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IoT based Biometric Student Access Control and Attendance Management

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Abstract: ***The Fingerprint-Based Attendance Management System offers an innovative solution for automating attendance tracking in educational institutions. Utilizing an ATmega328 microcontroller and fingerprint sensor, the system enables efficient capture of student attendance data. Real-time feedback is provided through an LCD display, ensuring users are promptly informed of authentication status. Captured fingerprint IDs are transmitted to a cloud-based server for comparison with stored student records. Upon successful matching, attendance is marked, and SMS notifications are sent to parents, enhancing communication and transparency. Additionally, a teacher management interface within the cloud system allows for recording student internal marks and managing attendance records. The system prioritizes security, reliability, and accuracy to maintain the integrity of attendance data. By streamlining attendance tracking processes and improving communication between schools and parents, the system contributes to enhanced efficiency and accountability in educational institutions.***
Keywords: ***iot, fingerprint, embedded, cloud, database***

I. INTRODUCTION

In educational institutions worldwide, the accurate tracking of student attendance remains a critical administrative task. Traditional methods, such as manual recording or barcode scanning, often prove time-consuming and prone to errors. In response to these challenges, the Fingerprint-Based Attendance Management System presents a modernized approach, leveraging biometric technology to streamline attendance tracking processes. By employing an ATmega328 microcontroller and fingerprint sensor, this system offers a reliable and efficient means of capturing student attendance data. The primary objective of this project is to develop a robust attendance management system that not only automates the attendance tracking process but also enhances its accuracy and reliability. Through the integration of advanced hardware components and cloud-based storage, the system ensures real-time data transmission and secure storage of attendance records. Moreover, by providing instant feedback on authentication status through an LCD display, the system enhances user experience and transparency. The Fingerprint-Based Attendance Management System also addresses the need for improved communication between educational institutions and parents. Upon successful authentication, the system triggers SMS notifications to inform parents of their child's attendance. Furthermore, a teacher management interface within the cloud system facilitates the recording of internal marks and simplifies attendance record management, contributing to the overall efficiency and effectiveness of educational administration. With its focus on automation, accuracy, and communication enhancement, the Fingerprint-Based Attendance Management System represents a significant advancement in attendance tracking technology. By streamlining administrative processes and promoting transparency, the system aims to optimize educational operations and foster a conducive learning environment for students.

II. PROBLEM STATEMENT

A. Literature Survey

Old ways to track who comes to school take too long and make mistakes. They use paper or manual entry, which means it's hard to know if students are really there. But now, things are changing with new tech that uses body data and the internet to manage who's in class. These new systems don't let people cheat their way into class and give real-time data on who's there. The tech also lets all the devices talk to each other so school staff can check who's in class from far away and get full reports on attendance right away. By using these new tools, schools can keep a close eye on who's in class and do so without much work. This way, they can follow the rules on attendance and make sure everything runs smoothly. Overall, these new ways are a big jump in solving the issues with old methods and offer a good, precise, and fast way to manage who's in school in this day and age.

The paper [1] Face detection in real-time is a component of an automated face recognition system that is also employed in the development of a separate research subject. As a result, there are a variety of ways for dealing with face detection issues.

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The paper [2] describes about the usage of algorithms for the real-time recognition of traffic signs to alert the driver. Using this tech for more than just traffic signs, we can use it for recognizing faces in different places like classes at schools. With the same CNN model and OpenCV, the system can find faces and mark who's present. This system is a part of Intelligent Transport System(ITS) which can pave way in dimension of a Smart system. The work is done making use of Convolution Neural Network (CNN) classification model with inbuilt OpenCV functions to pre-process the images for traffic sign detection and recognition using Binarization and Region Of Interest(ROI). The same mechanism will be in recognition of student faces to mark attendance and make this a smart system in universities.

The paper [3] "Automatic Attendance Monitoring System" by P Padma Rekha, D Amudhan, and N. Pavithra is the utilization of face recognition technology forms the cornerstone of this upgraded attendance system, addressing the limitations of its predecessor. Employing a camera for image capture, the system conducts face detection and recognition processes. Upon capturing an image, it undergoes comparison with a database of faces, marking attendance once a match is found. Despite considerable efforts directed towards refining the face detection algorithm for accuracy, the system's lack of portability remains a concern. Relying on a standalone computer necessitates a constant power supply, rendering it immobile. This system is primarily suited for scenarios where students must report attendance for each class, posing inconvenience in terms of flexibility. To mitigate this constraint, a shift towards an embedded design for the entire attendance management system is proposed, enabling seamless operation on battery power. Such an embedded design not only enhances portability but also widens its applicability across diverse educational environments, from classrooms to outdoor activities and field trips.

