AI Based Attendance and Access Control Security System Using Raspberry Pi

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Abstract: *This paper presents an AI based attendance and access control system using a Raspberry Pi platform, designed to improve security and automate traditional attendance methods. The system uses face recognition to automate attendance and improve security. It reduces manual work and prevents proxy attendance. Conventional attendance systems such as manual registers, RFID cards, & fingerprint scanners have limitations like proxy attendance, time consumption, and hygiene problems. To overcome the issue the proposed system uses a camera module integrated with Raspberry Pi and applies face recognition techniques using RealVNC and machine learning algorithms. This system is cost effective, efficient, and scalable for real world applications such as schools, offices and secure environments. The system captures real time facial images, detects and recognizes faces, and compares them with a stored database to mark attendance automatically. Additionally, the system controls access by allowing only authorized individuals to unlock the door using a relay module, while unauthorized attempts trigger alerts. Experimental results show that the system provides high accuracy, reduces manual effort, and enhances security in institutions and workplaces*

Keywords: RFID, Face recognition, Detection, Accuracy, RealVNC, Raspberry Pi, Camera.

I. INTRODUCTION

In recent years, the demand for smart and automated systems has increased significantly due to rapid advancements in Artificial Intelligence (AI) and embedded systems. Traditional attendance systems such as manual registers, RFID cards, and biometric systems are widely used but have several limitations. Manual systems are time-consuming and prone to human errors, while RFID cards can be misused through proxy attendance.

II. LITERATURE SURVEY

The literature survey provides an overview of existing attendance and access control system and highlights their limitations which led to the development of AI-based solutions. The traditional method of attendance involves maintaining registers where attendance is marked manually. Although simple and low cost, it is time consuming, prone to human errors, and allow proxy attendance. Biometric systems use physical characteristics such as fingerprints or iris recognition for identification. These systems provide better security compared to manual and RFID methods. The literature survey shows that while traditional and existing systems have certain advantages, they have also have significant drawbacks. The proposed AI-based system aims to overcome these challenges effectively.

III. METHODOLOGY

System Overview: The proposed system is built using Raspberry Pi, a camera module, and AI-based face recognition techniques.

Image Acquisition: The system uses a camera connected to the Raspberry Pi to capture real-time video frame.
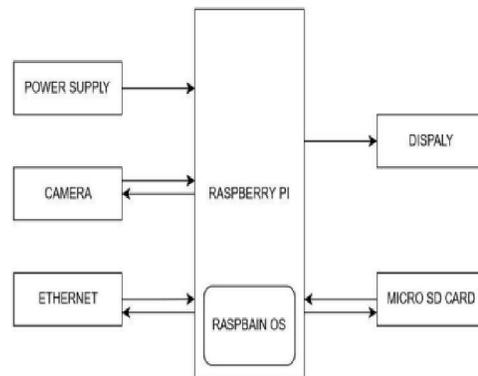
Face Detection: The system identifies the presence of a human face in the captured image using algorithms like RealVNC.

Database Management: A database is used to store user details such as name, roll no., face data.

Attendance Marking: Once the face is recognized, the system marks attendance automatically in the database.

IV. SYSTEM DESIGN

Face Recognition Library:- Face recognition algorithm can extract features from a face image namely positions of forehead, eyes, nose, mouth, chin, jaws.

Face landmarks:- There are 68 specific points that exist on every face.

Face Encodings:- This is the 128 encoding feature vector from a retrained network over millions of images.

V. IMPLEMENTATION

1. Hardware Setup:

The system is built using Raspberry Pi as the main processing unit. A camera module is connected to capture real-time facial images. A relay module is interfaced with the Raspberry Pi to control the electronic door lock. Additional components like LED indicators and buzzer are used for status indication and alerts.

2. Software Setup

The system is implemented using Python programming language. Libraries such as RealVNC are used for face detection and image processing. Face recognition algorithms are trained using datasets of authorized users.

3. Dataset Collection

Images of authorized individuals are captured and stored in a dataset. Each image is labeled with the person's name or ID. Multiple images are taken under different lighting and angles to improve accuracy.

4. Model Training

The collected dataset is used to train the face recognition model. Feature extraction techniques convert facial data into numerical representations. The trained model is saved and used for real-time recognition.

5. Real-Time Face Recognition

The camera continuously captures video frames for processing. Faces are detected and matched with stored data using RealVNC. If a match is found, the person's identity is displayed on the screen.

6. Attendance Recording

Once the face is recognized, attendance is automatically recorded in the database. The system stores details such as name, date, and time. Duplicate entries for the same person on the same day are avoided.

7. Access Control Integration

The system integrates access control using a relay module and electronic lock. If the recognized person is authorized, a signal is sent to unlock the door. If the person is unknown, access is denied and an alert is triggered.

8. User Interface

A simple interface is provided to display recognized faces and system status. It may include attendance logs and system notifications.

9. Testing and Validation

The system is tested under different conditions such as lighting, distance, and multiple users. Performance metrics like accuracy and response time are evaluated.

10. Challenges Faced

Lighting variations
Face angle differences
Processing speed limitations
Problems: Light change
            Face angle
            Speed issue

11. Final Deployment

The system is installed at entry points such as doors or gates for real-time operation.

VI. RESULT

The result of the proposed AI based attendance and access control system demonstrate its effectiveness in real time face recognition, attendance marking, and security management.

- System Accuracy
- Real time performance
- Attendance efficiency
- Access Control performance
- User convenience
- Security enhancement

VII. ADVANTAGES

- Contactless operation
- High security
- No proxy attendance
- Time efficient
- Cost effective
- Real time monitoring
- Automatic record keeping
- Easy to use
- Multi functionality
- Better accuracy

VIII. APPLICATION

- Schools & Colleges
- Offices & Companies
- Hostels
- Industrial areas
- Government Buildings
- Libraries & Labs

IX. FUTURE SCOPE

1. Cloud Integration
The proposed system can be further enhanced with advanced technologies to improve performance, scalability and usability. The system can be connected to cloud platforms for storing and accessing data remotely.

2. Mobile Application Integration
A mobile app can be developed for real-time attendance monitoring and notifications.

3. Mask Detection
The system can be upgraded to detect faces even when users wear masks.

4. Improved AI Algorithms
Advanced machine learning and deep learning models can increase accuracy.

5. Multi-Camera Support
Multiple cameras can be integrated for covering large areas.

6. Voice Recognition Integration
Voice recognition can be added as an additional security layer.

7. IoT Integration
The system can be connected with IoT devices for smart automation.

8. Real-Time Alerts & Notifications
Instant alerts can be sent via SMS or email for unauthorized access.

9. Data Analytics
Attendance data can be analyzed to generate reports and insights.

10. Integration with Other Security Systems
It can be integrated with CCTV and alarm systems for enhanced security.

11. High-End Hardware Upgrade
Using advanced devices instead of Raspberry Pi can improve speed and performance.

X. CONCLUSION

The Automatic Attendance System Based on Face Detection and Recognition using Raspberry Pi and RealVNC provides an efficient, contactless, and secure method for attendance tracking. By leveraging the machine learning algorithm for face detection and an optimized recognition model, the system ensures real-time identification with minimal error. The integration of a structured database allows seamless record-keeping, eliminating the need for manual attendance. This system not only enhances accuracy but also reduces the administrative workload in institutions and organizations. Overall, it demonstrates the potential of face recognition technology in automating everyday tasks, improving security, and ensuring a streamlined attendance process.

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