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Affordable IOT Security: A Raspberry Pico System for Attendance and Intruder Detection

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ABSTRACT: This paper introduces an innovative and budget-friendly IoT-based facial recognition system tailored for attendance tracking and intruder detection, leveraging the power of Raspberry Pi.. The system not only automates attendance records, updating them in real time and sending them via email, Designed with cost efficiency in mind, it operates on low power and uses readily available components, such as an external camera and a PIR sensor for motion detection. This practical solution is particularly well-suited for use in hostels, schools, industrial facilities, and other environments requiring secure, contactless systems. Future plans for enhancement include incorporating advanced features like liveness detection, expanding the dataset for higher accuracy, and upgrading the hardware for improved portability and seamless IoT integration. These upgrades aim to position the system as a cutting-edge tool for modern surveillance needs.

I. INTRODUCTION:

In recent years, there has been a significant shift toward automation in personal and organizational security systems, driven by the need for efficiency, reliability, and scalability. Among the key areas gaining attention is the domain of attendance monitoring and intruder detection, especially in settings like educational institutions, hostels, offices, and industrial premises. Traditional attendance systems, such as manual logs or RFID-based swipe cards, are not only prone to human error and manipulation but also fail to provide real-time validation or remote accessibility. Likewise, conventional surveillance mechanisms often require continuous human supervision, making them resource-intensive and inefficient for large-scale or cost-sensitive environments.The emergence of Internet of Things (IoT) technologies, paired with advances in facial recognition, offers a transformative solution to these limitations. By enabling devices to communicate and perform intelligent tasks autonomously, IoT makes it possible to design smarter, real-time, and energy-efficient systems. Within this landscape, facial recognition stands out as a robust and contactless biometric method for identity verification, capable of both tracking attendance and identifying unauthorized individuals. The integration of these technologies with platforms like the Raspberry Pi—a compact, affordable, and programmable microcomputer—has enabled the development of sophisticated systems even in budget-constrained environments. This research introduces an IoT-based facial recognition system specifically tailored to two primary functions: automated attendance tracking and intruder detection. Designed using Raspberry Pi, a PIR motion sensor, and an external camera module, the system provides real-time image capture, facial authentication, and automated data updates. Attendance records are instantly generated and sent via email, reducing the administrative overhead and improving data accuracy. Meanwhile, the same setup is leveraged for motion-triggered surveillance to identify unrecognized faces, effectively functioning as a dual-purpose tool for both convenience and security. What makes this approach particularly compelling is its low-cost and energy-efficient design. Many existing systems in this space rely on expensive proprietary hardware or cloud services with high operational costs. In contrast, the proposed system prioritizes open-source libraries, locally stored data, and modular architecture, making it ideal for use in developing countries, educational hostels, and small-to-medium enterprises (SMEs). It also serves as an excellent prototype for future smart home and office applications, where compactness, autonomy, and affordability are essential.

II. LITERATURE SURVEY:

1. IoT-Based Security Systems Using Raspberry Pi

Several researchers have explored low-cost IoT security solutions using Raspberry Pi.

A study in International Journal of Engineering Research & Technology presents an IoT-based surveillance system that integrates sensors, cameras, and cloud connectivity for real-time monitoring and alerts.

These systems emphasize “affordability, remote access, and automation”, making them suitable for smart homes and institutions.

2. Intrusion Detection Systems (IDS) in IoT

A recent paper proposes a Raspberry Pi-based IDS that detects cyber threats and sends alerts via messaging platforms like Telegram.

Traditional IDS approaches also use tools like packet sniffers (e.g., Wireshark) to monitor suspicious network activity.

3. Smart Surveillance and Human Detection

A survey in Image and Vision Computing highlights different “human detection techniques” (HOG, Haar Cascade, CNN) implemented on Raspberry Pi.

Another system combines “PIR sensors + camera + image processing” to detect intruders and trigger alerts.

