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Smart School Bus Safety System Using IOT

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ABSTRACT

Making sure students are safe while they're on their way to school is a big concern for both schools and parents. This paper presents a super innovative solution that uses all kinds of advanced technologies and innovative methods to keep kids safe during their bus rides.

The system incorporates various components including GSM, GPS, ESP8266, ESP32 camera module and LCD display to enable comprehensive monitoring and communication capabilities. The Telegram bot interface facilitates direct access for parents, allowing them to access real-time photos captured on the school bus to verify their child's attendance and safety. Additionally, GSM technology is used to send instant messages to parents and school authorities regarding bus departures, arrivals, and emergency situations, ensuring immediate response and intervention. Furthermore, the project uses database visualization techniques to efficiently analyze and present the data collected, enabling a nuanced analysis of bus routes, timing, and safety trends. An intuitive mobile app provides a user-friendly interface for parents to visualize their child's in and out time with real-time bus status through GPS integration. The inclusion of an LCD display increases the system's versatility, providing an additional means of displaying important information such as bus status, warnings, and safety reminders.

Through its implementation, the "Smart School Bus Safety System" aims to reduce the risks associated with school transport and provide safe and efficient travel for students. This research paper highlights the system's holistic approach, leveraging advanced technologies for real-time monitoring, communication, and data analysis, which ultimately contributes to enhancing student safety and well-being.

Keywords: IOT, RFID, LCD, GPS, GSM, ESP32 Camera Module, ESP8266

1. INTRODUCTION :

Ensuring the safety and security of students during their daily commute to and from school is not just a logistical concern, but a fundamental responsibility of every educational institution and society as a whole. With numerous accidents, incidents and risks associated with school transport reported around the world, the need for effective monitoring and communication systems has never been more urgent. Parents entrust their children to school transport services with the expectation that they will be transported safely to and from school, therefore the well-being of students during transport is of the utmost importance. Therefore, the development and implementation of the "Smart School Bus Safety System" represents a significant step forward in fulfilling this obligation. By providing real-time monitoring and communication capabilities, this system not only increases the safety of students, but also offers peace of mind to parents and carers, ensuring the well-being of their children during their journey.

Despite the importance of ensuring student safety during school transportation, traditional methods of monitoring and communication have often been insufficient to address the dynamic challenges and risks associated with transportation. Existing studies have highlighted several deficiencies in current school bus safety protocols, including reliance on manual checks, limited communication channels, and delayed emergency response. For example, research by Smith et al. (2018) highlighted the ineffectiveness of manual staff counts and visual checks in ensuring student presence and safety on board. Similarly, a study conducted by Johnson and Brown (2019) highlighted the limitations of existing communication methods in providing timely updates and alerts to parents and school authorities during emergencies. These findings underscore the need for innovative solutions such as the "Smart School Bus Safety System" to bridge existing gaps and increase student safety during transportation.

The development and implementation of a "Smart School Bus Safety System" offers significant value by addressing deficiencies identified in existing studies and traditional approaches to school bus safety. By integrating advanced technologies such as GSM, GPS, and camera modules, this system fills critical gaps in student monitoring and communication, enabling real-time monitoring, 24/7 student surveillance, and instant alerts during emergencies. In addition, the incorporation of database visualization techniques and a user-friendly mobile application adds further value by facilitating efficient data analysis and providing parents with transparent views of their child's bus journey. Through its comprehensive approach to student safety, the "Smart School Bus Safety System" not only enhances the safety of students during transportation, but also serves as a blueprint for future advancements in school transportation systems around the world, contributing to the overall well-being of students. and peace of mind for parents and carers.

2. LITERATURE REVIEW

The Internet of Things (IoT) has emerged as a transformative technology with diverse applications across various sectors, including education. In the context of school safety, IoT offers innovative solutions to enhance security and monitoring capabilities. By connecting physical devices and sensors to the internet, IoT enables real-time data collection, analysis, and communication, facilitating proactive measures to ensure student safety during school hours and transit.

The purpose of this literature review is to provide a comprehensive understanding of IoT-based school safety systems, focusing on their definition, components, technological aspects, and practical applications. By exploring existing literature on this topic, the review aims to identify common themes, challenges, and recommendations for future research and policy development. The scope of the review encompasses an examination of IoT technologies utilized in enhancing school safety, examples of IoT devices and sensors commonly used in school safety applications, and potential implications for response times, effectiveness, and policy frameworks.

