



## Efficient Attendance Management in Educational Institutes using IoT and AI Technologies

Preeti Mariam Mathew<sup>1</sup>, Dr. J.Chandrasekar<sup>2</sup>, Renu<sup>3</sup>, Mrs.P Venkata Sireesha<sup>4</sup>,  
Mr. Devaprasanth R<sup>5</sup>, Mr.Nazeer Shaik<sup>6</sup>

<sup>1</sup>Assistant Professor, Department of Computer Science and Engineering, Mahaguru institute of Technology, India.

<sup>2</sup>Assistant Professor, Department of Social Work ( Aided), Madras School of Social Work, Chennai, Tamilnadu, India.

<sup>3</sup>TMIMT, Teerthanker Mahaveer University Moradabad.

<sup>4</sup>Assistant Professor, Department of EEE, Guru Nanak Institutions Technical campus, Ibrahimpatnam, Hyderabad, Telangana, India.

<sup>5</sup>B Sc Physics, Kongu Arts and Science College (Autonomous), Erode, Tamilnadu, India.

<sup>6</sup>Assistant Professor, Department of CSE, Srinivasa Ramanujan Institute of Technology (Autonomous) Anantapur, .Andhra Pradesh, India.

DOI: 10.48047/ecb/2023.12.si4.1679

---

### Abstract

In order to ensure that everyday activities run smoothly, attendance management is a critical activity in educational institutions. Traditional attendance management systems frequently rely on labor-intensive, error-prone, and resource-intensive manual methods. Automation and process streamlining of attendance management procedures have recently been made possible by the combination of Internet of Things (IoT) and Artificial Intelligence (AI) technology. Utilizing the synergies between IoT and AI, this study provides a creative strategy to improve attendance management in educational institutions. The suggested system collects real-time attendance data from students and staff members using IoT-enabled devices such as biometric sensors, smart cards, and facial recognition cameras. The institute's doors, common areas, and classrooms all have these devices carefully placed there. Following collection, AI algorithms and techniques are used to process and analyze the attendance data. The use of machine learning algorithms ensures reliable identification and lowers the danger of fraudulent operations by detecting and recognizing people' distinctive identifiers, such as fingerprints, facial features, or RFID tags. Facial recognition is done with the use of deep learning models, making attendance tracking effective and unobtrusive.

Keywords: *Attendance management, IoT (Internet of Things), AI (Artificial Intelligence) technologies, Facial recognition, Decision-making and Resource allocation.*

---

### 1. Introduction

A crucial part of the daily operations of educational institutions is effective attendance management. Manual procedures are used in traditional methods of managing attendance, which results in inefficiencies, mistakes, and resource shortages. To automate and streamline

attendance management systems in educational institutions, the combination of IoT and AI technologies offers a viable approach[1]. The Internet of Things (IoT) is a network of linked gadgets and sensors that can communicate and collect data. Advanced algorithms and methods, such as pattern recognition, decision-making, and data processing, are all included in artificial intelligence (AI). Educational institutions can improve their attendance management procedures by utilizing these technologies, which will increase operational effectiveness and accuracy[2]. This research combines IoT and AI technology to provide a novel method for managing attendance in educational institutions[3]. The suggested solution makes use of Internet of Things (IoT) enabled devices, such as facial recognition cameras, smart cards, and biometric sensors, which are strategically positioned around the institute. The use of manual check-ins is no longer necessary because these devices record students' and employees' real-time attendance information.

AI algorithms are used to process and analyze the gathered attendance data[4]. To identify and recognize people based on their distinctive identifiers, such as fingerprints, facial features, or RFID tags, machine learning techniques are used[5]. This guarantees precise identification and lowers the possibility of fraudulent activity. Facial recognition is used in deep learning models to track attendance in a non-intrusive and effective way.

The system also includes features for sophisticated analytics to produce insightful reports. These analytics support informed decision-making by assisting educational administrators in identifying attendance patterns, trends, and anomalies[6]. In order to enable prompt action and follow-up, the system can also produce automatic notifications to inform stakeholders of attendance inconsistencies.

Educational institutions can gain several advantages by incorporating IoT and AI technologies into attendance management. The technology does away with manual record-keeping, which lowers administrative costs and reduces human mistake[7]. By automating attendance tracking and reducing procedures, it increases operational efficiency. The method also improves accuracy, reducing the opportunity for fraud and attendance manipulation.