Common technologies:

- PIR sensors (motion detection)
- OpenCV (face detection/recognition)
- Camera modules

4. IoT-Based Home Security Systems

Research on Wi-Fi-enabled surveillance systems shows features like:

- Live video streaming
- Remote alerts
- Modular sensor integration

5. Intruder Detection & Theft Prevention Systems

IoT-based theft detection systems use:

- IR sensors
- Cameras
- Alarm systems

Low-cost sensors + Raspberry Pi = “effective real-time intruder detection”.

6. Attendance Systems Using IoT

A systematic review on IoT-based attendance systems shows that "RFID and biometric systems"are widely used. These systems:

- Eliminate manual attendance
- Prevent proxy attendance
- Provide real-time data logging

7. Integrated Systems (Attendance + Intruder Detection)

Advanced frameworks like "Pi-based security systems" combine:

- Recognition (authorized vs unauthorized users)
- Motion detection
- Cloud notifications

Conclusion of Survey

The literature shows that Raspberry Pi-based IoT systems are:

- Cost-effective
- Scalable
- Suitable for smart surveillance and automation

III. METHODOLOGY

1. System Overview

This system uses "RFID technology + Raspberry Pi + IoT" to:

- Automatically mark "attendance"
- Detect "unauthorized access (intruder)"
- Send "real-time alerts"

RFID replaces face recognition and makes the system "faster, cheaper, and more reliable"

2. Components Used

- Raspberry Pi
- RFID Reader (RC522)
- RFID Tags / Cards
- PIR Sensor (for intruder detection)
- Buzzer / LED
- Wi-Fi module (built-in)

RFID uses electromagnetic waves to read tag data without contact

3. System Architecture

(1) Input Layer

- RFID Reader scans tag
- PIR sensor detects motion (for security)

(2) Processing Layer (Raspberry Pi)

- Reads RFID UID (Unique ID)
- Compares with stored database
- Makes decision (authorized / unauthorized)

RFID reader sends tag data to Raspberry Pi for validation

(3) Storage Layer

Stores:

- Registered RFID IDs
- Attendance records
- Intruder logs

(4) IoT Communication Layer

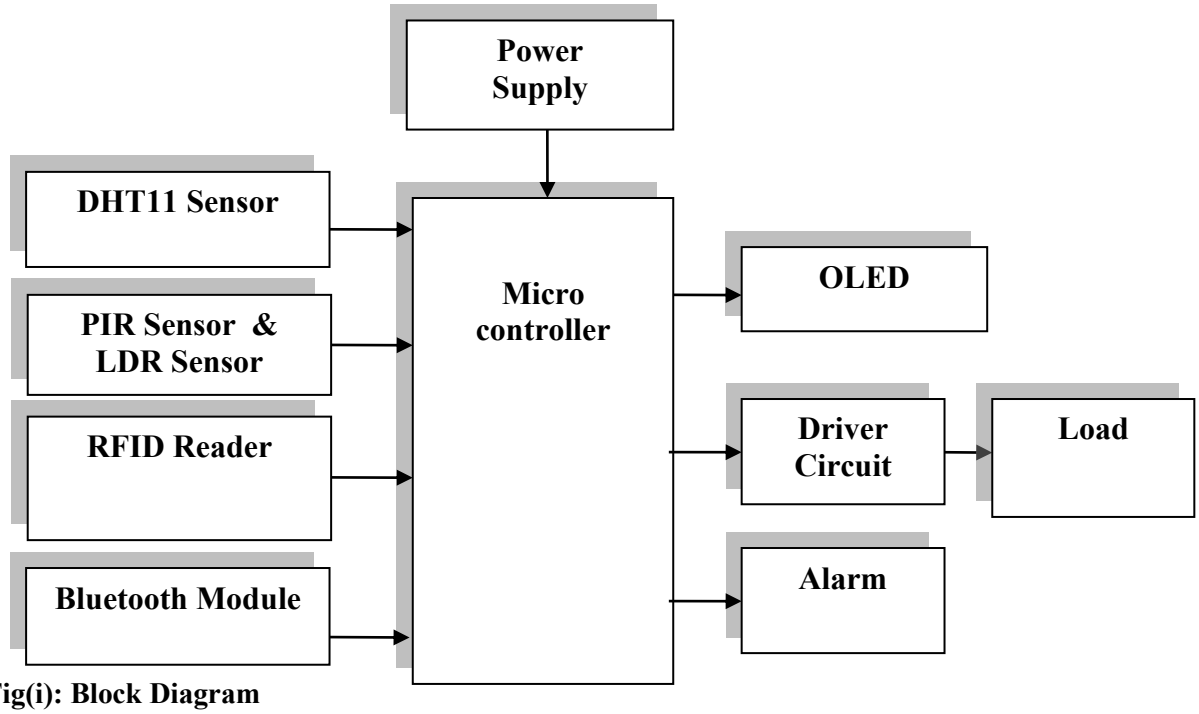
- Sends data to:
- Cloud / database
- Mobile alerts / email