In paper [4] "Face Recognition Based Student Attendance System with OpenCV" by CH.Vinod Kumar and, Dr. K. Raja Kumar, the utilization of OpenCV for face recognition, particularly in student attendance systems, involves detecting the number of individuals present in a classroom and subsequently marking their attendance through face detection and recognition algorithms. OpenCV's built-in haar cascades facilitate this process, requiring a digital camera to capture images within a fixed space. These images are then processed using haar cascades to detect frontal faces and eyes. Subsequently, the LBPH algorithm is employed to train these facial features, with the trained faces being stored in a database for comparison. Attendance is then recorded for recognized individuals based on the comparison results of the trained images.

Other paper proposed by [5] introduced a real-time computer vision algorithm in automatic attendance management system. Employing a non-intrusive camera, the system captures images within the classroom and extracts faces for comparison with those stored in its database. Leveraging machine learning algorithms commonly utilized in computer vision, alongside Haar Classifiers for image training, the system enhances facial recognition capabilities. Upon capturing a face, the image is converted to grayscale and undergoes subtraction with stored images. Subsequently, the processed image is transmitted to a server for storage and later processing.

In paper [6] "Online Attendance System" by Dr A. Babu Karuppiah, M Jeyalakshmi, R Raja Raja the system involves positioning a camera at the front of the classroom to capture facial images, subsequently forming a face dataset that is transmitted to a server for storage and processing. Key modules include the Face Detector and Face Recognizer, utilizing HAAR classifiers and the OpenCV library for face detection, while employing the EigenFaces algorithm for rapid face recognition. To ensure accuracy, captured faces and student image database faces are converted to grayscale and subjected to background subtraction to eliminate interference from other objects. Raspberry Pi serves as an ideal computing tool, functioning as both a desktop computer and server, obviating the need for bulky desktop computers in every classroom. Each image in the database is timestamped for tracking, with older images gradually replaced by new ones upon successful face recognition, allowing the system to adapt to changes in students' appearances over time.

The paper [7] "Face Detection and recognition using Raspberry Pi" by Ishitha gupta, Varsha Patil, Chaitali Kadam, Shreya Dumbre the objective is to replace RFID cards and passwords with face recognition for accessing high-security systems, emphasizing the significance of facial recognition in surveillance and security applications. Face recognition has emerged as a paramount method for user identification, necessitating a cost-effective and efficient system. The goal is to investigate the feasibility of deploying a Raspberry Pi-based facial recognition system utilizing conventional techniques like PCA and Haar detection. Leveraging the Raspberry Pi kit, the aim is to develop a user-friendly and cost-effective system without compromising on performance.

In paper [8] "Classroom Attendance Using Face Detection and Raspberry Pi", Priya pasurmati, P.Purna Sekhar describes the current attendance marking system relies on manual processes, leading to significant productivity loss and increased wait times for students. To address this issue, automating attendance through face recognition offers a promising solution. Leveraging Raspberry Pi, the project aims to identify faces in real-time, utilizing the OpenCV open-source tool for image processing.

It comprises five key modules: Face detection, Face preprocessing, Face training, Face identification, and Attendance Database. The system is trained with a Student Database containing facial data for recognition purposes. A user-friendly interface allows administrators and faculty members to monitor the student database. Haar Cascade algorithm, as proposed by Viola-Jones, is employed for face detection, while LBP histograms facilitate face recognition, with MySQL used for database storage and updates. The proposed system automatically records student attendance and stores it in the database, with authorization granted to faculty and administrators to manage the Attendance Management System.