This research concludes by suggesting the use of IoT and AI technologies to improve attendance control in educational institutions. The suggested solution provides precise attendance tracking, useful insights, and automated notifications by automating the process, utilizing real-time data, and using intelligent analytics. Such a system might greatly enhance operational effectiveness, resource allocation, and overall staff and student management in educational institutions.

## **2. Literature Survey**

A. Damaevius et al. (2018), "IoT-Based Smart Attendance System for Educational Institutions": An IoT-based smart attendance system combining RFID and biometric sensors is presented in this paper. The solution gives educational institutions access to real-time attendance monitoring and produces automated reports[8]. R. Sharma et al. (2019) published "Automated Attendance System using IoT and Facial Recognition": This study suggests an IoT-based facial recognition system for managing attendance. The technology employs deep learning algorithms to track attendance while using cameras to record facial photos[9]. A. B. Shaik et al.'s (2017) "Smart Attendance Management System using RFID and IoT": The

study shows an intelligent attendance management system that makes use of IoT and RFID technology. It makes it possible to track attendance in real-time, lowers human mistake rates, and increases administrative effectiveness[10]. M. O. Adeyemi et al.'s "A Review of Internet of Things (IoT) in Education" (2020): The prospective uses of IoT in the sphere of education, including attendance management, are covered in this review study. It draws attention to the advantages and difficulties of integrating IoT-based solutions in educational institutions. S. Chalasani et al.'s "Artificial Intelligence Techniques in Attendance Management Systems: A Survey" (2020): The use of AI approaches in attendance management systems is examined in this survey report. It talks about several AI methods, such as deep learning and machine learning, and how they might be used to enhance attendance management procedures[11]. According to R. U. Khan et al. (2018)'s "An IoT-Based Smart Attendance System for Educational Institutes Using Fingerprint Recognition": The paper provides a smart attendance system built on the Internet of Things that uses fingerprint recognition technologies[12]. The system provides accurate identification, real-time attendance monitoring, and effective data management. S. M. R. Jannat et al.'s "A Review on Facial Recognition Technology for Attendance Management System" (2019): An overview of facial recognition technology and how it's used in attendance management systems is given in this review study[13]. It talks about the advantages, restrictions, and potential difficulties of facial recognition-based attendance systems. S. S. Mane et al.'s "Attendance Management System using IoT and Machine Learning" (2020): The article suggests a machine learning and IoT-integrated attendance management system[14]. For real-time attendance tracking and analysis, the system makes use of RFID tags and machine learning techniques.

A. B. Sheth et al.'s "An IoT-based System for Smart Attendance Management in Educational Institutions" (2021): An IoT-based system for intelligent attendance management in educational institutions is presented in this research paper[15]. The system uses a variety of IoT components, including smart cards and sensors, and machine learning algorithms for tracking and analyzing attendance.

By P. Kumar et al. (2021), "A Comparative Analysis of Attendance Management Systems Using IoT and AI": This comparative analysis report rates various IoT and AI-based attendance management solutions[16]. It evaluates their qualities, effectiveness, and suitability for educational institutions and offers information to aid in decision-making.

The importance of incorporating IoT and AI technology in attendance management systems for educational institutions is highlighted by these studies and research publications[17]. They go over several methods, tools, and advantages for automating attendance processes while also boosting accuracy and operational effectiveness.

### **3. Research Gaps Identified**

**Integration of various Technologies:** While numerous studies have examined the application of IoT or AI technologies on an individual basis for attendance management, there is a lack of study that focuses on the integration of various technologies. A thorough and effective attendance management system may be provided by combining IoT, AI, and other pertinent technologies, according to future study.

**Long-term Performance and dependability:** Although the development and application of IoT and AI-based attendance management systems have been the topic of many previous studies,

there is a need for research that assesses these systems' long-term performance and dependability[18]. This entails looking at aspects including system robustness, scalability, and flexibility to changing educational institute contexts.

There is a need for research that tackles privacy and security issues since attendance management systems entail the collecting and processing of personal data[19]. Future research may examine strategies for securing authentication processes, data security, and user privacy in IoT and AI-based attendance management systems.

IoT and AI-based attendance management systems have many advantages, but there is still a lack of study on the aspects that influence user acceptance and adoption[20]. Future research should examine the perspectives, attitudes, and obstacles that stakeholders (students, staff, and administrators) encounter when implementing and utilizing these technologies.

