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RFID and Raspberry Pi based Attendance System Using Face Recognition

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Abstract
To Usually, schools have an attendance system where they are recorded manually by the teachers. Later this data is entered into a computer and the aggregate percentage of student's attendance is calculated. This method results in duplication of work and increases manpower requirements. Recently, student's attendance has been considered as one of the crucial elements or issues that reflects the academic achievements and the performance contributed to any school authorities compared to the traditional methods that impose time-consuming and inefficiency. Raspberry Pi microprocessors can be used to interface with an RFID (Radio Frequency Identification) reader to save user information and time to an SD (Storage Device) card. The reader can also emit radio frequency signals that are received by RFID tags, which then transmit their unique identification numbers. RFID is a wireless technology which uses to a purpose of identifying and tracking an object via radio waves to transfer data from an electronic tag, called RFID tag or label to send data to RFID reader, then immediately web camera starts to recognise the face of the student and marks his/her attendance. This Raspberry Pi based project is for reducing manpower and implementing automation of attendance system and furthermore being beneficial for the schools or any other workplace.

Keywords: *RFID, Raspberry Pi, face recognition.*

1. Introduction
Attendance tracking is a fundamental administrative task in educational institutions and workplaces. Traditional methods—such as manual registers or biometric systems—are often time-consuming, error-prone, and susceptible to manipulation. In response, Radio Frequency Identification (RFID) technology has emerged as a contactless, efficient alternative. When paired with the Raspberry Pi, a compact and cost-effective computing platform, RFID systems can be transformed into intelligent, automated attendance solutions. This was coming from our reference (Akbar, M. S. et al., 2018). Our project aims to develop an RFID and Raspberry Pi-based attendance system integrated with face recognition technology. This innovative approach automates the process of attendance tracking, ensuring accuracy, security, and convenience. By leveraging RFID (Radio Frequency identification) for quick identification and Raspberry Pi as the core processing unit, the system is highly customizable. The addition of face recognition enhances verification, preventing unauthorized access or fraudulent entries. This project has wide-ranging applications in educational institutions, workplaces, and events, providing a reliable and efficient solution for attendance management. Prior studies have demonstrated the viability of RFID-based attendance systems for reducing human effort and improving accuracy (Akbar et al., 2018). However, issues such as proxy attendance, lack of real-time data access, can be reduced with this project. Combining Raspberry Pi with facial recognition presents a promising solution by adding a biometric verification layer, improving reliability and reducing impersonation risks. The purpose of this work is to develop a low-cost, modular, and secure attendance system using RFID and Raspberry Pi, enriched with facial recognition and real-time feedback. It aims to contribute a

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practical and scalable framework for attendance tracking that meets modern requirements for transparency, security, and operational efficiency. The objective of this project is to develop a reliable RFID and Raspberry Pi-based attendance system using face recognition, ensuring a secure and automated attendance tracking for institutions and workplaces. By integrating RFID technology with facial recognition, the system will provide dual authentication to prevent fraudulent entries while ensuring accurate attendance records. Real-time data processing and secure storage using Raspberry Pi will enable efficient data acquisition, processing, and synchronization. A user-friendly interface will allow administrators to manage attendance records, generate reports, and analyze trends, while ensuring a seamless experience for users. Comprehensive validation and testing will assess recognition accuracy, RFID authentication reliability, and performance metrics to optimize the system's effectiveness, while comparative analysis against existing methods will highlight improvements in accuracy and efficiency. Potential expansions and future enhancements, such as biometric authentication, AI-driven analytics, and IoT-based notifications, will be explored to further enhance security and functionality. Through this work, the project contributes to advancing automated attendance systems, offering a secure, scalable, and intelligent solution for modern institutions. [1]

1.1.Hardware Requirements

1.1.1. Raspberry Pi 4

- It is a microprocessor for facial identification and image processing using machine learning.
- It acts as a central processing unit, capturing and processing data from sensors like cameras or RFID (Radio Frequency Identification) readers then storing and transmitting attendance records.

1.1.2. EM-18 Reader Module

- EM-18 is a RFID reader which is used to read RFID tags at a frequency of 125kHz.
- It is a compact and cost - effective RFID Reader module that allows easy integration of RFID functionality into projects requiring identification and tracking capabilities.

1.1.3. LCD Display

- LCD Displays are used to show information like the user's name, ID, attendance status (present/absent).
- LCD acts as a user - friendly interface, allowing users to interact with system and view their attendance.

1.1.4. Web Camera

- It is used to capture images of students in a classroom.
- Computer vision and Machine Learning algorithms are used to detect and recognize faces within the captured images.

1.1.5. SD Card

It is used to store the current time and the UID (unique identification number) of an RFID tag that is read by the RFID reader.

1.1.6. Wires

It is used for power, data communication and connecting various components like RFID reader and display screens to the main control unit.

