Volume 10, Issue 6, June – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1392

Smart School Monitoring System Integrated with Smart Bus

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Publication Date: 2025/06/26

Abstract: An inventive way to improve school management's operational transparency, safety, and efficiency is the Smart School Monitoring System Integrated with Smart Bus. This system offers smooth student and school bus tracking and management by combining cutting-edge IoT, GPS, and real-time monitoring technologies. It guarantees a safe and effective learning environment by establishing a connection between parents, schools, and transportation services. The two main modules of the system are Smart Bus Tracking and Smart School Monitoring. CCTV surveillance, automated parent notifications, and RFID-based attendance tracking are all included in the school monitoring module. It allows for real-time updates on student attendance, keeps an eye on events taking place on campus, and notifies parents of any anomalies. Analytics tools are added to this module to give useful information about resource usage, classroom occupancy, and attendance trends. Through the integration of GPS tracking, driver behavior monitoring, and emergency response features, the smart bus module guarantees student safety while in transit. Through a specialized mobile application, parents can monitor bus routes and get real-time updates on pickup and drop-off locations. The system also uses geo-fencing to notify authorities in the event that buses stray from their designated routes. Automated alerts, speed monitoring, and driver fatigue detection all help make school transportation safer. Administrators can monitor all operations, including bus logistics and school activities, from a single interface with this integrated solution's centralized dashboard. It lowers the possibility of misunderstandings or delays by encouraging efficient communication between parents, schools, and transportation personnel. Cloud-based data storage upholds strict data security protocols while guaranteeing the system's scalability and accessibility. In addition to improving student safety and security, the Smart School Monitoring System Integrated with Smart Bus also simplifies daily tasks, minimizes manual intervention, and builds confidence among all parties involved. A modern, intelligent, and sustainable educational ecosystem is made possible by utilizing smart technology.

Keywords: *CCTV; RFID; GPS; IoT.*

How to Cite: Keerthi K S; Prashanth G S (2025) Smart School Monitoring System Integrated with Smart Bus. *International Journal of Innovative Science and Research Technology*, 10(6), 1893-1899. https://doi.org/10.38124/ijisrt/25jun1392

I. INTRODUCTION

The way we interact with our surroundings has been completely transformed in today's quickly evolving technological landscape by the incorporation of Internet of Things (IoT) solutions into commonplace objects. Advanced technology is integrated into a smart school system to improve the overall learning environment and expedite school operations. By implementing innovations like smart notice boards, school buses with GPS and GSM, and facial recognition for attendance, schools can make learning safer, more effective, and more interesting. Attendance systems that use facial recognition are among the essential elements of smart school systems. With the help of this technology, teachers and students can save time and ensure accuracy when tracking attendance. The system recognizes students and logs their attendance as soon as they walk into the classroom or school grounds using facial recognition algorithms. In contrast to conventional approaches, this system gives administrators and parents access to real-time data while minimizing errors and the possibility of manipulation. Furthermore, it can swiftly identify unauthorized people, improving school security. Traditional paper-based bulletin boards are replaced by smart notice boards, which use a digital platform that can show dynamic information in real time. School administrators can instantly distribute announcements, updates, and critical notices to the entire school or to particular student and staff groups thanks to these notice boards' internet connectivity. Smart notice boards help schools save money on printing and cut down on paper waste by centralizing information. These boards can also

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incorporate multimedia components, like animations or videos, to make announcements more interesting and approachable. Any school's top priority is to ensure the safety of its students while they are traveling. Smart school buses are outfitted with GPS (Global Positioning System) and GSM (Global System for Mobile Communications) technology to track and monitor their movements in real time. The bus's location, pick-up and drop-off times, and notifications of any delays or route changes are all available in real time to parents and school officials. Parents, the school, and the bus driver can all communicate in both directions thanks to GSM technology, which makes emergency assistance possible right away. This technology gives parents peace of mind and guarantees the safety of the students. The smart school system provides an integrated solution that improves safety and communication while also increasing operational efficiency by integrating cutting-edge technologies like GPS/GSM-enabled school buses, smart notice boards, and face recognition for attendance. In addition to giving students a safer and more stimulating learning environment, this progressive approach equips schools to meet the demands of contemporary education.