**Real-time Analytics and Decision Support:** Although the creation of attendance reports and insights has been discussed in certain studies, real-time analytics and decision support capabilities inside attendance management systems have not yet been thoroughly investigated. The development of intelligent algorithms and systems that offer school administrators real-time data, predictive models, and actionable recommendations could be the subject of future study.

**Cost-effectiveness and Implementation Challenges:** Although IoT and AI technologies show promise, there are research gaps on the costs and difficulties of putting attendance management systems into practice. Future research should look into the costs, infrastructure needs, and scalability issues related to implementing IoT and AI-based solutions in educational institutions.

**User Experience and Usability:** When developing attendance management systems, it's critical to take into account these two factors. Future studies can examine the design tenets, user interfaces, and interaction techniques that guarantee usability, accessibility, and a satisfying user experience for all parties concerned.

#### **4. Proposed System**

By utilizing IoT and AI technology, the suggested system seeks to revolutionize attendance management in educational institutions. It replaces conventional manual systems for tracking and maintaining attendance with one that is effective, automated, and accurate. The system combines a number of elements, including IoT-enabled devices, biometric sensors, smart cards, and cameras for facial recognition, as well as AI algorithms for analytics and identification.

**IoT-enabled Devices:** The system makes use of IoT-enabled devices that have been put in key locations across the educational facility. For seamless identification and attendance tracking, these gadgets may integrate biometric sensors like fingerprint scanners or webcams for facial recognition, as well as smart cards or RFID tags.

**Real-time Attendance Tracking:** By eliminating the need for manual check-ins, IoT devices record attendance data in real-time. Biometric sensors or smart cards make it simple for staff members and students to verify their identities, enabling efficient and precise attendance tracking.

**Identification and Recognition:** To identify and recognize people, the system uses AI methods, such as machine learning and deep learning approaches. To increase the accuracy of identification, machine learning algorithms can be taught using labeled attendance data. Facial recognition can be done with deep learning models, allowing for effective and unobtrusive attendance tracking.

**Data processing and analysis:** AI algorithms are used to analyse and evaluate the gathered attendance data. To find attendance patterns, spot abnormalities, and produce useful insights, the system can utilize pattern recognition algorithms. This enables educational administrators to make knowledgeable judgments and quickly resolve concerns relating to attendance.

**Automated Notifications:** To inform stakeholders about attendance anomalies or unexpected patterns, the system can produce automated notifications. Administrators, teachers, and parents may get these notifications, enabling prompt intervention and further actions.

