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Smart Attendance Using Face Recognition and Fingerprint Using Raspberry PI

MR K Vinod Kumar[1], Dokuparthi Srividya [2], Erla Trimurthy [3], Shaik Abdul Rehaman [4], Uppu.Sravanthi[5], Thippireddy Venkata Siva Sai Reddy [6]

[1]Associate Professor, Dept. Of ECE, PBR VITS, Kavali, Nellore District, Andhra Pradesh, India
[2-6]UG Students, Dept. Of ECE, PBR VITS, Kavali, Nellore District, Andhra Pradesh, India

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ABSTRACT - The Raspberry Pi-based smart attendance system using face recognition and fingerprint authentication is an intelligent monitoring system designed to automate attendance management in educational institutions and workplaces using advanced biometric technologies. The system is built around a Raspberry Pi microprocessor, which controls the overall operation of user identification and attendance recording. The system integrates a USB web camera for capturing facial images and an R307 fingerprint sensor for secure biometric verification to ensure accurate and reliable user authentication. The Raspberry Pi processes the captured biometric data using image processing and fingerprint matching algorithms to identify authorized individuals and record attendance automatically. An I2C LCD display is used to provide real-time system messages and attendance status to users, while a GSM communication module sends instant SMS notifications to administrators, teachers, or parents regarding attendance updates. The system stores attendance records in a digital database or Excel sheet for future reference and monitoring. Designed for educational institutions and organizational environments, this system reduces manual effort, prevents proxy attendance, improves accuracy, and promotes secure and efficient automated attendance management practices..

Key Words: Smart Attendance System, Face Recognition, Fingerprint Sensor, Raspberry Pi, Biometric Authentication.

1. INTRODUCTION

A Smart Attendance System is a combination of computer hardware and software, along with biometric sensors and communication modules, designed to perform a specific function of automatically recording and monitoring attendance in educational institutions and workplaces. A good example is the biometric attendance system used in colleges and offices. Many organizations use such systems every day to manage attendance records efficiently, but very few people realize that technologies such as face recognition, fingerprint authentication, and embedded processors like the Raspberry Pi are involved in identifying individuals and securely storing their attendance information.

This is in direct contrast to the traditional manual attendance system used in classrooms or offices. It also involves registers, writing materials, and human supervision to record attendance. However, a manual attendance system is not designed to provide automatic identification or real-time monitoring; rather, it depends on human effort and is more prone to errors and misuse. Many people use the term automated attendance system to make this distinction clear. As implemented, an automated attendance system works intelligently by verifying user identity and recording attendance without manual intervention. One institution may use it for monitoring student attendance, another may use it for employee time tracking, and a third may use it to maintain secure attendance records in restricted environments.

smart attendance system is a component within a larger management or security system. For example, modern educational institutions and organizations use multiple automated systems to improve efficiency and safety. One system controls attendance monitoring, another manages access control to secure areas, and a third provides communication through SMS notifications to administrators or parents. In some cases, these systems are connected through network communication or database systems to share information and generate reports, but that is not always a requirement for basic attendance functionality.

2. LITERATURE SURVEY

Several research works have been carried out in the field of biometric identification systems, image processing techniques, and automated attendance monitoring technologies to improve attendance accuracy and system efficiency. One such work titled **"Automated Attendance Monitoring System Using Face Recognition"** proposes an attendance management system that records attendance automatically using facial recognition instead of traditional manual methods. The system uses face detection and recognition algorithms such as Haar Cascade Classifier and Local Binary Patterns Histogram (LBPH) to identify individuals in real time and store attendance records in a database. This approach improves efficiency, reduces manual errors, and prevents proxy attendance in educational institutions.

Similarly, another study titled **"Biometric Attendance System Using Fingerprint Recognition on Raspberry Pi"** focuses on developing a secure authentication system using fingerprint sensors for identity verification. The research examines factors such as fingerprint image quality, database size, matching algorithms, and system response time to ensure reliable attendance recording. These systems demonstrate the advantages of biometric authentication in improving security and accuracy in attendance management. Overall, these studies indicate that integrating biometric technologies, embedded systems, and automated monitoring solutions can significantly enhance attendance efficiency, reduce administrative workload, and provide secure and reliable attendance tracking in modern institutions

3. EXISTING SYSTEM

Traditional attendance management systems still rely on manual registers or basic identification methods for tasks like recording student or employee attendance in institutions and workplaces. These methods are time-consuming, inconsistent, and unreliable due to human errors and dependency on manual supervision. Manual processes often lead to proxy attendance, incorrect record keeping, and delays in updating attendance data, especially in large classrooms or organizations. Moreover, increasing administrative workload and the lack of automated monitoring reduce the overall efficiency, accuracy, and reliability of attendance management systems.