In Paper [9] the system was designed to utilize hardware components such as Raspberry Pi and a wired camera, complemented by software integration of OpenCV. Facial recognition begins with face detection, a crucial initial step to ensure recognition accuracy. Haar Cascade Classifier was employed for face detection, followed by PCA for recognition. This attendance management solution, powered by Raspberry Pi and a wired camera, leverages OpenCV to automate attendance marking through real-time face identification. The combination of Raspberry Pi's flexibility and OpenCV's sophisticated algorithms ensures reliable performance, with PCA enhancing recognition precision by analyzing key facial characteristics. In educational environments, this portable and cost-effective system offers a scalable solution to attendance management, streamlining processes and boosting operational efficiency.

B. Objectives

Automate attendance tracking using fingerprint biometric. Provide instant feedback on authentication status via LCD display.
Establish cloud-based storage for secure attendance record keeping. Enable SMS notifications to parents and teacher management interface for efficient record management.

C. Existing System

Existing system is a manual entry for the students. Here the attendance will be carried out in the handwritten registers. It will be a tedious job to maintain the record for the user. The human effort is more here. The Fingerprint technology serves as an identity proof to take the attendance of students. The device reads finger patterns from the fingerprint module and verifies this data with the already stored pattern in its database. RFID attendance system provides wireless identification of stakeholders when they fall in the radiofrequency range of the RFID attendance reader. To mark the attendance automatically, the students or staff need to carry the RFID tag that contains unique information about them such as class/section/name/ID number.

D. Proposed System

The proposed system automates the attendance system of educational institutions and reduces the shortcoming of the existing manual system. Smart device will be developed which is capable of recognizing the identity of each individual and eventually record the attendance data into a database system.

III. METHODOLOGY

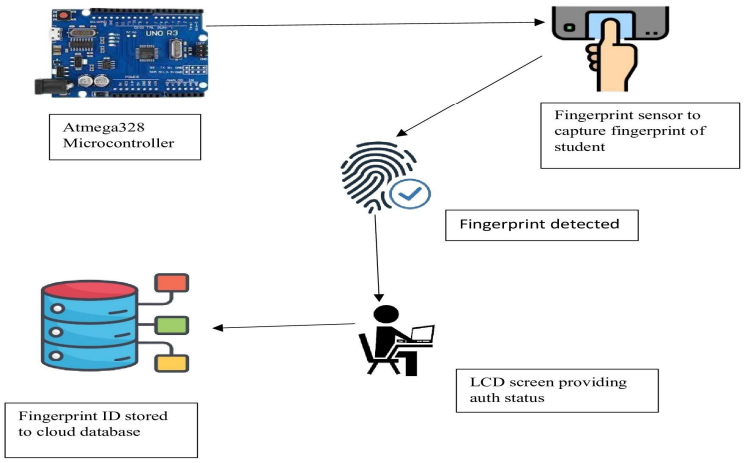


Fig 3.1

The methodology is as shown in Fig 3.1

Project Involves Atmega328 Microcontroller, Fingerprint sensor, ESP01 wifi module.

1) Utilize the ATmega328 microcontroller to interface with the fingerprint sensor, capturing fingerprint data upon student authentication.
2) Display authentication status on an LCD screen, providing real-time feedback to users regarding successful or failed fingerprint recognition.
3) Transmit the captured fingerprint ID to a cloud-based server for comparison with the stored student database.
4) If the fingerprint ID matches an entry in the database, mark the student's attendance and trigger an SMS notification to inform parents.
5) Implement a teacher interface within the cloud system for recording student internal marks and managing attendance records.
6) Ensure data integrity, security, and system reliability throughout the process to maintain accurate attendance records and communication with stakeholders.

