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RFID-Based Attendance System with Camera Screen

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Abstract: ***This paper proposes a dual-authentication-based smart attendance system, integrating Radio Frequency Identification (RFID) with an ESP32-CAM image capture module. Conventional attendance systems, which work on manual entry or RFID single-factor authentication methods, are subjected to proxy manipulation and human error. The proposed attendance system verifies the attendance of individuals at two stages. At the first stage, RFID tags attached to the users are scanned; simultaneously, a live face image is captured. In parallel to the process flow, at the instant of scanning, the RFID UID is read by Arduino Uno, which is then reflected for instant feedback onto the LCD, buzzer, and LED indicators. Simultaneously, ESP32-CAM captures the user image, encodes it in base64 format, and sends it with the user's unique identifier (UID) to the MySQL database using the XAMPP local server. The model was implemented in real environments and recorded high accuracy, fast authentication, and reliable image logging. The designed model is cost-effective, scalable, and meant for educational institutions and workplaces where safeguarded attendance tracking is needed.***
Keywords: RFID, ESP32-CAM, IoT Attendance System, Dual Authentication, Image Capture, Automation.

I. INTRODUCTION

Attendance monitoring remains one of the chief requirements in any educational or working facility. Paper-based attendance suffers from inefficiencies due to time delay, inconsistency, and a possibility of proxy marking. Biometric attendance systems guarantee some enhancements but suffer from hygiene concerns, slower processing during peak hours, and dependency on environmental factors.

As a result, RFID-based systems gained popularity for their speed and convenience. However, as described earlier, RFID alone cannot prevent proxy usage since anyone with a registered card can mark attendance. There exists the need for a hybrid system that can ensure both identity authentication and quick processing.

The paper proposes an intelligent attendance framework by using RFID for user identification and ESP32-CAM for capturing the live image of the user. This combination increases the security of the system and overcomes the drawbacks of a single-factor attendance system.

II. LITERATURE REVIEW

Various automated systems for attendance have been proposed using biometrics, RFID, and image processing. One important contribution was a model based on face recognition that improved identity verification and minimized the problem of proxy attendances.

[1] Al-Muhaidhri and Hussain elaborated face-recognition-based attendance system to eliminate errors, which would also avoid proxy attendance.

Another study was devoted to enhancing attendance reliability by means of biometric features, specifically fingerprints, for the accurate authentication of users and prevention of identity misuse. This method strengthened security in an environment where proxy attendance was habitual.

[2] Olagunju et al.introduced a fingerprint-based staff attendance monitoring system that could minimize buddy punching.

The researchers also sought low-cost automated solutions using RFID technology, allowing unique identification tag IDs to simplify student identification and record keeping. Such systems proved effective for contactless, quick attendance in large institutions.

[3] Ula et al. proposed an RFID-based attendance system that automatically tracked the students by means of tag-based recognition.

Another approach used computer vision methods to automatically recognize faces and update the attendance without user intervention. This model thus relies on real-time image processing for verification based on facial features.

[4] Bhatti et al. implemented a face-recognition-based automated attendance platform using image processing techniques.

A more advanced hybrid technique used RFID tag scanning along with face verification for added security. This two-tiered system made sure that attendance would be marked only when the tag, as well as the face, matched with the registered user.
[5]Sruthi et al. proposed a hybrid RFID and face recognition system for secure double-layer authentication.
While most of the existing works focus on automation and accuracy through biometrics, RFID, or facial recognition, none of these offer a low-cost, real-time dual authentication integrating RFID with ESP32-CAM-based live image capture. This gap is effectively addressed in the system proposed here.

III. SYSTEM ARCHITECTURE

A. *OVERVIEW*

The system uses two major authentication steps:

1) Reading the RFID UID using Arduino and RC522 module
2) Capturing a live face image using ESP32-CAM and uploading it to a database.