II. LITERATURE REVIEW

[1] **Lukas, Samuel, Aditya Rama Mitra, Ririn Ikana Desanti, and Dion Krisnadi. "Student attendance system in classroom using face recognition technique." In 2016 International Conference on Information and Communication Technology Convergence (ICTC), pp.1032-1035. IEEE, 2016**.

Human face recognition (HFR), a crucial area of biometric verification, has found extensive use in a variety of applications, including network security, human-computer interaction, door access control systems, and video monitoring or surveillance systems. By combining Discrete Wavelet Transforms (DWT) and Discrete Cosine Transforms (DCT) to extract the features of the student's face and then using the Radial Basis Function (RBF) to classify the facial objects, this paper suggests a face recognition technique for a classroom student attendance system. According to the results of experiments with 16 students in a classroom, 121 out of 148 face recognition attempts were successful.

[2] Sawhney, Shreyak, Karan Kacker, Samyak Jain, Shailendra Narayan Singh, and Rakesh Garg. "Real-time smart attendance system using face recognition techniques."In 2019 9th international conference on cloud computing, data science and engineering, pp. 522-525. IEEE, 2019.

One biometric technique to enhance this system is face recognition. Facial recognition is a key component of biometric verification and is widely used in a variety of applications, including network security, computer-human interaction, CCTV footage systems, video monitoring, and indoor access systems. The issue of proxies and students being marked present even though they are not physically present can be readily resolved by applying this framework. Face detection and face recognition are the primary implementation steps in this kind of system. Using Eigen face values, Principle Component Analysis (PCA), and Convolutional Neural Networks (CNN), this paper suggests a model for implementing an automated attendance management system for students in a class. Following these, it should be possible to connect the identified faces by comparing them with the database of student faces. This model will be an effective way to handle student attendance and records.

[3] **Merai, Bhumi, Rohit Jain, and Ruby Mishra. "Smart notice board." International Journal of Advanced Research in Computer and Communication Engineering 4, no. 4 (2015): 105-107.**

This work aims to give users a straightforward, quick, and dependable method of displaying important notices on an LCD. Users can also send messages to be displayed on the LCD. Through an Android application created for this project, the message can be sent to the GSM SIM900 module, which contains a SIM card. In a similar vein, a system for automating lighting, fans, and other household appliances has been developed. can be turned on or off with the same Android app that was created for this project. So, from anywhere in the world, you can use the Android application to control your home appliances and display notices on an LCD screen.

[4] Abbott, Eric, and David Powell. "Land-vehicle navigation using GPS." Proceedings of the IEEE 87, no. 1 (1999): 145-162.

Numerous land-vehicle navigation applications now make navigation systems feasible thanks to the Global Positioning System (GPS). Nowadays, a wide range of land-based vehicles, including cars, farming and mining equipment, and others, have GPS-based navigation systems (e.g. G. mobile robots and golf carts). The reader is introduced to some of the problems associated with each of these applications and each one is discussed. There is discussion of one specific technical element of land vehicle navigation. In particular, the study covered in this paper offers a quantitative analysis of how individual navigation sensors affect a land-vehicle navigation system's performance. The impact of various navigation sensor performance levels on the precision of vehicle positioning is investigated. The accuracy of the position fixes provided by the GPS receiver when GPS position fixes are available and the rate gyro's bias drift when GPS position fixes are not are found to be the main causes of positioning error for a typical navigation system. Additionally, the findings indicate that the relative contributions of each dead reckoning navigation sensor error are significantly influenced by the accuracy of the GPS position fixes. These findings' ramifications for sensor and navigation system design are examined.

[5] Ghazi, Irtsam, Ihtisham ul Haq, Muhammad Rashid Maqbool, and Sanaan Saud. "GPS based autonomous vehicle navigation and control system." In 2016 13th International Bhurban Conference on Applied Sciences and Technology (IBCAST), pp. 238-244. IEEE, 2016.

The paper's primary goal is to create a comprehensive routing system that can receive input from regular users through a basic Android application. Two algorithms have been developed for this project's implementation. The first algorithm

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1392

is an autonomous route calculation algorithm that uses a PC to determine coordinates between any two input coordinates at each road intersection. After receiving the user's input coordinates, the PC sends the output coordinates to the cab. Our prototype robots are guided by the second algorithm, which is a control algorithm. Distance formulas are used to achieve this. The code computes an error signal by comparing the robot's current heading with the desired set point, which is obtained as input coordinates. The robot modifies its direction in response to this signal in order to move within its bounds. Applications for this kind of system are numerous and include directing a fully autonomous robot to troubled areas, among other uses.