A. UML Use-Case Diagram

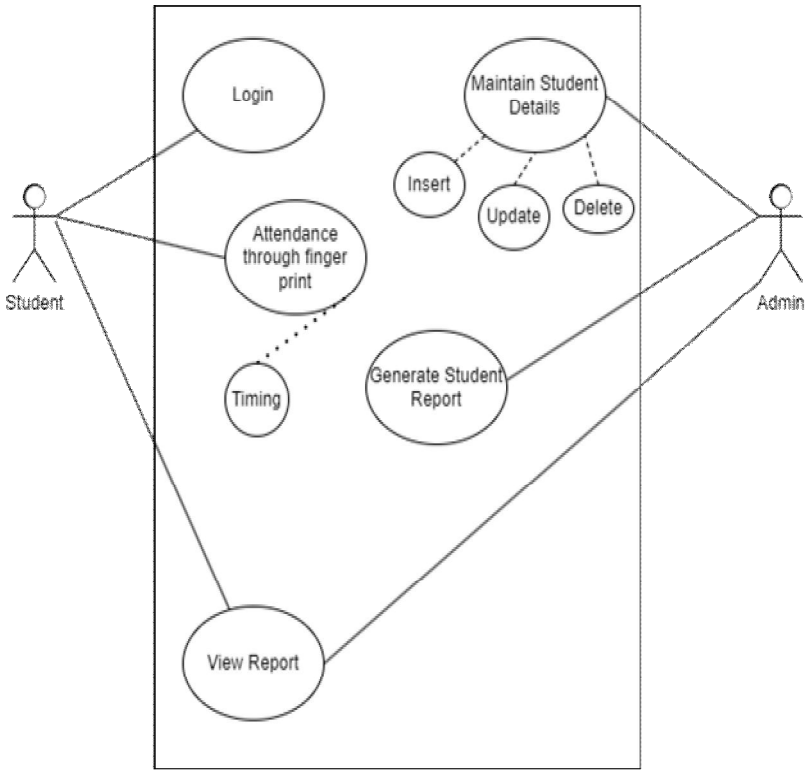


Fig 3.2

IV. RESULTS AND DISCUSSION

In our project methodology, we have used the ATmega328 microcontroller as a fundamental component to interact with the fingerprint sensor. When a student place their finger upon the sensor, the ATmega328 processes this biometric data. Subsequently, an LCD screen displays real-time authentication status, ensuring a responsive and user-friendly experience.This is an important moment. Here, a fingerprint data clicks through and join with the cloud database. Here is the main part of our system, which consists of a cloud server carefully compare the obtained fingerprint with our huge student cloud database. On positive identification, the system automatically register the student's attendance, operations similar to that of an electronic response. Alongside this, Real time SMS notifications is dispatched to notify parents that their child has arrived safely to the institution. Additionally, our model includes a friendly interface within the cloud environment, designed specially for the use of educators. The interface constitutes a teachers empowerment tool with the streamlined attendance management capabilities as well as efficient the student’s semester wise grades. Here, the paramount importance is on data integrity, system security and robust reliability so that the accurate attendance records and efficient communication channels would be the needs of educational institutions.