1.2.Software Requirement

1.2.1. Thonny IDE

The Thonny IDE is a beginner-friendly integrated development environment designed for Python programming. It offers an intuitive interface for writing, debugging, and executing Python code, making it ideal for users at all skill levels. With features like a simple debugger, variable tracking, and step-by-step code execution, Thonny helps users understand Python programming concepts and troubleshoot efficiently. It's compatible with various platforms and provides seamless integration for microcontroller programming, such as with Raspberry. (Figure 1) A clear understanding of the general design and logic of working and also the identification of the major requirements of the prototype build a strong foundation about the work which would help in advancing to the implementation stage.

1.2.2. VNC Viewer

The VNC Viewer tool is highly beneficial in the RFID and Raspberry Pi-based attendance system as it enables remote access and control of the Raspberry

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Pi. With VNC Viewer, administrators can monitor and manage the system from any device, eliminating the need for physical interaction with the Raspberry Pi. This is particularly useful for troubleshooting, updating software, or accessing attendance data stored on the Raspberry Pi. The tool provides a graphical interface, making it user-friendly and efficient for managing the system remotely. (Figure 2)

Figure 1 Thonny IDE

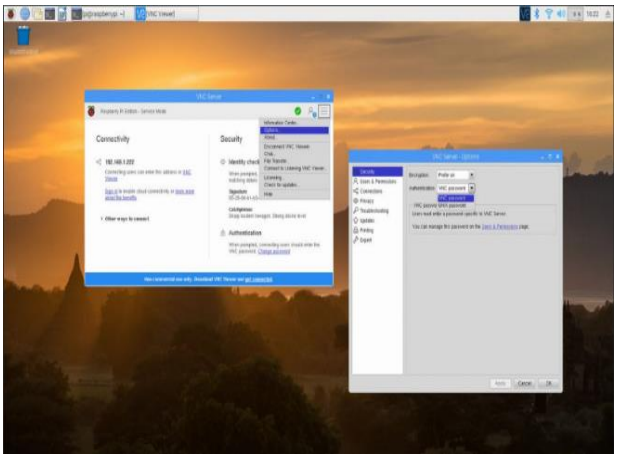

Figure 2 VNC Viewer

2. Methodology

The methodology outlines the step-by-step approach adopted to design and implement the hybrid attendance management system. The project integrates RFID technology and facial recognition on a Raspberry Pi platform, ensuring secure and automated tracking of attendance. [2]

System Design: It is the designing of the overall architecture of the RFID-based attendance system, including the hardware and software components. It includes the making of block diagram and circuit diagram. (Figure 3)

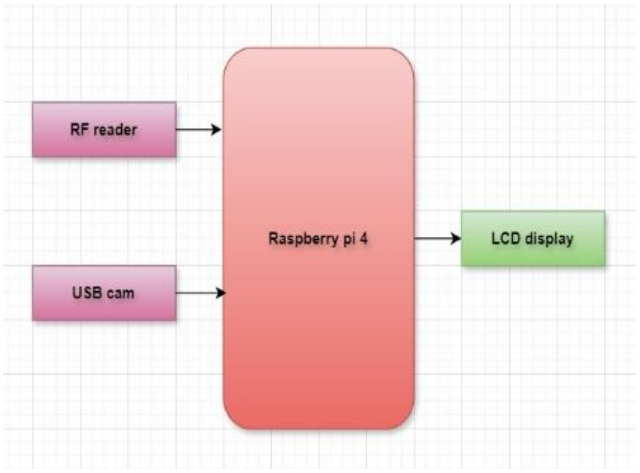

Figure 3 Block Diagram [1]

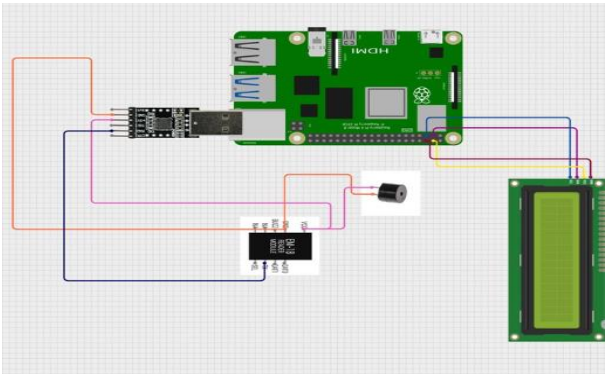

Figure 4 Circuit Diagram [2]

- **RFID Tag Selection:** Selecting suitable RFID tags that can be used for attendance tracking, considering factors such as range, frequency, and durability. [3]
- **RFID Reader Selection:** Select an RFID reader that is compatible with the chosen RFID tags and can connect to the Raspberry Pi. Here we have taken a EM-18 Reader Module. EM-18 is a RFID reader which is used to read RFID tags at a frequency of 125kHz. It is a compact and cost - effective RFID Reader module that allows easy integration of RFID functionality into projects requiring identification and tracking capabilities.