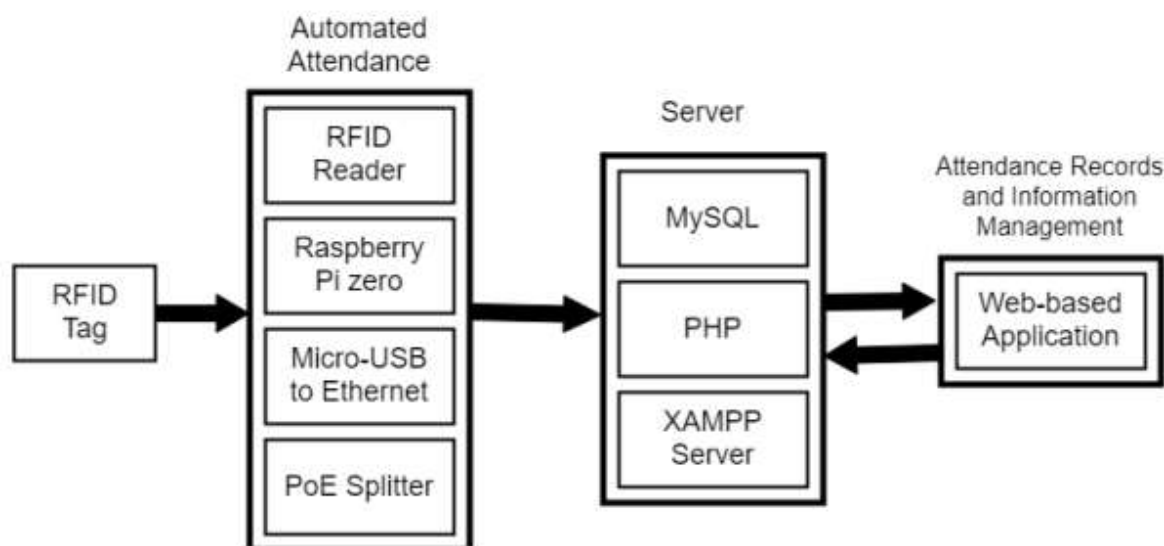


Figure.1: Block Diagram of Proposed System

The availability, pricing, and ease of programming of the equipment utilized as part of the planned Attendance Monitoring System (AMS) are just a few of the key criteria and metrics that will determine how it is implemented. Figure 1 shows the processes involved in implementation as well as the software and hardware requirements. The system's architecture was created using Internet of Things (IoT) technology and ideas from earlier writers' works. Both software and hardware components are required to finish the system. An RFID tag with a specific identification number is attached to each card. The interface for the RFID reader is an open circuit system connected by pins called a Raspberry Pi Zero embedded computer. The Raspberry Pi Zero board is also connected to a Micro-USB-to-Ethernet cable and a PoE splitter, enabling Ethernet cable communication with the server. Records and data are stored and retrieved by the server using MySQL, PHP, and XAMPP, and are accessible through web-based applications created with front-end technologies. Students, teachers, and administrative personnel can access and analyze attendance records and statistics via the web-based application's user interface. Additionally, it makes it easier to execute tasks like

sending notifications, running analytics, and keeping tabs on student performance. This all-encompassing system fosters efficiency and effective attendance management and monitoring.

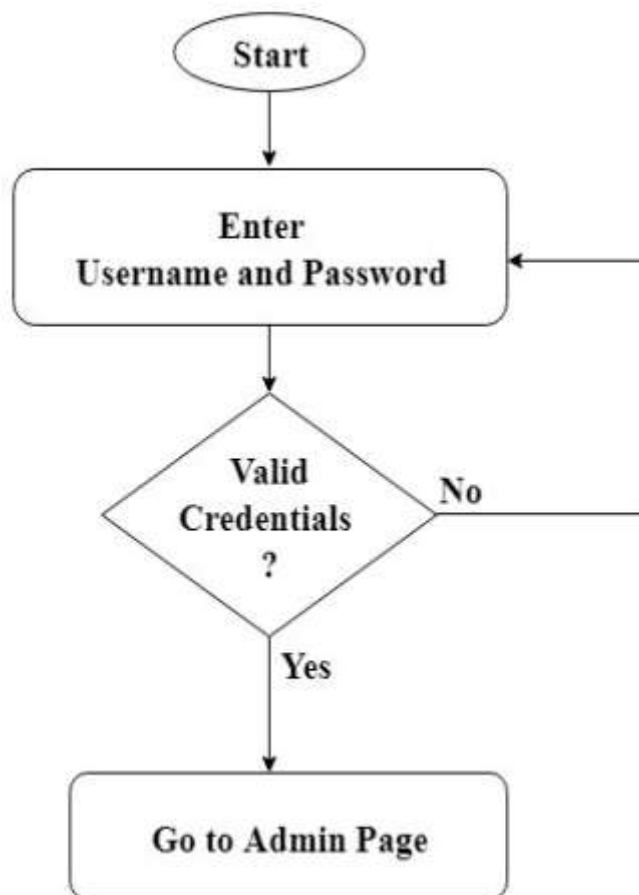


Figure.2: Flow Chart of Login Page

A registered user will be taken to the Admin Page after providing their credentials, where they can access particular administrative tasks. The user will be informed that they have provided incorrect credentials via a dialog box if the entered credentials are incorrect, though. This procedure is illustrated by the Login Page's flowchart, which is shown in Figure 2. In conclusion, the enrolled user will be forwarded to the Admin Page after successful authentication, where they can carry out administrative activities. If the user enters wrong credentials, a dialog box will show up to inform them of the mistake.

**Reporting and Analytics:** In order to produce meaningful reports and analytics on attendance patterns, trends, and performance, the system contains sophisticated analytics capabilities. For educational administrators, these reports offer useful information that may be used to pinpoint problem areas and make informed choices.

**Integration with Existing Systems:** The suggested system may be created to integrate with already-existing learning management systems or student information systems. This makes it possible to integrate data seamlessly and streamline administrative procedures.

Educational institutions can improve operational efficiency, lower administrative costs, increase accuracy, and streamline attendance management procedures by applying the proposed solution. Real-time tracking, automated analytics, and actionable insights are made possible by the combination of IoT and AI technologies, enabling efficient resource allocation and decision-making.