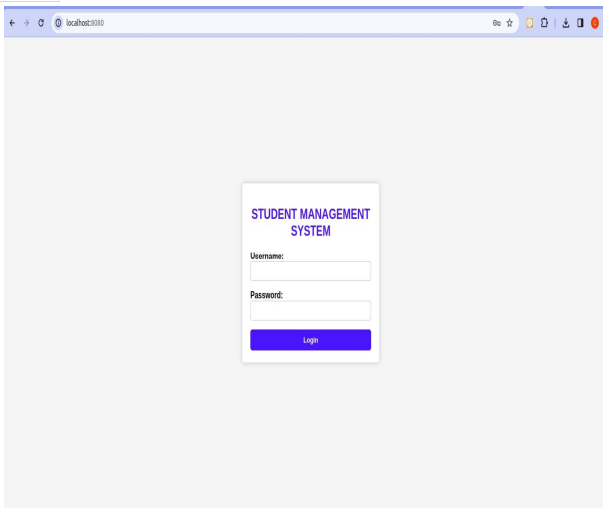


Fig 4.1

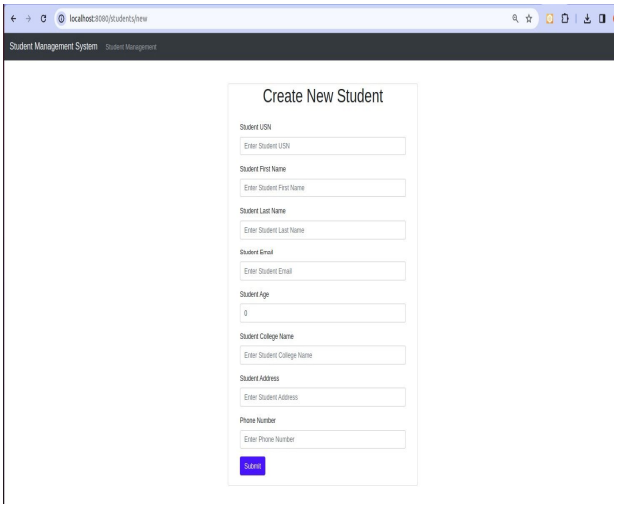


Fig 4.2

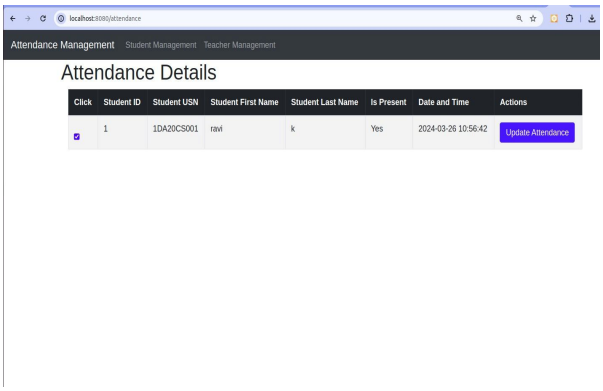


Fig 4.3

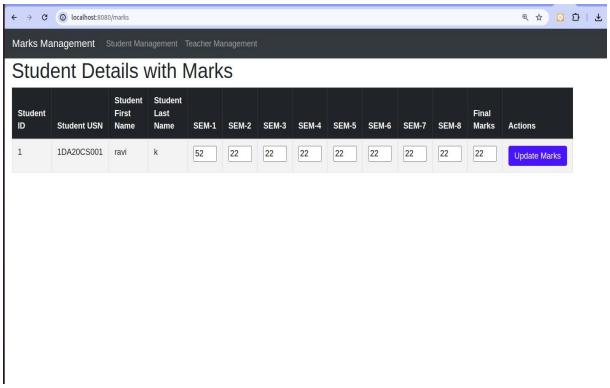


Fig 4.4

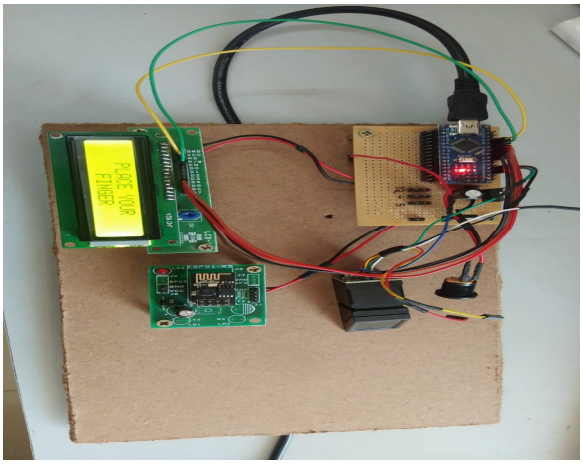


Fig 4.5

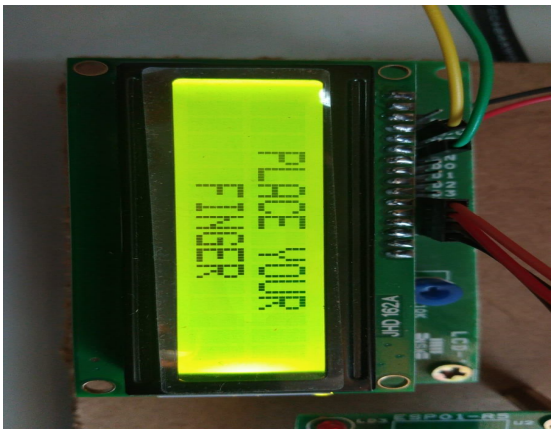


Fig 4.6

V. CONCLUSIONS

The inclusion of IoT technology that has biometric student access control and attendance record puts it at the top among the security systems and attendance tracking in educational settings that we have. This system would merge layers of biometric verification on top of the IoT, thereby ensuring a secure and concurrent tracking in real-time of student face-to-face attendance.