A. Problem Statement

For educational institutions, ensuring student safety and effective management during school hours and transportation continues to be a major challenge. Conventional systems lack real-time monitoring, frequently rely on manual attendance tracking, and offer little avenue for communication between parents, teachers, and transportation personnel. This creates risks such as unauthorized campus entry, delayed parent notifications, and unsafe bus transit. Inconsistent reporting of school bus movements and driver conduct further jeopardizes student safety. Additionally, the absence of centralized data management hinders administrative efficiency and resource optimization. There is a critical need for an integrated solution to address these gaps, enhancing safety, transparency, and operational effectiveness in schools and their transportation systems.

B. Aim of the work

To design and develop a smart school monitoring system integrated with smart bus.

C. Objectives of the work

- To recognize the face of the student using image processing and mark the attendance.
- To monitor the location of school bus through GPS.
- To display the students information on the notice board.
- To develop the software to monitor students attendance for parents and teachers.

III. METHODOLOGY

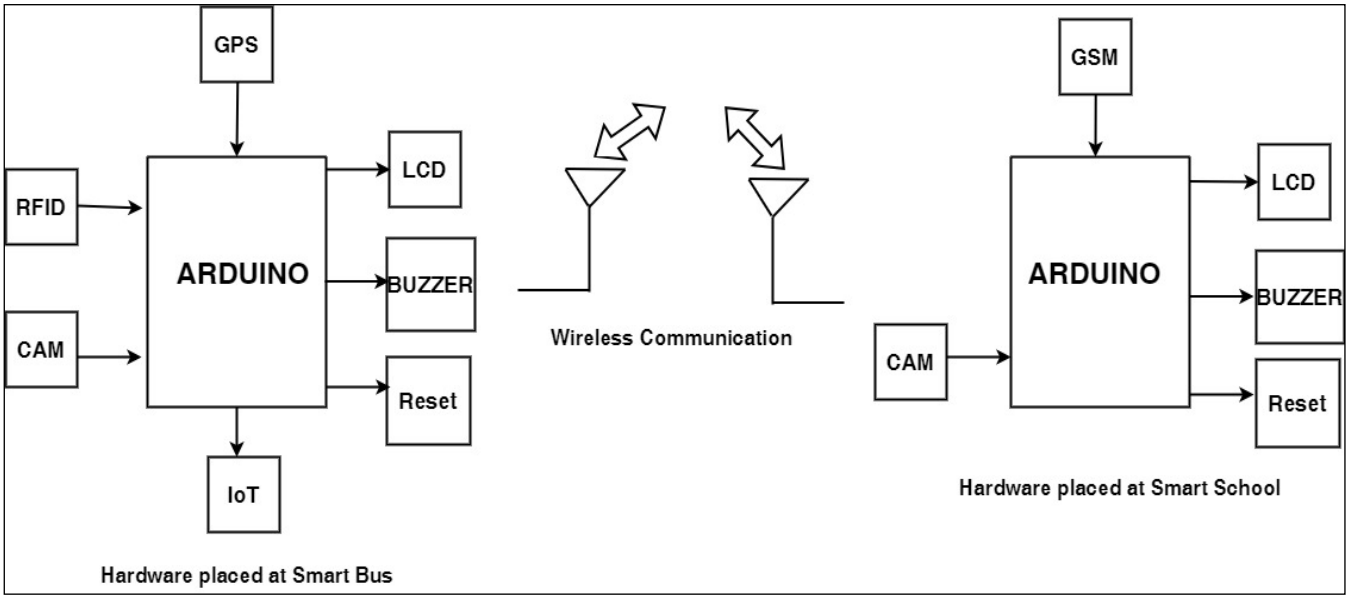

Fig 1: Smart School Monitoring System

A. Working Principle

- Students attendance is automatically recorded by scanning their RFID cards on the RFID module that is connected to the Arduino microcontroller. The purpose of this data transmission is real-time monitoring.
- Images or videos are taken by the CAM (camera) modules for security and verification reasons. While one camera keeps an eye on events taking place on campus, another keeps an eye on the school bus.
- The data, such as attendance records, bus positions, and alarms, are transferred wirelessly between modules based on the Arduino architecture and using IoT (Internet of Things) technology.
- By providing administrators and parents with location updates, notifications, or messages, the bus system's GSM module enables real-time communication.
- The LCD screens show important information like bus notifications or attendance status, and the buzzer sounds an alert for important events like emergencies or RFID mismatches.
- IoT modules transmit data in real time (e.g. Bus location, student attendance) to a centralized system, allowing parents and administrators to keep an eye on things from a mobile.
- All parts are guaranteed to operate consistently by a regulated RPS (regulated power supply), and a reset switch is provided for system restarts.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1392