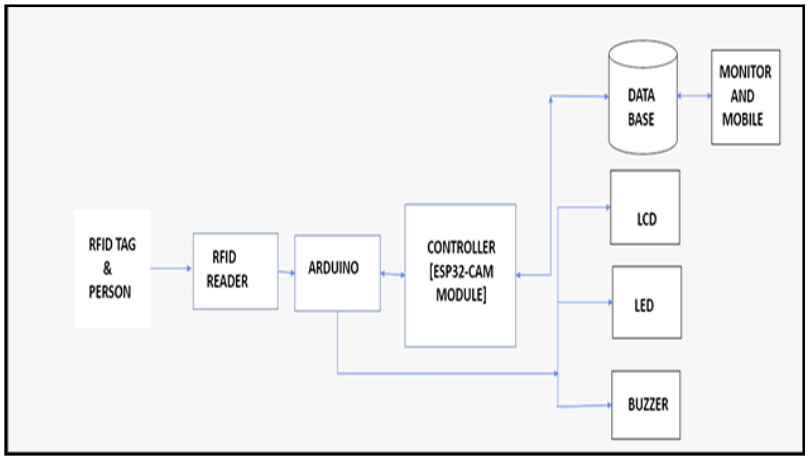


Figure1:BlockDiagram

B. *COMPONENTS USED*

1) HARDWARE:-

The hardware components used in the system include Arduino Uno, RC522 RFID Reader, ESP32-CAM module, 16×2 LCD display, LED indicators, buzzer, and 5V power supply.

2) SOFTWARE :-

These are the software components used in the system: Arduino IDE, ESP32-CAM firmware, PHP scripts, MySQL database, and XAMPP server.

IV. METHODOLOGY

A. *ENROLMENT PROCESS*

The users register themselves by capturing the RFID UID and associating that to their details. In addition, the reference face image is stored in the database for purposes of verification.

B. *ATTENDANCE PROCESS*

Attendance:

1) The RFID UID is read.
2) ESP32-CAM takes a new image.
3) The server stores the UID, image, and timestamp.
4) Admins can view logs through the web dashboard.

C. *DATA STORAGE*

The MySQL database contains user information, attendance logs, and the Base64 encoded facial images, which can be retrieved easily and accessed securely.

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V. RESULTS

The system displayed the welcome messages, detected RFID tags, captured face images, and updated MySQL records correctly. Monitoring in the web dashboard showed real-time representations with correct timestamps and user images. Correspondingly, error cases like unauthorized UID or face mismatch resulted in red LEDs and buzzer alerts.

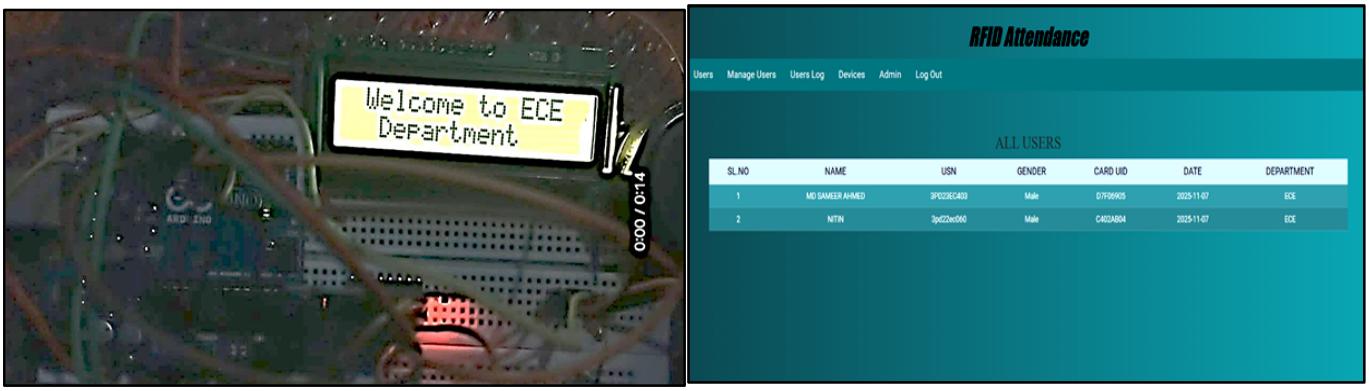


Figure 2: System output showing the LCD welcome message, and the web dashboard displaying the user details.

1) Observed Performance:

- Accuracy: 98% successful authentication during testing
- Average Response Time: Less than 2 seconds
- Causes of Failure: Poor light, wrong camera angle

2) Database Functionality

The MySQL interface displayed user information, timestamps, and stored images correctly. Admins were able to filter or export attendance data efficiently.