S.Srinivas on this study provides an IoT-primarily based technique to high school bus tracking, emphasizing the function of IoT generation in enhancing baby protection and actual-time communication with dad and mom. RFID tag is used as a first degree of verification. Only after a hit RFID identification the scholars are made to undergo the 2d degree of verification the usage of a digital camera. Here, the digicam captures the pupil's photograph and verifies it with the image the is formerly stored and assessments if the scholar is sporting the mask or not. This machine also monitors the temperature of the pupil the usage of IR sensor. [1]

M. Kumari, A. Kumar developed a school bus tracking application, underscoring the importance of mobile applications in improving parental engagement and child safety.[6]

We use advanced techniques like QR code technology and pupil ID technology. QR code is scanned, and the student's personal data can be generated and using QR code with ID card got here up with excessive best outcomes. With the help of software tools, identity cards are beneficial for instructional organization as they are free of fee. [2]

R. S. Krishnan et al. A secure bus management system was proposed for colleges, integrating IoT technology to address security concerns, especially during the COVID-19 pandemic. Parents are periodically provided with parking information to get their child ready for school at a scheduled time before the bus arrives at the boarding area. College bus rides are maintained and updated for college officials for new facilities. [3]

The proposed system is equipped with ARDUINO (UNONO6M) controllers and SIM800L modules as well as an integrated GSM modem and GPS receiver. Vehicle speed tracking via GPS provides the global location of the vehicle with accurate longitude and latitude coordinates from (2.5 m) to (3.5 m) satellites and then, all data is transmitted via GPRS service to a remote server over TCP (Connection Protocol and Internet). which are partially embedded in a web-based application. Surprisingly, the proposed scheme provides more accurate results compared to previous works. [4]

A. Ahmed introduced a smarter and safer tracking system for school buses with a focus on enhancing safety measures while in transit. This proposed system includes an Android application that can be used to send information to students as they enter and exit using radio frequency identification (RFID) and fingerprint scanners, ensuring that students' attendance is dually authenticated emphasize. The system will also notify parents when the bus is 15 minutes from home. 'Window Signalling' will also be used to ensure safety on board. [5]

The proposed system provides real-time data about various features of the vehicle, including location, route, speed, passenger list, driver compliance, schedule, etc. In this system in which we use Raspberry Pi 3b+ to connect GPS, RFID, PIR technology and Firebase Server to Cloud via WiFi. The vehicle's current geographic information is determined using the Neo 6M GPS module. The PIR sensor module is used to obtain the vehicle occupancy rate. RFID card modules are used for passenger tracking to calculate passenger costs and safety and security of passengers. All the data from the modules used are transferred to a real-time database that we implemented in firebase and the data can be accessed by the passenger, fleet manager and driver using the website. A web portal is used to display all data for the passengers and the fleet manager for buses and drivers. [6]

The literature review will also investigate the impact of IoT-based school safety systems on response times and effectiveness in managing security incidents and emergencies. This includes analyzing case studies and empirical research to evaluate the real-world effectiveness of IoT devices in detecting threats, alerting authorities, and facilitating timely responses. By assessing the impact of IoT technologies on response times and effectiveness, the review aims to identify best practices and strategies for optimizing school safety protocols and emergency preparedness. A critical aspect of the literature review will be to identify and analyze the challenges faced in the implementation of IoT-based school safety systems. This includes examining factors such as cost, scalability, privacy concerns, data security, and regulatory compliance. By exploring the challenges and barriers to implementation, the review aims to provide insights into potential obstacles and considerations for stakeholders involved in deploying IoT solutions in educational environments.

Lastly, the literature review will offer recommendations for future research and policy development in the field of IoT-based school safety systems. This includes identifying areas for further investigation, such as emerging technologies, best practices in deployment and management, and policy frameworks for ensuring privacy and security. By providing recommendations for future research and policy initiatives, the review aims to guide decision-makers and practitioners in advancing the development and adoption of IoT solutions to enhance school safety.

3. METHODOLOGY

3.1 Proposed method

The research problem addressed in this study focuses on improving student safety during school transportation through the implementation of the "Smart School Bus Safety System." To answer this problem, various types of data are essential. These include real-time location data of school buses, student attendance records, communication logs, and feedback from stakeholders such as parents, school administrators, and transportation staff. This data will allow for the evaluation of the system's effectiveness in enhancing student's safety and well-being during their daily commute to and from school.