4. PROPOSED SYSTEM

The proposed model is a Raspberry Pi-based smart attendance system designed to automate attendance monitoring and secure identification using face recognition and fingerprint authentication technologies. A Raspberry Pi microprocessor acts as the central control unit, interfacing with a USB web camera to capture facial images and an R307 fingerprint sensor to verify user identity through biometric authentication. An I2C-based LCD display is employed to provide real-time system messages and attendance status to users, while a GSM communication module supports sending instant SMS notifications to administrators or authorized personnel. The system is integrated with image processing and fingerprint matching algorithms, allowing automatic attendance recording and secure data management through digital storage such as an Excel sheet or local database. Power is supplied through a regulated power supply to ensure stable system operation and reliable performance. All hardware components are assembled in a compact enclosure to provide safe and continuous operation in institutional environments. This proposed system reduces manual effort, improves attendance accuracy, and supports efficient and secure automated attendance management in educational institutions .

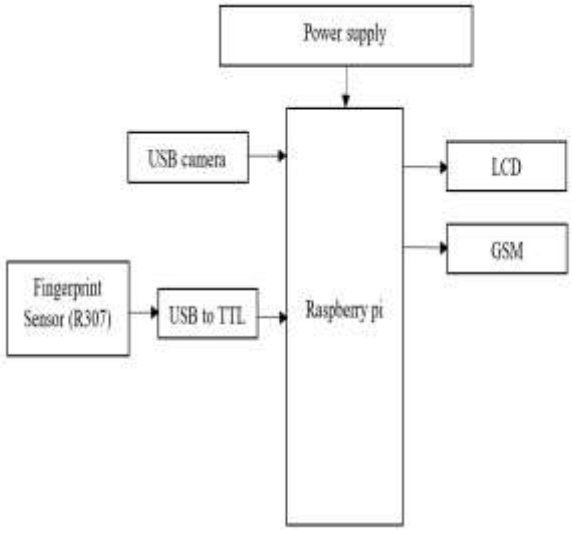

Fig 4.1:Block Diagram of Proposed System

Initially, the user interacts with the smart attendance system by placing their finger on the fingerprint sensor connected to the Raspberry Pi. The system prompts the user through messages displayed on the LCD screen, indicating the readiness of the device to capture biometric data. When the user places their finger on the sensor, the fingerprint

image is scanned and transmitted to the Raspberry Pi for processing and verification against the stored fingerprint database. If the fingerprint matches with a registered user, the system proceeds to the next stage of authentication. If the fingerprint does not match, the system denies access and displays an error message on the LCD screen.

The system then activates the face recognition process using a USB web camera connected to the Raspberry Pi. When the user's face is detected, the camera captures the facial image and sends it to the Raspberry Pi for analysis using face recognition algorithms.

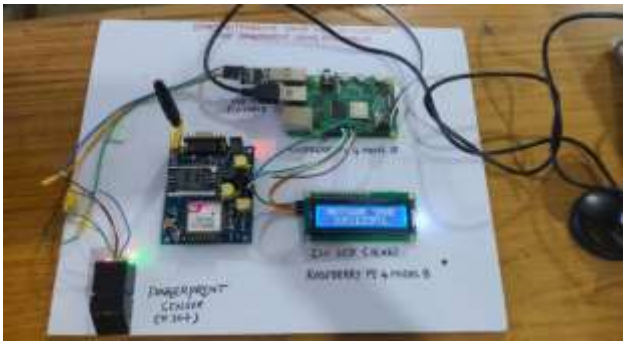

Fig 4.2:Working Model of the Proposed System

For attendance recording, once both fingerprint and face authentication processes are successfully completed, the Raspberry Pi automatically records the user's attendance details such as name, date, and time in a digital database or Excel sheet stored in the system. At the same time, the LCD display shows a confirmation message indicating that attendance has been successfully recorded. This ensures accurate and secure attendance management without manual intervention.

For communication and notification, the system uses a GSM module connected to the Raspberry Pi. When attendance is successfully recorded, the Raspberry Pi sends a command to the GSM module to transmit an SMS notification to authorized individuals such as parents, teachers, or administrators. The message contains information about the user's attendance status and time of entry. Through this working mechanism, the proposed system enables secure and automated attendance monitoring using biometric authentication technologies. The integration of the Raspberry Pi controller, fingerprint sensor, face recognition camera, and GSM communication module allows the system to perform attendance operations efficiently and reliably in educational institutions and workplaces.