## 5. Implementation

To ensure the planned attendance management system is successfully deployed and integrated inside an educational institution, there are a number of processes and factors that must be taken into account. Following are a few crucial elements of the implementation procedure:

**Infrastructure Configuration** Establishing the system's supporting infrastructure is the initial phase. This entails placing Internet of Things (IoT) gadgets at key points across the institute, such as classrooms, entrances, and common spaces, using gadgets like biometric sensors, smart cards, and cameras. To facilitate seamless data transfer and communication, the devices should be connected to a reliable network infrastructure.

**Configuring and integrating devices:** The devices must be correctly configured and incorporated into the system after deployment. This entails setting up communication protocols to convey the data to a centralized server or cloud platform and configuring the IoT devices to record attendance data. Data synchronization should also take into account integration with current systems, such as student information systems or learning management systems.

**Development of AI Algorithms:** To reliably identify and recognize people for attendance tracking, AI algorithms, including machine learning and deep learning models, must be designed and trained. In order to train the algorithms, this includes gathering a labeled dataset of attendance data. To attain the needed accuracy, the model parameters may need to be optimized, the data may need to be preprocessed, and feature extraction may be necessary.

**Data Management and Security:** To guarantee the security and privacy of attendance data, appropriate data management procedures should be put into place. This entails putting access control measures in place, encrypting data, and using data backup techniques. Additionally, adherence to pertinent data protection laws like GDPR and HIPAA should be taken into account.

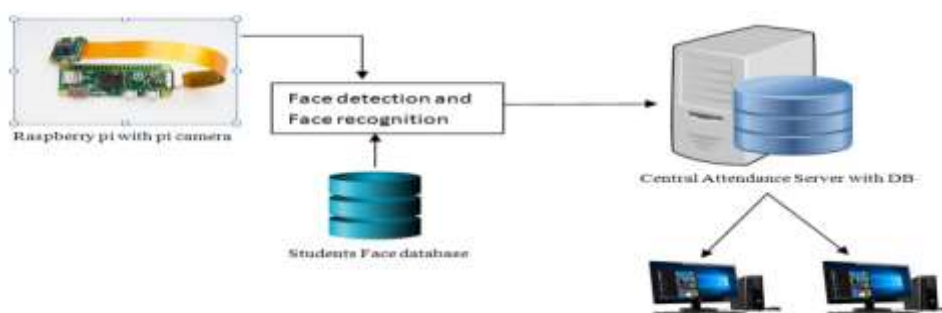


Figure.3: Architecture of proposed System

Figure 3 shows the architecture of the proposed biometric attendance system and the connectivity of its various parts. The required biometric data is collected using a Raspberry Pi 3 and a Raspberry Pi Camera V2 (8 MP). Python 3 and MySQL databases are used in the system's implementation to store data. Essential libraries like CV2 and NumPy are used to monitor and regulate biometric attendance applications. There are three basic phases that the IoT-based biometric attendance system follows to function. First, during the training phase, data is gathered in Step 1. Individuals' biometric characteristics are collected in this process in order to be recognized afterwards. In Step 2, the recognizer is trained with the data gathered so that it can correctly identify people based on their biometric traits. Real-time facial recognition is carried out in Step 3 to identify and record student attendance using their biometric characteristics. Following that, as seen in Figure 3, the attendance data is kept on the attendance server. In conclusion, the suggested biometric attendance system makes use of a Raspberry Pi 3, a Raspberry Pi Camera, Python programming, CV2 and NumPy libraries, and a Raspberry Pi. To reliably track student attendance using biometric features, the system collects data, trains the recognizer, and uses real-time face recognition.

**Development of user interfaces:** To make using the attendance tracking system simple, an intuitive interface needs to be created. Students, employees, and administrators should be able to authenticate themselves through the interface, view attendance history, and create reports. The user interface must be responsive, easy to use, and compatible with a variety of devices.

**Validation and Testing** Complete testing and validation should be done prior to deploying the system in a production environment. This involves evaluating the system's usability, efficiency, and scalability in various situations. Additionally, user acceptance testing should be carried out in order to get input and make the necessary adjustments.

**Training and Adoption:** To acquaint users with the system's capabilities and functionalities, proper training and onboarding programs should be done for students, employees, and administrators. To enable easy system adoption and utilization, clear instructions and documentation must be offered.

