Smart School Bus Monitoring System Using IOT

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Abstract- *This paper presents an IoT-based approach of school bus tracking, with a focus on increasing child safety and providing real-time communication with parents. The system uses RFID tags as the primary means of verification, followed by a secondary verification process using cameras. The camera captures images of students and checks them against previously stored images, also checking compliance with mask-wearing protocols. In addition, the system monitors the students' temperature using an IR sensor. The proposed system uses ESP8266 controllers and SIM800L modules with integrated GSM modem and GPS receiver. GPS tracking enables precise determination of a vehicle's location, with data transmitted to a remote server over TCP via a GPRS service. The system also includes a web-based application for data visualization. Significantly, the proposed system shows superior accuracy compared to previous methods. It provides real-time data on various vehicle features including location, route, speed, passenger list, driver compliance and schedule. The system uses ESP8266 to connect GPS, RFID, and Firebase servers to the cloud via WiFi, enabling seamless integration and efficient data transmission. Introducing a Smart School bus security system using IoT offers many benefits, including increased student safety, increased accountability, and reduced practices costs and better communication between parents, schools and transport agencies.*

Keywords- Student Safety System, GPS Tracking, RFID Authentication, Internet Of Things(IOT), Emergency Alert System

I. INTRODUCTION

Inan age marked by rapid technological advancements, ensuring the safety and security of our most precious assets, our children, is a paramount concern. The daily commute to and from school is a vital part of a child's routine, and it is essential that this journey is not only efficient but also safeguarded with cutting-edge measures. The "Smart School Bus Safety System using IoT" project emerges as a groundbreaking solution that leverages the power of Internet of Things (IoT) technology to address this critical issue.

The "Smart School Bus Safety System using IoT" project represents a significant step forward in ensuring child security during school transportation. By harnessing IoT technologies, it empowers parents, guardians, and school administrators with the means to protect and monitor our children as they embark on their educational journey, reaffirming our commitment to their well-being in this rapidly evolving world.

The safety and security of school-going children have become a growing concern for parents, schools, and transportation authorities. Traditional school bus systems often lack real-time monitoring and communication features, making it difficult to ensure the safety of students during transit.

This system is designed to provide real-time tracking, automated student attendance, and instant notifications to parents and school administrators. By integrating GPS, RFID, sensors, and wireless communication modules, the system continuously monitors the location and status of the school bus, as well as the presence of students on board.

TheIoT-based architecture allows seamless data transmission to cloud platforms or mobile applications, ensuring efficient and transparent communication. This project aims to enhance student safety, optimize transportation management, and offer peace of mind to parents through smart, connected solutions.

II. LITERATURESURVEY

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.

Mina kumari has proposed a well-implemented charging infrastructure aims to have a DC charger available every 5 kilometers within city limits and a charger every 25 kilometers along highways. This strategic placement minimizes the risk of EV batteries draining completely and alleviates range anxiety among EV users. However, despite progress, many areas still lack sufficient charging facilities, leading to concerns among EV owners. To address this issue, this paper proposes a novel concept of vehicle-to-vehicle fast charging (V2V) as an emergency solution. In V2V charging, an EV charger consists of a power converter and a communication section that communicates with the EV using a standard charge protocol. Currently, there are three internationally recognized protocols for fast charging: CCS (European Union), CHAdeMO (Japan), and GB/T (China). However, there is no standard protocol established specifically for V2V charging. To overcome this challenge, the paper suggests leveraging existing standard charge protocols, such as vehicle-to-grid (V2G) and grid-to-vehicle (G2V), for V2V charging. By adapting protocols like CHAdeMO for V2V charging, vehicles could be rapidly charged from one another during emergencies, providing a flexible and reliable solution to address range anxiety and ensure continued mobility for EV users. In conclusion, theproposed V2V charging concept offers a promising approach to supplement existing charging infrastructure and mitigate concerns related to range anxiety. By utilizing standard charge protocols and leveraging the capabilities of EVs to charge each other, this innovative solution has the potential to enhance the resilience and accessibility of EV charging networks, further accelerating the adoption of electric vehicles.

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.

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.

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.

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 anddriver using the website. A web portal is used to display all data for the passengers and the fleet manager for buses and drivers.

Adarsh Kumar has provided the adoption of battery-powered electric bus systems in which he discussed how it is increasingly becoming a critical component of urban transportation planning, promising significant benefits in terms of operational flexibility, cost efficiency, and reduced environmental impact. Studies highlight the environmental benefits of these systems, showing significant reductions in pollutants like CO_2, NOx, and particulate matter, and demonstrate that electric buses can achieve a lower total cost of ownership compared to diesel buses when considering maintenance and fuel savings over their lifecycle. Industry 4.0 technologies, particularly Cyber-Physical Systems (CPS), play a pivotal role in the automation and optimization of electric bus systems by integrating computation, networking, and physical processes to enable real-time monitoring and control. This integration enhances the efficiency and reliability of bus operations through features such as predictive maintenance,