ADVANTAGES

- Automated
- Accurate
- Secure
- Efficient
- Time-saving

APPLICATIONS

- Educational institutions
- Corporate offices
- Government organizations
- Banking sectors

5. RESULTS AND DISCUSSIONS

The proposed smart attendance system was successfully implemented using the Raspberry Pi platform. The system automatically records attendance using biometric authentication methods such as fingerprint recognition and face detection. The user interacts with the system by placing their finger on the fingerprint sensor and positioning their face in front of the camera. commands to the Arduino Mega 2560 controller. The Arduino Mega 2560 processes these The system receives biometric input data and performs user identification through image processing and fingerprint matching algorithms. The captured data is processed by the Raspberry Pi controller, which verifies the identity of the user and records attendance details in a digital file or database. When an unauthorized user attempts access, the system denies authentication and displays an appropriate message on the LCD screen.

Fig. 5.1: Place Finger

When the user places a valid finger on the fingerprint sensor, the system activates the face recognition process as shown in Fig.5.2. The camera captures the facial image of the user, and the Raspberry Pi compares the image with the stored database to confirm the user's identity. Once the face is successfully recognized, the system records attendance details such as name, date, and time. The LCD display shows a confirmation message indicating successful attendance recording.

Fig. 5.2: User Performing Fingerprint Authentication

When attendance is successfully recorded, the GSM communication module is activated as shown in Fig.5.3. The system sends an SMS notification to authorized individuals such as parents, teachers, or administrators informing them about the attendance status. If the user is not recognized, the system displays an error message and attendance is not recorded.

The experimental results demonstrate that the proposed smart attendance system can successfully perform automated attendance recording using biometric authentication technologies. This system helps in reducing manual work, preventing proxy attendance, improving attendance accuracy, and supporting efficient and secure attendance management in educational institutions and workplaces.

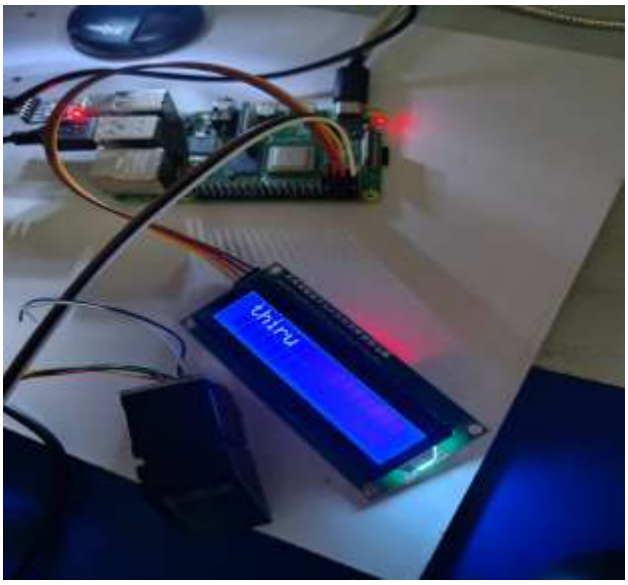

Fig. 5.3: Raspberry Pi and LCD Display Showing System

Similarly, when the attendance process is successfully completed, the GSM module is activated and an SMS notification is sent to authorized individuals such as parents, teachers. When the system detects an unauthorized user or mismatch in biometric authentication, the attendance process is stopped and an error message is displayed on the LCD screen shownFig.5.4.

Fig. 5.4: Showing the Process in Terminal Window

The experimental results demonstrate that the proposed smart attendance system can successfully perform automated attendance recording using biometric authentication technologies such as face recognition and fingerprint verification.

This system helps in reducing manual effort, preventing proxy attendance, and supporting efficient and secure attendance management in educational institutions and workplaces.

6. CONCLUSION AND FUTURESCOPE

The Raspberry Pi-based smart attendance system presents an efficient and reliable solution for modern attendance management challenges in educational institutions and workplaces. By automating critical attendance tasks such as user identification and attendance recording, the system minimizes manual effort, enhances accuracy, and improves overall administrative efficiency. The integration of the Raspberry Pi controller with a fingerprint sensor, face recognition camera, LCD display, and GSM communication module ensures secure and dependable attendance operations. The use of biometric authentication as the primary identification method makes the system highly secure and prevents unauthorized access or proxy attendance. Furthermore, the integration of communication technology enables real-time monitoring and notification, offering convenience and better control to administrators. This proposed system is especially beneficial for institutions seeking affordable and secure automation solutions. Overall, the model supports efficient attendance management, promotes system reliability, and contributes to the advancement of smart and automated monitoring technologies.

FUTURE SCOPE

A smart attendance system offers numerous possibilities for enhancing accuracy, security, and efficiency in attendance management practices. In future, by adding advanced technologies such as cloud storage and mobile application support, the system can enable remote monitoring and easy access to attendance records from anywhere. By integrating additional features such as RFID modules, artificial intelligence-based face recognition, and internet connectivity, the system can automatically detect users faster and provide real-time attendance analysis, thereby minimizing manual supervision and improving the performance of smart attendance systems.

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