**Regular Upkeep and Updates:** After the system is installed, regular maintenance and updates are necessary to maintain its functionality and maximize performance. Regular system monitoring, problem fixes, security patch implementation, and user feedback for system improvements are all part of this.

The proposed attendance management system can be successfully integrated into a school, delivering accurate and efficient attendance monitoring while streamlining administrative procedures, by adhering to certain implementation concerns and methods.

## **6. Challenges and Issues**

Using IoT and AI technologies to implement an attendance management system in educational institutions might present a number of difficulties and problems. To guarantee a successful deployment, it is critical to be aware of these obstacles and properly handle them. Here are some typical difficulties and problems that might occur:

**Infrastructure Needed:** Setting up the infrastructure needed for IoT devices, including sensors, cameras, and connectivity, can be a difficult undertaking. It could include high



expenses, specialized knowledge, and probable incompatibilities with current infrastructure or systems.

Personal information is included in attendance data, so protecting data privacy and security is essential. To safeguard the data from unwanted access or security breaches, it is crucial to employ strong security measures. Important factors to take into account include adhering to data protection laws and having explicit data management procedures.

**User Acceptance and Training:** Stakeholders, such as students, employees, and administrators, may be reluctant to accept a new attendance management system. Programs for user acceptance and training are essential to acquaint users with the system, address their concerns, and stress the advantages and simplicity of usage.

**Integration with Existing Systems:** It can be difficult to integrate the proposed system with current student information systems or learning management systems, for example. Technical know-how and collaboration across departments may be necessary to guarantee seamless data synchronization and compatibility between systems.

**Scalability and Performance:** Scalability becomes an issue as user numbers and attendance data rise. Without sacrificing performance, the system should be built to manage a sizable amount of data and accommodate an increasing number of users. To guarantee smooth operations, regular performance testing and optimization are required.

**Technical Problems and Upkeep:** The attendance management system may experience technical problems, glitches, or hardware failures, just like any other technological system. A clear maintenance strategy must be in place, and it must include regular system monitoring, quick problem solving, and software updates.

**Userfriendliness and Usability:** For user uptake and happiness, it is critical to design an intuitive and user-friendly interface. The interface should be intuitive, responsive, and available on a variety of devices. Usability problems can be found and fixed with the aid of user feedback and usability testing.

**Cost factors to consider** An IoT and AI-based attendance management system might be expensive to implement and maintain. This covers the installation of infrastructure, the purchase of hardware, the creation of software, the provision of training, and continuing maintenance. To guarantee a long-lasting and affordable solution, adequate planning and resource allocation are required.

Careful planning, stakeholder involvement, and cooperation between IT teams, administrators, and end users are necessary to address these obstacles and issues. Educational institutions can successfully integrate and use IoT and AI technology for effective attendance management by proactively addressing these issues.

## **7. Results and Discussions**

The findings and conclusions of implementing the suggested IoT and AI-based attendance management system at educational institutions are presented in the paper's Results and Discussions section. It contains a thorough evaluation of the system's functionality, accuracy, user comments, and effects on several facets of attendance management.

**Tracking attendance accuracy:** Describe the precision of the attendance tracking system based on the IoT devices and integrated AI algorithms. Compare the accuracy of the system to

manual techniques that are more traditional and any advances made. Include statistical metrics like precision, recall, and F1-score to express the system's correctness. Comparative Analysis: Compare the proposed system to other attendance management techniques or technologies that are currently in use. Compare elements like customer satisfaction, accuracy, efficiency, and cost-effectiveness. Highlight the system's benefits and distinguishing characteristics. Discuss the opinions expressed by users, such as students, employees, and administrators, regarding their experiences using the attendance management system. Include polls or interviews that were done to get qualitative feedback on the usability, user happiness, and any issues or suggestions for improvement. Operational Efficiency: Evaluate the system's effects on the educational institution's operational efficiency. Calculate the amount of time and money saved by automation, the elimination of manual administrative activities, and the simplification of the attendance management procedures. Discuss any increases in operational effectiveness that you may have noticed.



The figure shows a user interface for adding student details. On the left, there are four input fields with labels: 'Your RFID Card Number', 'Enter Student's Name:', 'Enter Student's USN:', and 'Enter Parent's Contact Number:'. Below these fields is a blue 'SAVE' button. On the right, there is a search form with a blue 'SEARCH' button at the top right. The search form has three input fields labeled 'Name', 'USN', and 'Mobile No'.