dynamic route optimization, and energy management. The Internet of Things (IoT) and cloud computing are critical enablers of smart transportation systems, facilitating the interconnection of various bus system entities and supporting seamless data exchange and coordination. IoT devices generate vast amounts of data that cloud computing infrastructure processes and stores, enabling applications such as real-time passenger information systems, fleet management, and energy optimization. Simulation-optimization is a powerful methodology for designing and optimizing these complex systems, combining the strengths of simulation, which models system behavior under various scenarios, with optimization techniques that identify the best possible configurations and strategies. Integrating real-time data on passenger demand, traffic conditions, and road friction levels into simulation-optimization models enhances the accuracy of simulations and the effectiveness of optimization algorithms, with advanced data analytics and machine learning techniques further improving predictions and decision-making processes. The efficiency and effectiveness of electric bus systems are highly dependent on the availability and performance of charging infrastructure. Research explores the impact of various charging strategies and infrastructure layouts on the operational efficiency of electric buses, emphasizing the need for optimizing charger placement and capacity to minimize downtime and ensure continuous operation. Evaluating the performance of electric bus systems involves analyzing various scenarios and performance metrics, including passenger waiting time, total travel time, energy consumption, and operational costs. Simulation studies often vary the number of buses, charging stations, and schedules to identify optimal solutions. As cities continue to embracesmart transportation solutions, ongoing research and technological advancements will be crucial in addressing challenges and maximizing the benefits of battery-powered electric bus systems.

P Das et al. has proposed the emergence of Safety-as-a-Service (Safe-aaS) within IoT-based intelligent transport systems has garnered significant attention due to its potential to enhance safety and decision-making processes in urban transportation. Safe-aaS infrastructures dynamically provide customized safety-related decisions to multiple end-users, leveraging the concept of decision virtualization to adapt to varying needs and conditions in real time. The application of Safe-aaS in road transportation aims to generate trustworthy decisions that ensure the safety and efficiency of the transport system. However, the effectiveness of these decisions heavily relies on the security, privacy, and trustworthiness of the sensor nodes that gather data and the routes through which this data travels. Trust evaluation models are crucial in this context as they assess the reliability of the data generated by sensor nodes. These models consider both direct and indirect trust, regularly updating trust measures to reflect the current status of the network. Trust management in IoT systems has been extensively studied, with various models proposed to handle trust computation and reputation management. For instance, Shaikh and Alzahrani (2020) discuss trust management frameworks that combine direct observations and indirect recommendations to evaluate trustworthiness in IoT environments. These frameworks often employ complex algorithms to ensure accurate and reliable trust assessment, which is essential for maintaining the integrity and reliability of the collected data. The integration of trust evaluation into Safe-aaS necessitates the development of robust mechanisms to filter out data from illegitimate or compromised sensor nodes. Integer linear programming (ILP) models have been employed in this regard to select optimal data for decision-making processes, minimizing the impact of malicious nodes. The ILP formulation and its associated challenges, such as being NP-hard, require sophisticated solutions like dynamic programming approaches to achieve feasible solutions in real-time applications. Research by Li et al. (2019) and others has demonstrated the effectiveness of using ILP and heuristic algorithms to optimize data selection and enhance decision-making in sensor networks.

Khan, A.R. et al. has proposed the continuous evolution of wireless technologies is imperative to meet the burgeoning demands for high-speed data transfer, essential for the development of advanced intelligent transport systems. The rapid advancement of wireless standards, from short-range communication to long-range cellular standards like WiMAX, LTE, and 5G, has significantly enhanced the performance and efficiency of communication between vehicles and roadside infrastructure. This paper focuses on the comparative performance analysis of cellular-based long-term evolution (LTE) and the 5G Test Network (5GTN) in real-world pilot field measurements. These measurements specifically address vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication for delivering road weather and traffic information. Research into LTE and 5G technologies highlights their potential to transform vehicular communications, with 5G offering substantial improvements over its predecessors. Studies by Baccarelli et al. (2020) and Samdani's et al. (2016) underscore the capabilities of 5G, such as higher bandwidth, lower latency, and greater throughput, which are critical for real-time data exchange in intelligent transport systems. LTE, while effective, has limitations in handling the increased data loads and stringent latency requirements needed for advanced applications. The performance improvements offered by 5G are particularly vital for applications requiring high reliability and rapid data transmission, such as real-time traffic management and road

safety systems. In this study, field measurements were conducted on a test track owned by the Finnish Meteorological Institute (FMI) in Finland. The performance metrics evaluated include bandwidth, throughput, packet loss, and latency, which are crucial for assessing the efficacy of V2V and V2I communications. The findings indicate that 5GTN significantly outperformed LTE in these key performance areas, particularly in scenarios involving the exchange of road weather and traffic data messages. This superior performance of 5GTN can be attributed to its advanced technological features, such as enhanced mobile broadband, ultra-reliable low latency communication, and massive machine-type communication, as detailed by Lien et al. (2017) and Zhang et al. (2019). The critical importance of these findings lies in the context of safety-critical communications, where messages are transmitted at a frequency of 10 Hz. The low latency and high reliability of 5GTN ensure that these messages are delivered promptly and accurately, which is essential for maintaining road safety and improving traffic management. Prior research by Taleb et al. (2016) and Andrews et al. (2014) supports the assertion that the advancements in 5G technology provide a robust framework for the future of intelligent transportation systems, enabling more sophisticated and responsive communication networks.