Methods of data collection involve several approaches. Real-time location data of school buses can be collected using GPS technology installed within the buses. Student attendance records can be gathered through RFID or barcode scanning systems upon boarding and disembarking from the bus. Communication logs can be obtained through the system's messaging functionalities, documenting interactions between the system, parents, and school authorities. Feedback from stakeholders can be collected through surveys, interviews, and focus groups to gauge perceptions and experiences regarding the system's usability and effectiveness in ensuring student safety.

3.2 Algorithm

i. When a student boards the school bus, they are required to scan their RFID tag using a designated RFID reader placed at the entrance of the bus.
ii. The RFID reader detects the unique identifier associated with the student's tag.
iii. Upon successful RFID tag scanning, the LCD screen on the bus displays the student's name associated with the scanned tag.
iv. The LCD screen shows a message indicating that the student's entry has been marked.
v. As the integrated camera module captures a photo of the student, it promptly sends it to the administration's Telegram App. From there, the administration can easily forward the image to the parents.
vi. The RFID reader sends the scanned student's information, including their unique identifier and entry timestamp, to the Firebase database.
vii. A dedicated mobile application, designed for parents and school administrators, interfaces with the Firebase database to retrieve real-time data.
viii. The app displays the student's entry time, along with their name and other relevant details, providing parents with visibility into their child's bus journey.
ix. As students continue to exit the bus and scan their RFID tags, the process repeats, with each exit marked on the LCD screen and transmitted to the Firebase database and sends student photo at the time of exit to administration telegram bot.
x. The mobile app continuously updates with real-time entry data, ensuring parents are informed about their child's whereabouts throughout the journey.

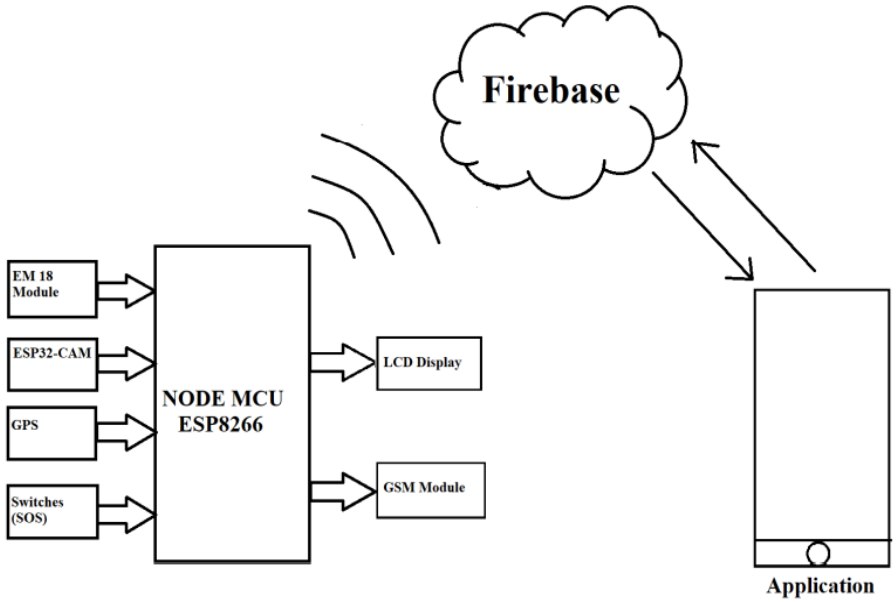

Figure 1: Block Diagram

4. RESULT

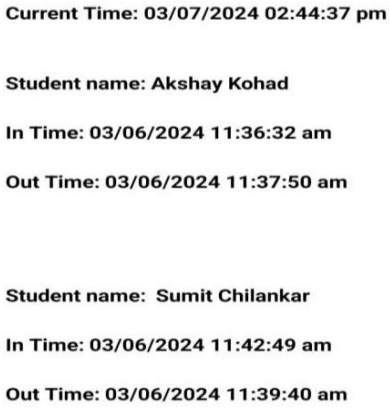

Figure 2: Data in-out

Figure 2 (Data in-out): The system records the in/out time of students; upon entry, tapping their RFID card registers the in-time along with the student's name, displaying the information on the application through Firebase. Similarly, when leaving, tapping the card logs the out-time, updating the application in real-time via Firebase.