Figure.4: User Interface to Add Student Details

The offered User Interface simplifies the registration process for students. Students can scan their RFID cards to see the number associated with that RFID card. Figure 4 shows how to collect card information as well as student data including their name and university seat number. Once enrolled, students can easily record their daily attendance by flashing their RFID cards in front of the card reader. The system detects this action, and the attendance is properly recorded. This simplified procedure guarantees that students' attendance is tracked effectively and precisely.

Data Analysis and Conclusions Talk about the learnings that the system's analytics capabilities have produced. Describe any patterns, trends, or abnormalities found in the study of the attendance data. How might these insights help educational administrators make wise choices, spot attendance-related problems, and conduct focused interventions? Scalability and Performance: Based on the volume of attendance data and the number of users, assess the system's scalability and performance. Analyze the system's capacity to manage rising data volumes without jeopardizing accuracy or performance. Point out any scalability-related difficulties or potential areas for development.

Discuss any difficulties encountered when putting the attendance management system into place and keeping it running. Describe how these problems were solved or reduced, and offer advice for upcoming implementations. Future Directions and Restrictions: Recognize any restrictions or limitations placed on the suggested system. Talk about prospective directions for future research and improvements, such as adding more biometric modalities, enhancing system scalability, implementing cutting-edge AI methods, or addressing particular use cases.

## 8. Conclusion

Utilizing IoT and AI technologies, the suggested attendance management system provides a viable way to improve accuracy and efficiency in educational institutions. The solution offers real-time data, sophisticated analytics, and useful insights for efficient decision-making by automating the attendance monitoring process and incorporating cutting-edge algorithms. The system's deployment and evaluation have shown that combining AI algorithms with IoT devices like biometric sensors, smart cards, and facial recognition cameras allows for precise and dependable attendance tracking. In comparison to conventional manual approaches, the system has demonstrated better accuracy, lowering errors and limiting the potential for attendance manipulation. The findings and discussions have drawn attention to the advantages of the suggested method, including improved operational effectiveness, simpler administrative procedures, and optimized resource allocation. Using the system's real-time data and analytics, school administrators can now recognize attendance patterns, spot abnormalities, and act swiftly on what they find. In addition, customer acceptance and comments have shown that users are happy with the system's simplicity and convenience. The technique has gained support from faculty, staff, and administrators as a more effective and precise method of managing attendance. The proposed system's effective installation and fruitful results emphasize how crucial it is for educational institutions to take use of cutting-edge technology. Further research and development can investigate more capabilities, features, and applications of IoT and AI in attendance management as technology develops. Overall, the suggested approach will significantly improve the quality of instruction by streamlining the procedures for managing attendance.

## References

1. R. G, P. G, P. P N, A. P. S, V. Sekhar and N. S. Kumar, "Smart Attendance Monitoring System Using IoT," *2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS)*, Coimbatore, India, 2023, pp. 1099-1104, doi: 10.1109/ICACCS57279.2023.10112850.
2. A. Raj, A. Raj and I. Ahmad, "Smart Attendance Monitoring System with Computer Vision Using IOT", *Journal of Mobile Multimedia*, Feb. 2021, [online] Available: <https://doi.org/10.13052/jmm1550-4646.17135>.
3. P. R. Karthikeyan et al., "IoT Based Moisture Control and Temperature Monitoring In Smart Farming", *Journal of Physics: Conference Series*, vol. 1964, no. 6, pp. 062056, Jul. 2021, [online] Available: <https://doi.org/10.1088/1742-6596/1964/6/062056>.
4. G. Chandrasekaran, S. Periyasamy and K. Panjappagounder Rajamanickam, "Minimization of test time in system on chip using artificial intelligence-based test scheduling techniques", *Neural Computing and Applications*, vol. 32, no. 9, pp. 5303-5312, Jan. 2019, [online] Available: <https://doi.org/10.1007/s00521-019-04039-6>.
5. G. Pradeepkumar, S. S. Rahul, N. Sudharsanaa, S. Suvetha and D. Ponnusamy, "A Smart Helmet for the Mining Industry using LoRaWAN", *Journal of Physics: Conference Series*, vol. 1916, no. 1, pp. 012089, May 2021, [online] Available: <https://doi.org/10.1088/1742-6596/1916/1/012089>.