- All of the modules are integrated into the school system for centralized monitoring. It guarantees the seamless flow of real-time updates and improves security with automated alerts, guaranteeing both operational effectiveness and student safety.

B. Flow Charts of the Proposed Methodology

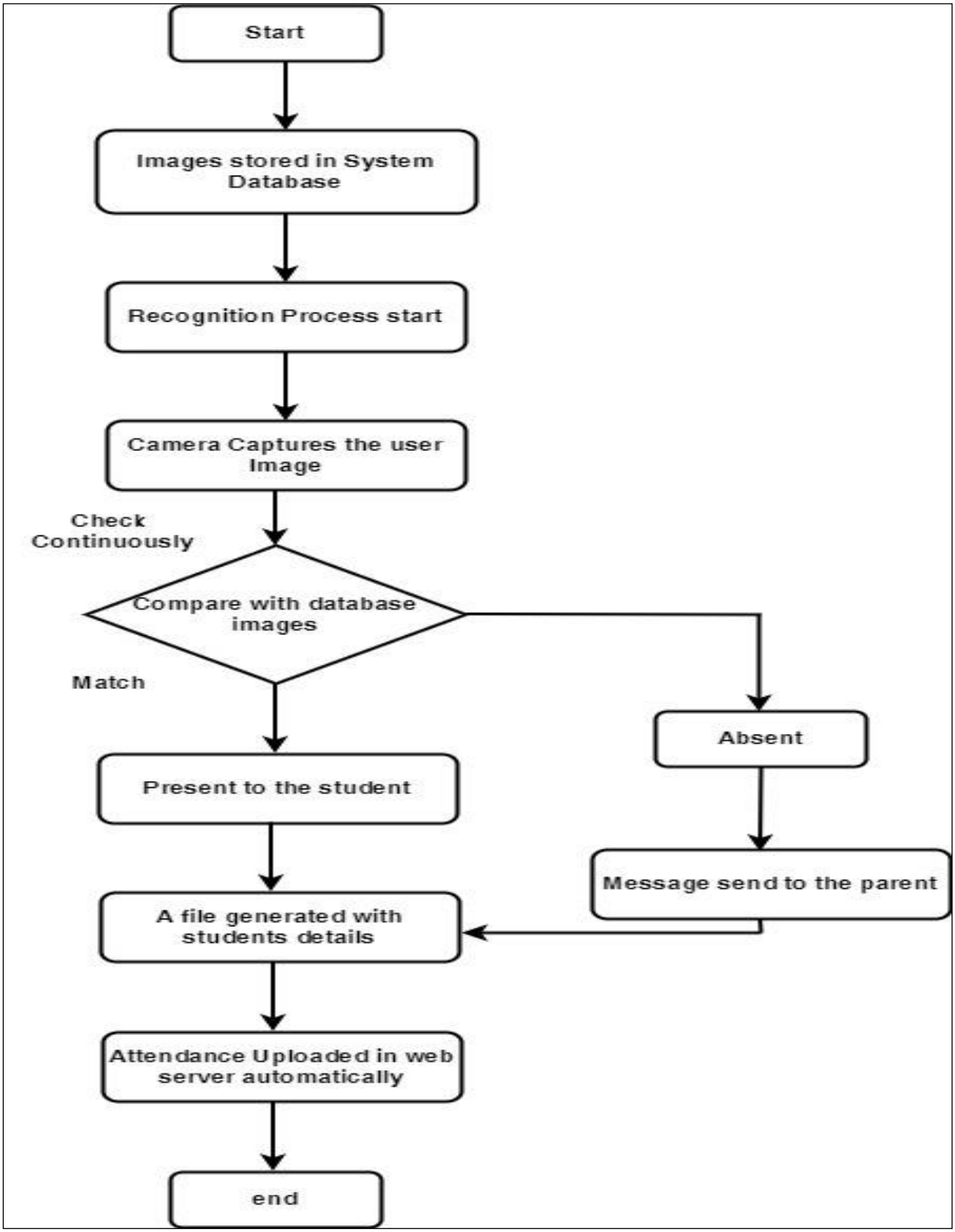

Fig 2: Flow Chart for Smart School Monitoring System

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1392

Flow charts of the proposed work is shown in the Figure 2 and Figure 3 respectively. The steps involved in the proposed Smart School monitoring system is shown below