5. Working Flow

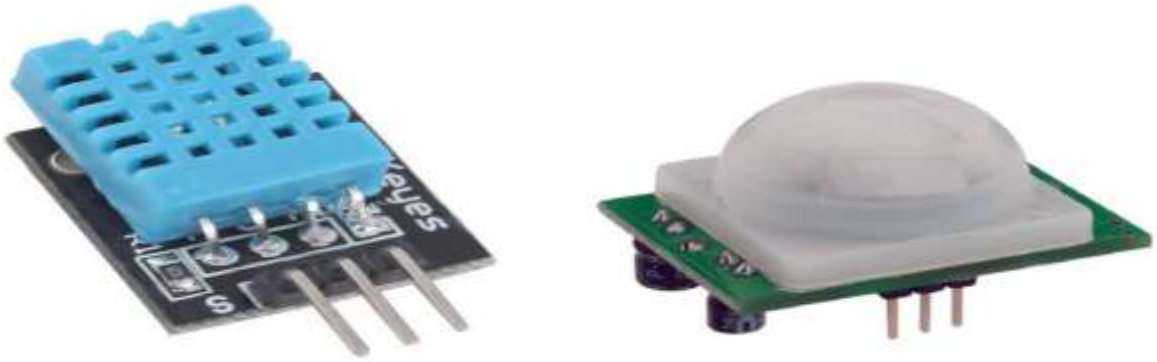
1. RFID tag scanned
2. Reader sends UID to Raspberry Pi
3. Pi checks database
4. If valid → attendance marked
5. If invalid → intruder alert
6. Notification sent via IoT

6. Key Features

- Fast and contactless attendance
- Low-cost system
- Accurate identification (no proxy)
- Real-time security alerts
- Easy to implement



Fig(i): Block Diagram



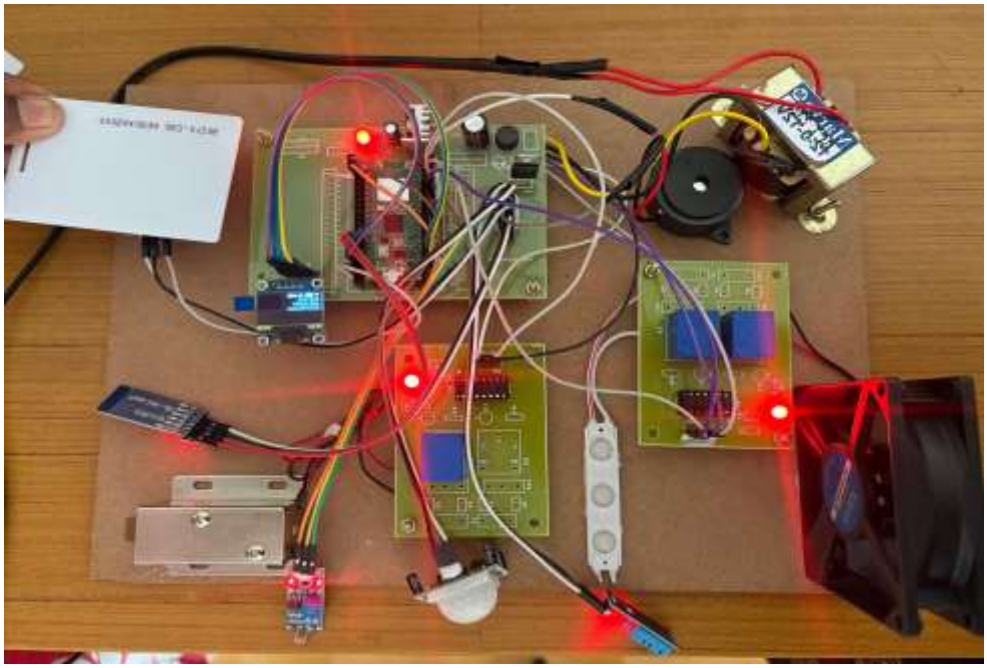
Fig(ii): Different Types Of Sensors Used