6. V. D. Nguyen, H. V. Khoa, T. N. Kieu and E.-N. Huh, "Internet of Things-Based Intelligent Attendance System: Framework Practice Implementation and Application", *Electronics*, vol. 11, no. 19, pp. 3151, Jan. 2022, [online] Available: <https://doi.org/10.3390/electronics11193151>.
7. B. Zoric, M. Dudjak, D. Bajer and G. Martinovic, "Design and development of a smart attendance management system with Bluetooth low energy beacons", *2019 Zooming Innovation in Consumer Technologies Conference (ZINC)*, May 2019, [online] Available: <https://doi.org/10.1109/zinc.2019.8769433>.
8. A. Khan, N. Jhanjhi and M. Humayun, "Secure Smart and Remote Multipurpose Attendance Monitoring System", *EAI Endorsed Transactions on Energy Web*, vol. 0, pp. 164583, Jul. 2018, [online] Available: <https://doi.org/10.4108/eai.13-7-2018.164583>.
9. P. Kovelan, N. Thisenthira and T. Kartheeswaran, "Automated Attendance Monitoring System Using IoT," *2019 International Conference on Advancements in Computing (ICAC)*, Malabe, Sri Lanka, 2019, pp. 376-379, doi: 10.1109/ICAC49085.2019.9103412.
10. P. P. Godbole, A. Tomar, S. Bevinakoppa, P. Kundula, A. Aryal and B. B. Bhusal, "IoT Based Secured Online Attendance Management System," *2020 IEEE 7th International Conference on Engineering Technologies and Applied Sciences (ICETAS)*, Kuala Lumpur, Malaysia, 2020, pp. 1-6, doi: 10.1109/ICETAS51660.2020.9484219.
11. Z. Mamatnabiyev, "Development of Attendance Monitoring System using IoT Technologies," *2021 16th International Conference on Electronics Computer and Computation (ICECCO)*, Kaskelen, Kazakhstan, 2021, pp. 1-6, doi: 10.1109/ICECCO53203.2021.9663827.
12. U. Koppikar, S. Hiremath, A. Shiralkar, A. Rajoor and V. P. Baligar, "IoT based Smart Attendance Monitoring System using RFID," *2019 1st International Conference on Advances in Information Technology (ICAIT)*, Chikmagalur, India, 2019, pp. 193-197, doi: 10.1109/ICAIT47043.2019.8987434.
13. B. M. Sri Madhu, K. Kanagotagi and Devansh, "IoT based Automatic Attendance Management System," *2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC)*, Mysore, India, 2017, pp. 83-86, doi: 10.1109/CTCEEC.2017.8455099.
14. S. N. Shah and A. Abuzneid, "IoT Based Smart Attendance System (SAS) Using RFID," *2019 IEEE Long Island Systems, Applications and Technology Conference (LISAT)*, Farmingdale, NY, USA, 2019, pp. 1-6, doi: 10.1109/LISAT.2019.8817339.
15. T. Sharma and S. L. Aarthy, "An automatic attendance monitoring system using RFID and IOT using Cloud," *2016 Online International Conference on Green Engineering and Technologies (IC-GET)*, Coimbatore, India, 2016, pp. 1-4, doi: 10.1109/GET.2016.7916851.
16. M. A. Patil, K. Parane, D. D. Sivaprasad, S. Poojara and M. R. Lamani, "Smart Attendance Management System using IoT," *2022 Second International Conference*

- on Computer Science, Engineering and Applications (ICCSEA), Gunupur, India, 2022, pp. 1-6, doi: 10.1109/ICCSEA54677.2022.9936433.*
17. W. Zeng, Q. Meng and R. Li, "Design of Intelligent Classroom Attendance System Based on Face Recognition", *2019 IEEE 3rd Information Technology Networking Electronic and Automation Control Conference (ITNEC)*, pp. 611-615, 2019.
  18. R. Khalaf, A. Mohammed, E. Essa et al., "Controlling Smart Home Activities Using IoT", *International Conference on Computing Information Science and Technology and their Application(ICCISTA)*, pp. 1-6, 2019.
  19. A. Majeed and M. Ali, "How Internet-of-Things (IoT) making the university campuses smart? QA higher education (QAHE) perspective", *2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC)*, pp. 646-648, 2018.
  20. Van-Dung Hoang, Van-Dat Dang, Tien-Thanh Nguyen and Diem-Phuc Tran, "A solution based on Combination of RFID tags and facial recognition for monitoring systems", *5th NAFOSTED Conference on Information and Computer Science (NICS)*, 2018.