- Start: The system is initialized at the start of the process
- Database setup: For future comparison, user (student) images are pre-stored in the system database.
- Recognition Process Initiation: The system is prepared to take pictures now that the facial recognition process has begun.
- Image Capture: As a user interacts with the system, a camera records their image.
- Comparison: The pre-stored database images and the captured image are continuously compared. If a student is found, the system marks the student as present otherwise as absent.
- Creation of the Attendance File: A file with the attendance information is created and stored.
- Automatic Upload: The process is finished when the attendance information is automatically uploaded to a web server. With this system, absentees can communicate instantly and attendance is tracked accurately and efficiently.

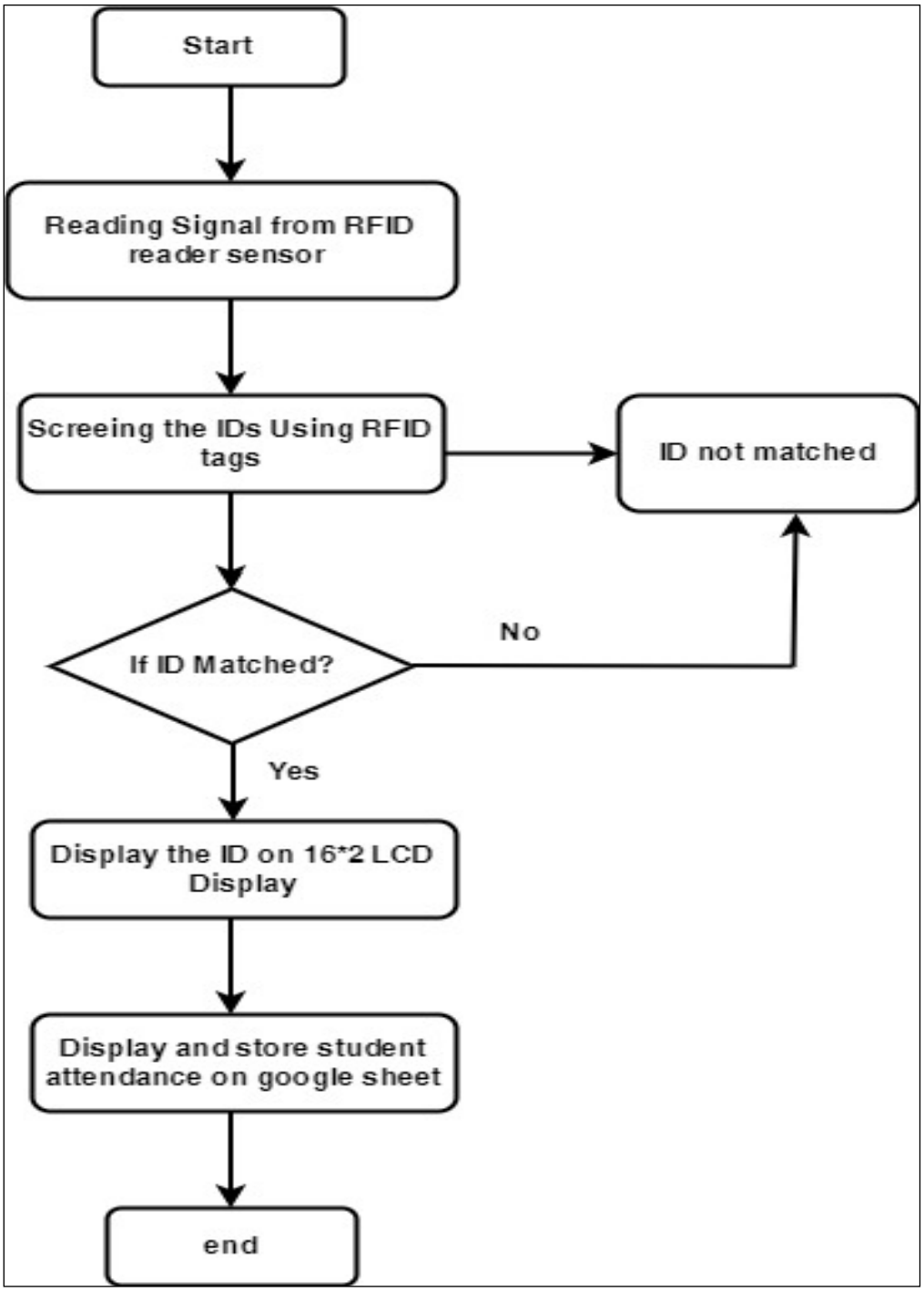

Fig 3: Flow Chart for Smart Bus Monitoring System

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jun1392