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- **Raspberry Pi Setup:** Set up the Raspberry Pi with the necessary operating system, software, and libraries to support the RFID reader and facial recognition system. Raspberry Pi Imager is used for the installation of OS (Operating System) in Raspberry Pi. Raspberry Pi Imager is the quick and easy way to install. [4]
- **Facial Recognition System:** Implement a facial recognition system using a library such as OpenCV, which can be integrated with the RFID system for dual authentication.
- **Database Design:** Design a database to store attendance records, including student/employee information, attendance timestamps, and other relevant details.
- **System Integration:** Integrate the RFID reader, facial recognition system, and database to create a seamless attendance tracking system.
- **Testing and Validation:** Test the system thoroughly to ensure accurate attendance tracking, and validate the results against manual attendance records.
- **Deployment:** Deploy the system in the desired location, such as a school or office, and provide training to administrators and users.
- **Maintenance and Updates:** Regularly maintain and update the system to ensure optimal performance, security, and functionality.

3. Results

The RFID and Raspberry Pi-based attendance system uses RFID tags for identification and Raspberry Pi for image processing and recording attendance data automatically. It ensures accurate, efficient and modern attendance tracking with real-time updates.

4. Discussion

The implementation of the RFID and Raspberry Pi-based attendance system demonstrated a significant improvement in automation, accuracy, and security compared to traditional attendance methods. By integrating RFID tag authentication with facial recognition, the system effectively mitigates the common issue of proxy attendance, which is frequently observed in educational and institutional settings. The combination of contactless card swiping and biometric verification ensures that attendance is both reliable and difficult to manipulate. One of the key advantages observed during testing was the real-time feedback mechanism enabled by the Raspberry Pi's interfacing with LCD and buzzer outputs. This immediate response system increased user engagement and clarity, allowing individuals to receive instant confirmation of a successful or failed attendance attempt. Furthermore, the use of Python allowed for efficient image processing, while the inclusion of a database ensured secure and organized data storage. (Figure 5) [5]

Conclusion

An RFID and Raspberry Pi-based attendance system integrated with face recognition offers a seamless, efficient, and secure way to automate attendance tracking. By combining RFID technology for swift identification and face recognition for enhanced verification, this system ensures accuracy and prevents fraudulent entries. The use of Raspberry Pi makes the setup customizable, and suitable for diverse environments, such as educational institutions and workplaces. This innovative approach enhances convenience while maintaining a high standard of reliability and security

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grateful to my family for their patience, motivation, and faith in my abilities during every phase of this project. This project reflects not only technical learning but also the strength of mentorship, teamwork, and perseverance.

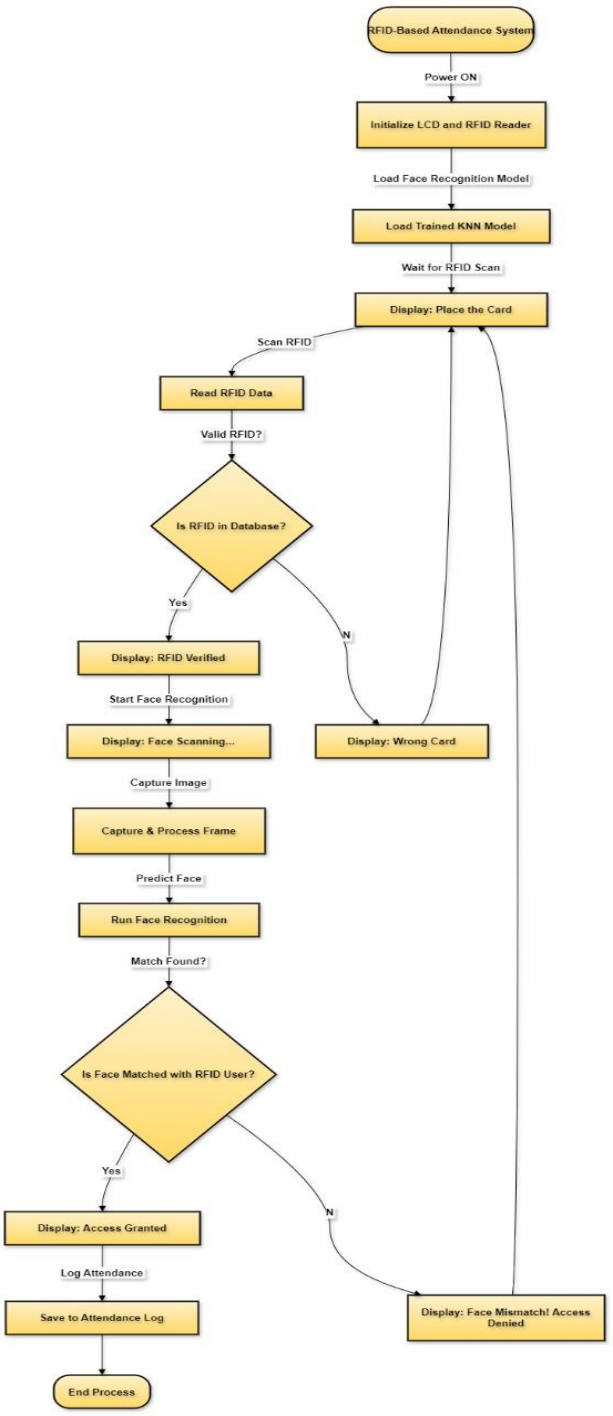

Figure 5 Flow Chart

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