Fig(iii): Control System Design

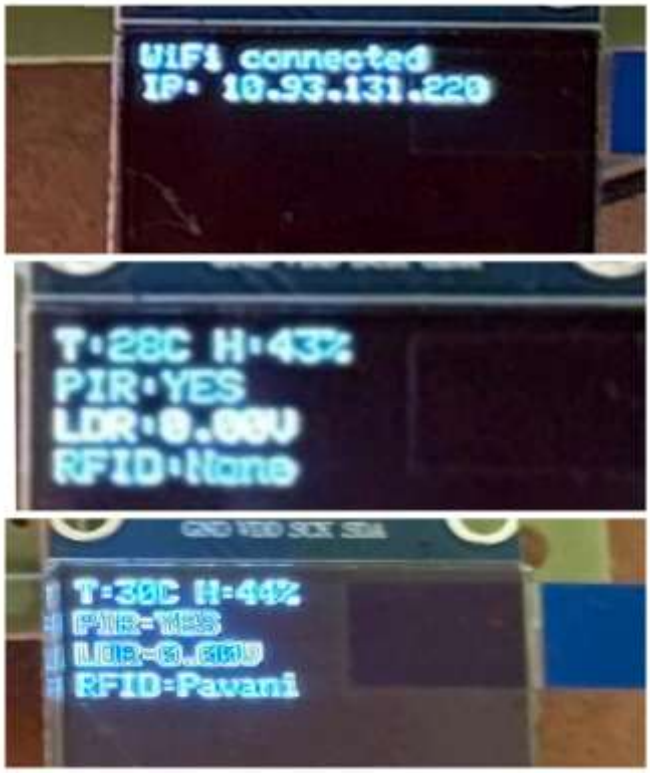
IV. RESULTS AND DISCUSSIONS

The developed 'affordable IoT security system using Raspberry Pi*'successfully performs both 'attendance monitoring' and 'intruder detection' in real time. The system integrates an 'RFID module' for attendance and sensors such as 'PIR (Passive Infrared Sensor)' for motion detection.

- The RFID reader accurately records attendance when authorized tags are scanned, and the data is stored in a database.The PIR sensor effectively detects human movement and triggers alerts when unauthorized motion is identified.
- The system sends notifications via IoT (e.g., mobile or web interface), ensuring remote monitoring.Additional components like buzzer/camera (if used) respond instantly during intrusion**.**Overall, the system operates reliably with low power consumption and minimal cost, making it suitable for small-scale applications like classrooms, labs, and homes.



Fig(iv): Results of all Measured Parameters using RFID Reader.



Fig(v): Results of all the measured parameters taken manually from kit

Conclusion:

The proposed IoT-based facial recognition system provides a smart, low-cost, and energy-efficient solution for both automated attendance tracking and intruder detection. By leveraging readily available components such as Raspberry Pi, PIR sensors, and external cameras, the system delivers real-time monitoring, seamless data handling, and contactless verification. Its practical design makes it highly adaptable for a range of environments including schools, hostels, and industrial sites. With planned enhancements like liveness detection and dataset expansion, the system holds strong potential to evolve into a more secure, accurate, and fully integrated surveillance tool. Overall, this work contributes meaningfully to the development of scalable, accessible smart security systems in the age of IoT.

Future Scope:

1. Integration with IoT Cloud: Real-time dashboard using Blynk or ThingSpeak.
2. Advanced AI: Implementing Convolutional Neural Networks (CNN) for higher accuracy.
3. Smart Door Lock: Actuating a solenoid lock upon recognizing a known person.

V . REFERENCES:

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