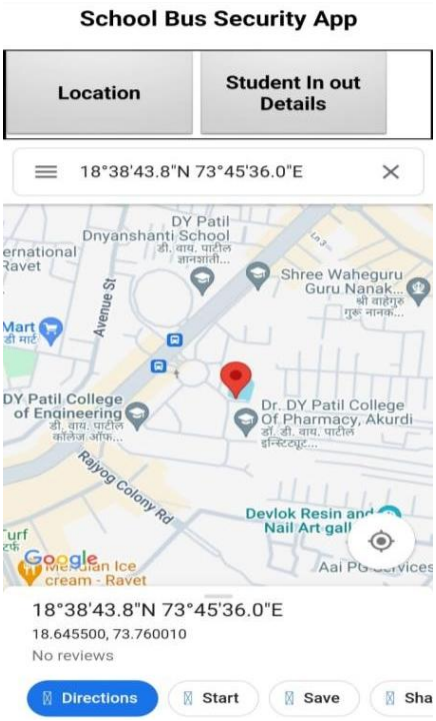

Figure 3: Location

Figure 3 (Location): This provides real-time tracking of the bus, allowing parents to monitor its current location at their discretion for enhanced visibility and peace of mind.

Figure 4: Telegram Bot

Figure 4 (Telegram Bot): The implemented system includes a feature where photographs of students are captured during the scanning of RFID cards upon boarding and disembarking from the school bus, which are then seamlessly transmitted via the Telegram bot to the school or college administration for monitoring and record-keeping purposes.

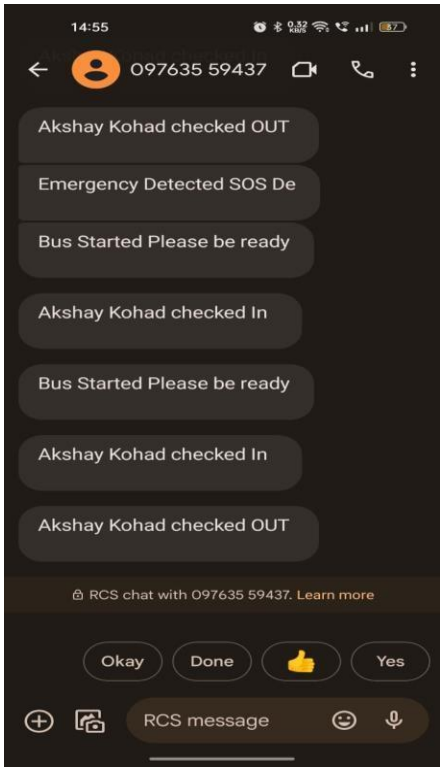

Figure 5: SMS Notification

Figure 5 (SMS Notification): The system ensures parental reassurance by sending SMS notifications to parents for each student, allowing them to verify their child's boarding and disembarking from the school bus. Additionally, it facilitates the transmission of SOS alerts through the same notification system for swift assistance in emergencies.

5. CONCLUSION

In summary, this research paper provided a comprehensive survey of IoT-based school security systems and highlighted their potential to improve security measures in educational environments. The literature review clarified the technological aspects of IoT devices, their integration with existing security infrastructure, and their impact on response time and efficiency. In addition, the review identified challenges to be faced in implementation and offered insight into recommendations for future research and policy development.

However, it is important to note the limitations of this study. One limitation is the reliance on existing literature, which may not include all recent developments and case studies in IoT-based school security systems. Additionally, the scope of the review may have been limited by the availability of relevant research articles and publications that potentially overlooked certain aspects of the topic.

Despite these limitations, the findings of this research have several implications for future scope, policy, and intervention. In terms of future scope, there is a need for continued research and innovation in the development of IoT-based school security systems, especially in addressing new threats and developing technological capabilities. Policy implications include the development of guidelines and regulations to ensure the ethical and responsible deployment of IoT solutions in educational environments that address privacy, data security, and interoperability concerns. In addition, interventions to promote awareness and adoption of IoT-based school security systems among educational institutions and stakeholders are critical to realizing the potential benefits of these technologies in enhancing student safety and well-being. By addressing these implications, stakeholders can work to create safer and more secure learning environments for students around the world.

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