The steps involved in the proposed Smart bus monitoring system is shown below

- Start: Following the system's power-up and readiness to read RFID signals, the procedure starts.
- Signal Reading: Students' RFID tags send signals that are detected and read by an RFID reader sensor.
- ID Screening: The system screens the ID obtained from the RFID tag: If the tag matches, the process continues or else the process stops.
- ID Display: To verify identification for matched IDs, the system shows the ID on a 16x2 LCD display.
- Attendance Recording: The student's attendance is tracked by the system and updated on a Google Sheet for future reference and storage.
- End: Once the attendance data has been successfully stored, the procedure is over. With a real-time display, automated record-keeping, and RFID technology, this system guarantees prompt and precise attendance marking.

IV. RESULTS

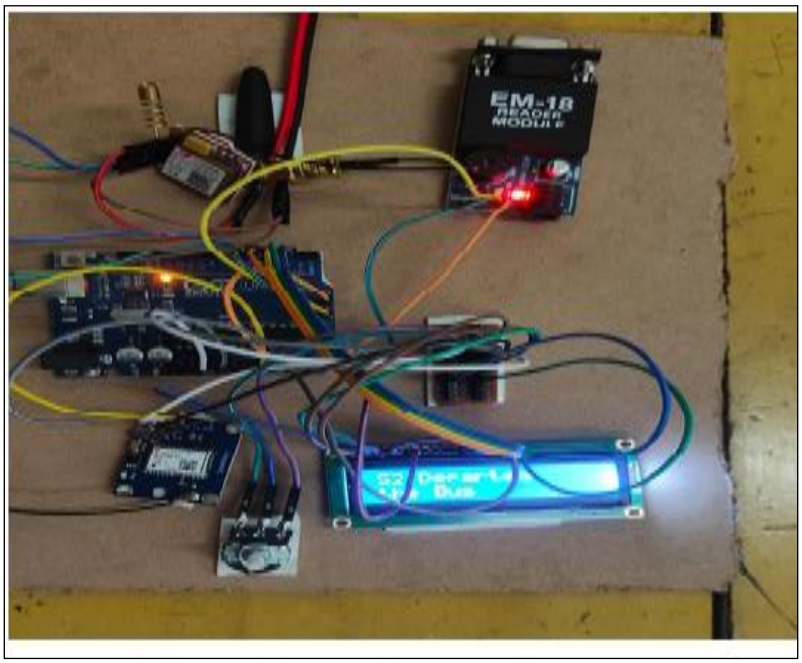

Fig 4: Hardware Deployed in the Bus

Fig 5: Message Received by the Parent Regarding the Boarding of a Student on to School Bus