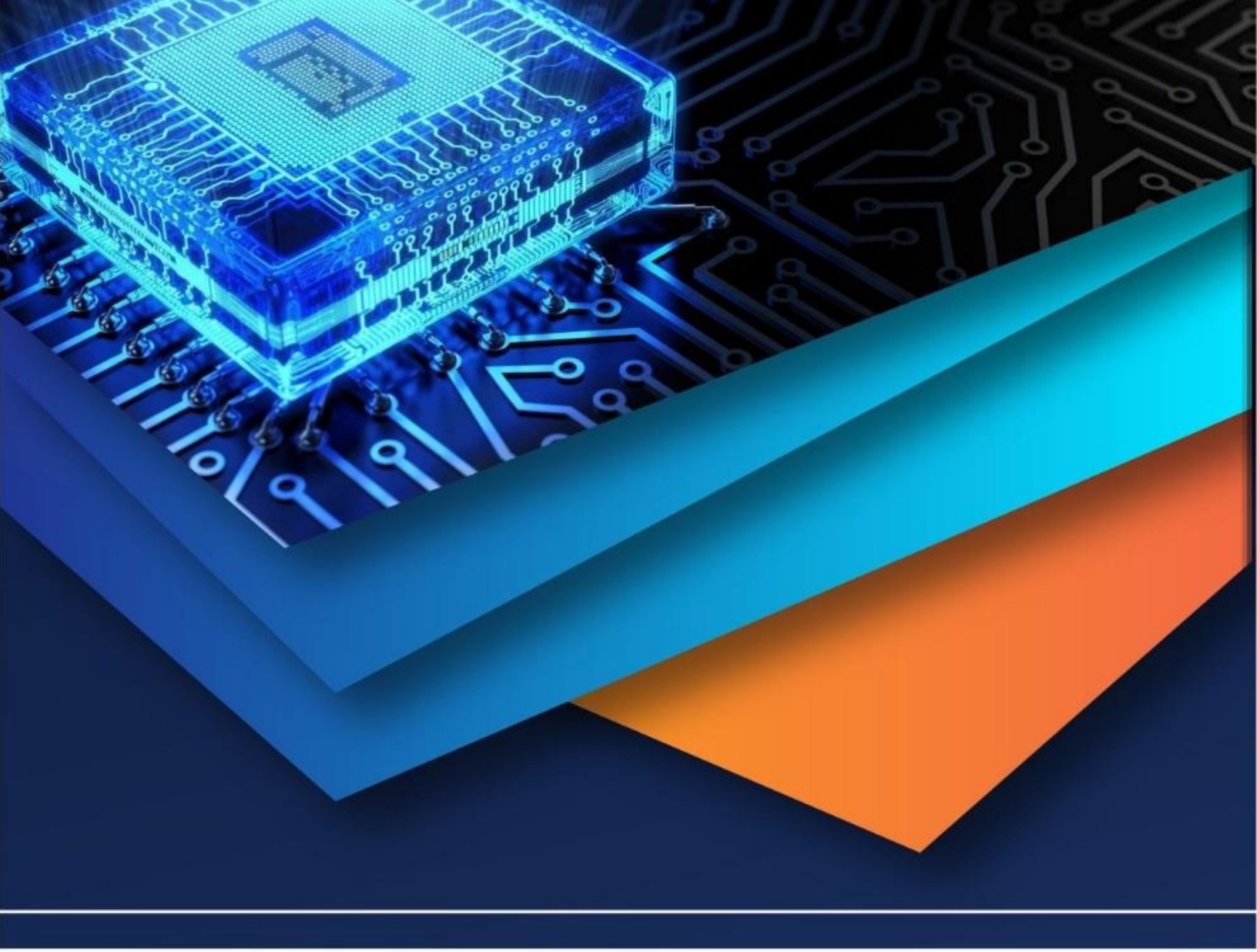
The biometric recognition together offers a way of enhancing the security of the system, with a positive outcome where only validate individuals get access to the system. Moreover, attendance auto-recording decreases errors and frauds and makes administrator's tasks more controllable in real time, thus he/she can promptly take action whenever abnormalities or security problems occur.In conclusion, the innovative IoT biometric solution addresses the challenges of educational establishment that are facing to boost up the security parameters and simplify the attendance process through automation. Regarding what's next there is always space for fine-tuning and streamlining the overall ecological system. Interfaced with Student Information Systems (SIS), put IoT ability stress, and explore biometric algorithm are important concerns to be worked on in the future. Through implementing the technologies advancements educational establishments can reach the highest possible level of the system effectiveness, make sense it will be a safe and efficient environment supporting learning.

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