VI. CONCLUSION

The given study demonstrates that the integration of RFID identification and live face capture with ESP32-CAM offers a secure, efficient, and low-cost solution for managing attendance. The system has shown ample potential in overcoming the drawbacks presented by both traditional and biometric methods while offering dual authentication, real-time data storage, and ease of usage. These results support the efficiency and suitability of the design to be deployed within schools, colleges, offices, and secure premises. Future research could aim at cloud deployment, mobile application-based authentication, and AI-driven face recognition to improve performance.

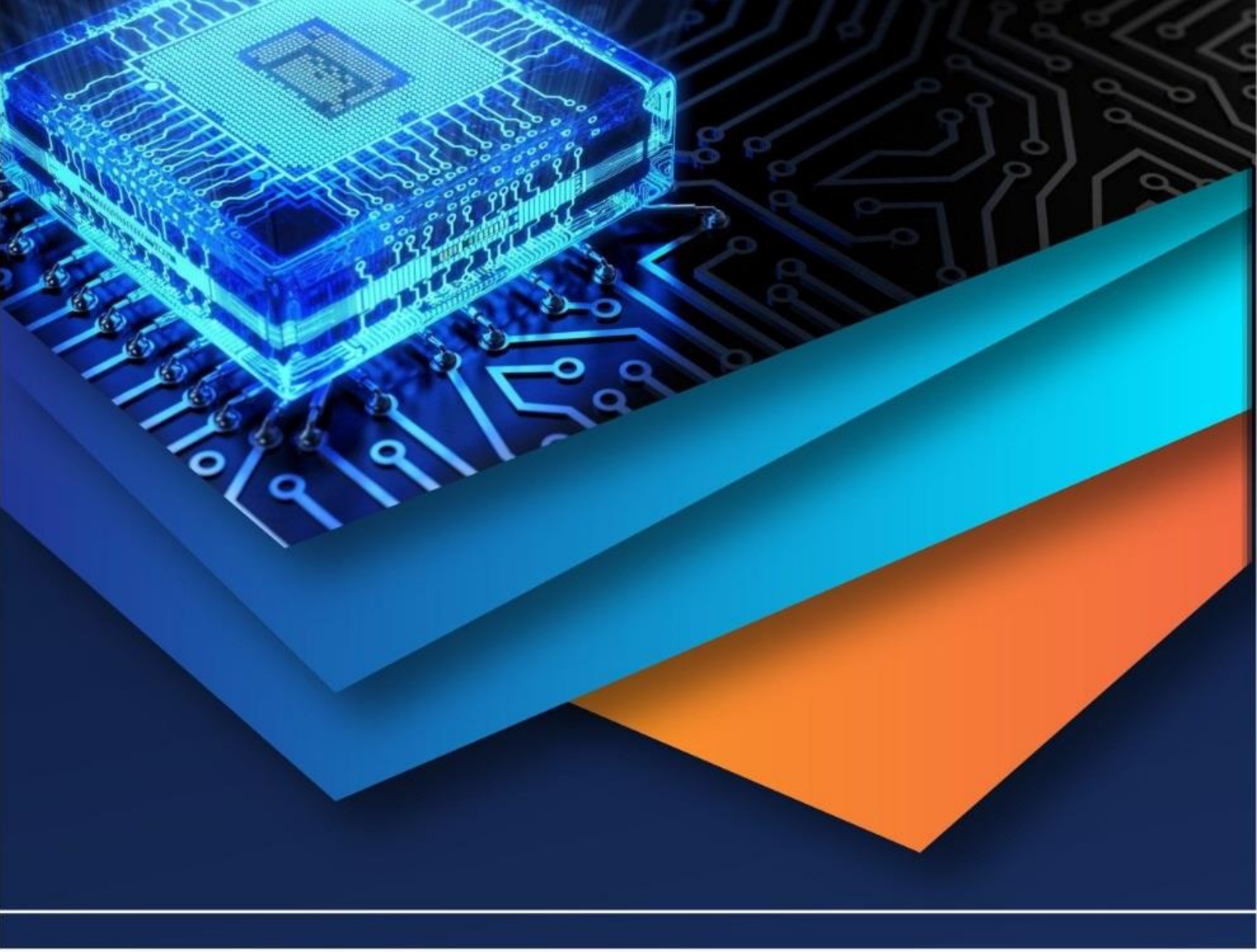
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