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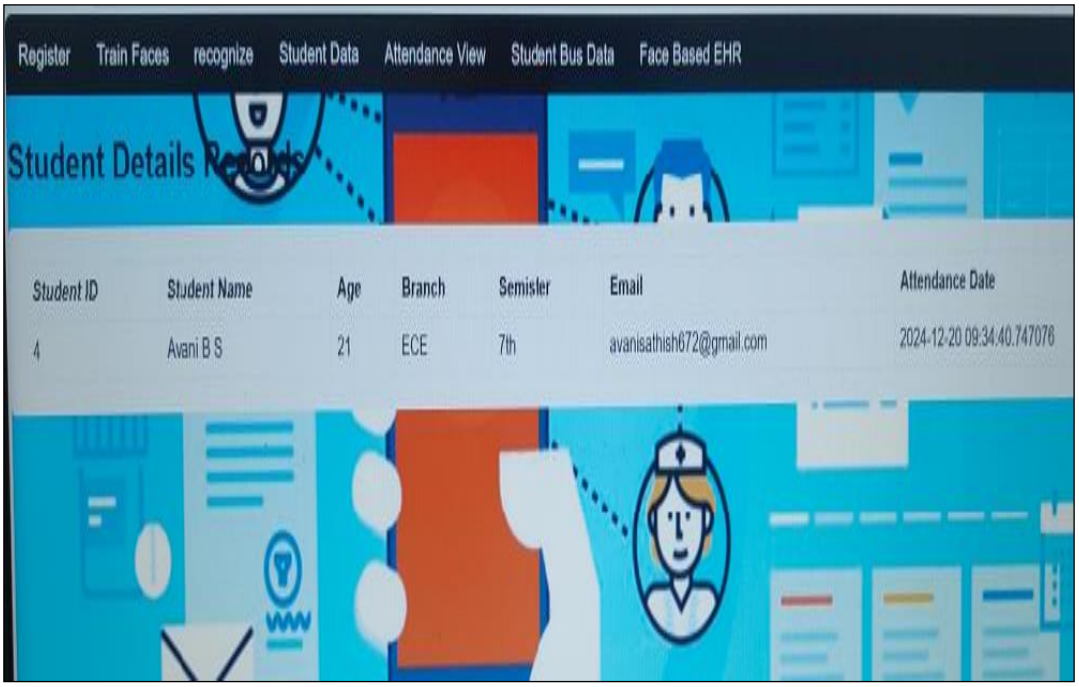

Fig 6: Display of tracked information about the student in the website

The hardware deployed in the bus is shown in the Figure 4 and process that take place is shown in the below steps

- The student first gets on the bus from home. Before boarding the bus, the student scans the RFID tag.
- After scanning the tag, the message is sent to the parent as shown in Figure 5.
- The scanned details and location are displayed in the website created, through which the parents can have even more detailed information as shown in Figure 6.
- Students scan their faces as soon as they arrive at school, and the image is then entered.
- The marked attendance details are shown in the website in a separate column.

V. CONCLUSION

The safety, operational, and communication issues that educational institutions face are successfully addressed by the Smart School Monitoring System Integrated with Smart Bus. The system guarantees smooth student monitoring on campus and while traveling by combining cutting-edge technologies like RFID, IoT, GSM, and camera surveillance. RFID-based automated attendance tracking reduces the need for human intervention, increases accuracy, and gives parents and administrators real-time updates. By offering real-time location updates, route monitoring, and geo-fencing alerts, GPS-enabled smart bus tracking improves transportation safety and guarantees safe transit for students. By providing instant notifications and system status, buzzer alerts and LCD displays improve responsiveness and user experience. In order to provide visual surveillance for increased security and to address worries about emergencies or unauthorized activity, the camera modules are essential. The system creates a more dependable and transparent ecosystem by bridging the communication gap between parents, school administrators, and transportation staff through wireless communication via IoT and GSM modules. The developed system not only improves student safety but also simplifies school operations, increasing productivity and stakeholder trust. It can be implemented in educational institutions of different sizes due to its modular design and scalability. The solution modernizes school administration by utilizing smart technology, guaranteeing a safe, connected, and closely watched learning environment.

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[1]. S. Lukas, A. R. Mitra, R. I. Desanti, and D. Krisnadi, “Student attendance system in classroom using face recognition technique,” in 2016 International Conference on Information and Communication Technology Convergence (ICTC). IEEE, 2016, pp. 1032–1035.

[2]. S. Sawhney, K. Kacker, S. Jain, S. N. Singh, and R. Garg, “Real-time smart attendance system using face recognition techniques,” in 2019 9th international conference on cloud computing, data science & engineering (Confluence). IEEE, 2019, pp. 522–525.

[3]. B. Merai, R. Jain, and R. Mishra, “Smart notice board,” International Journal of Advanced Research in Computer and Communication Engineering, vol. 4, no. 4, pp.105–107, 2015.

[4]. E. Abbott and D. Powell, “Land-vehicle navigation using gps,” Proceedings of the IEEE, vol. 87, no. 1, pp. 145–162, 1999.

[5]. I. Ghazi, I. ul Haq, M. R. Maqbool, and S. Saud, “Gps based autonomous vehicle navigation and control system,” in 2016 13th International Bhurban Conference on Applied Sciences and Technology (IBCAST). IEEE, 2016, pp. 238–244.