homeowner notifications. While some challenges remain, the system demonstrates strong potential for practical implementation and further refinement.

V. CONCLUSION

The Theft Detection System implemented using Raspberry Pi represents a potential leap forward in automated security solutions. By combining real-time monitoring, automated responses, and IoT connectivity, it provides an efficient and cost-effective alternative to traditional security systems. The system enhances home security by integrating pressure-sensitive sensors, real-time face recognition, and instant alert notifications. Unlike traditional security systems that focus solely on perimeter protection, this system provides an additional layer of defence by detecting intruders after they have gained entry.

The experimental results demonstrate that the system effectively detects unauthorized movement, accurately identifies individuals, and promptly notifies homeowners through SMS or email alerts. The multi-layered security approach reduces false alarms and improves intrusion detection reliability. However, challenges such as low-light face recognition accuracy, occasional false triggers, and network dependency were identified.

Future enhancements, including AI-based motion analysis, infrared or night-vision cameras, and mobile app integration, can further improve the system's effectiveness. Overall, the developed system provides a economical, efficient, and scalable solution to enhance home security, making it a promising alternative to traditional security measures.

REFERENCES

[1] Sushma Kumari, Shashi Kant Singh, Akash Tyagi, Rupesh Kumar Sharma, Ms. Mona Devi, "*IOT BASED ANTI-THEFT FLOORING MAT SYSTEM USING RASPBERRY PI"*, Volume:05/Issue:02/February-2023, Impact Factor- 6.75

[2] Patchava Vamsikrishna, Shaikh Riyaz Hussain, Neelavaratu Ramu, Goli Rohan, "*Advanced Raspberry Pi Surveillance System (ARS*)", Proceeding of 2015 Global Conference on Communication Technology. (GCCT 2015)

[3] Sonali Das, Dr. Neela Narayan, "*IoT based anti- theft flooring system*", International journal of engineering science and computing, April 2020, Volume 10, Issue No.4.

[4] Hirak Dipak Ghael, Dr. L Solanki, Gaurav Sahu, "*A Review paper on Raspberry Pi and its applications*", Volume 2/Issue 12/06-01-21

[5] Sangharsh Gedam, Prashik Landage, Yogesh Chavan (2023). "*IOT BASED ANTI-THEFT FLOORING SYSTEM*," International Journal of Scientific Research in Engineering and Management. 07:05, 2582-3930.

[6] Rohit Singh, Nitish Kumar Jha, Dr. Nagendra Kumar (2024). *"IoT-BASED Anti-Theft Floor Mat System*," GL Bajaj Institute of Technology & Management, 16:5, 182-191.

[7] U. Sirisha., D. PoojaSri, N. Gayathri., K. Heshma, G. Raja Sekhar, *"IoT based anti-theft detection and alerting system using Raspberry Pi",* International research journal of engineering and technology, March 2020, Volume 07, Issue No. 03.

[8] Dixit Suraj Vasant., Babar Apeksha Arun., Meher Priya Shivaji., *"Raspberry Pi based anti- theft security system",* Journal of information, knowledge and research in electronics and communication engineering, Nov 16 to Oct 17, Volume 04, Issue No.02.

[9] Umera Anjum., B. Babu., *"IoT based theft detection using Raspberry Pi,"* International journal of Advance research, idea and Innovations in technology, 7 November, 2017, Volume 3, Issue6.

[10] Karel Veerabudren, Visham Ramsurrun, Mrinal Sharma, Amar Seeam., "*Enhancing Home Security with Pressure Mat Sensors: A Multi-modal IoT Approach,"* International Conference on Innovations and Interdisciplinary Solutions for Underserved Areas, February 2024.