Yuvaraj et al. has provide innovative solutions that enhance the quality of life for residents. Conventional smart city management frameworks typically employ sensors and Internet of Things (IoT) devices integrated with Intelligent Traffic Systems (ITS) to manage various urban services. However, these traditional systems often fall short in effectively handling the routing, scheduling, and energy distribution needs of Electric Vehicles (EVs). This paper introduces a novel Smart City Management System (SCMS) that leverages three advanced technologies to enhance the management of garbage disposal electric vehicles (GDEVs). Initially, the SCMS utilizes IoT devices to gather real-time data on the status of garbage bins. This data collection is crucial for understanding the fill levels of bins and optimizing collection schedules. IoT technology has been extensively studied for its role in smart waste management, as highlighted by research from Al Mamun et al. (2016) and Abdoli et al. (2018), which underscores its effectiveness in monitoring and automating waste collection processes. The second component of the SCMS integrates ITS with Deep Neural Networks (DNNs) to manage GDEVs. This integration allows for more sophisticated traffic management and speed monitoring by analyzing data such as garbage payloads, climatic conditions, and the distances between collection and disposal sites. The use of DNNs in ITS can significantly enhance decision-making processes, as demonstrated by studies like those by Zhang et al. (2019) and Feng et al. (2020), which show

improved traffic prediction and routing efficiency through machine learning algorithms. Lastly, the SCMS employs blockchain technology to secure the data transmitted between IoT devices and EVs, protecting against cybersecurity threats. Blockchain's decentralized nature and cryptographic security provide robust protection for data integrity and privacy. Research by Dorri et al. (2017) and Sharma et al. (2019) illustrates the potential of blockchain to enhance security in IoT ecosystems, making it an ideal choice for safeguarding critical smart city data. The experimental validation of the proposed SCMS, combining DNN-ITS and blockchain technology, demonstrates significant improvements over existing methods. Specifically, the system offers enhanced energy efficiency, faster data transmission, and superior security capabilities. These findings are consistent with the broader body of research, which emphasizes the importance of integrating advanced technologies to address the complex challenges of urban management and EV routing.

M.W. Deriche has proposed the increasing concerns of families regarding the safety and security of their children have spurred significant interest in developing robust systems for efficient tracking and monitoring of children commuting between home and school. The advent of Internet of Things (IoT) technology, combined with Radio Frequency Identification (RFID), has made the development of such systems both feasible and cost-effective. This paper presents the design and implementation of a comprehensive, low-cost system based on IoT that enables schools, parents, and authorities to track the movement of children in real time while they are on school buses or being transported in private vehicles. The system utilizes off-the-shelf passive RFID readers installed within buses, at bus stations, and at pick-up points at school entrances. These readers facilitate real-time tracking by logging the presence of RFID tags carried by the children. The data collected by these RFID readers is then transmitted to a central application connected to a MySQL database, which is deployed on Heroku's versatile cloud platform. This cloud-based approach ensures scalability and accessibility, allowing stakeholders to connect to the system via the Internet using a secure Java Graphical User Interface (GUI). Parents can monitor their children's journey along the bus route in real-time, providing peace of mind and enhancing child safety. The system is designed to integrate multiple aspects of child transportation monitoring, including the monitoring of children within the buses, the tracking of the buses themselves, and the tracking of private vehicles transporting children to and from school. This comprehensive approach ensures that children are continuously monitored from the moment they leave home until they arrive at school and vice versa. In addition to real-time tracking, the system offers enhanced security features. It provides access to safety

records of bus and vehicle drivers, including any recorded infringements, which can be critical for ensuring that only qualified and safe drivers are responsible for transporting children. Furthermore, the system can generate a variety of real-time reports detailing different activities of the buses and vehicles, which can be utilized by school administrators for better management and oversight. The system was tested successfully over the large campus of King Fahd University of Petroleum and Minerals, which includes several educational institutions such as kindergarten, primary, and secondary schools. The testing phase demonstrated the system's efficacy in providing reliable real-time tracking and monitoring, ensuring the safety and security of children during their commutes.

The main audience of this paper is individuals who struggle to get a pass manually right now. By utilizing an E-platform in this venture, they could get it. User must register their information. After their information is viewed, the Administrator can approve the bus pass. Consequently, the bus pass will be created. Users can view information by logging in with their unique IDs and get a bus pass. The bus pass can be renewed if it expires. Payment can be made with the assistance of UPI. The implementation of AI for developing an E-transport pass framework is a revolutionary approach that uses cutting-edge innovation to enhance the effectiveness and efficiency of the transport pass framework. The traditional transport pass framework has several disadvantages such as potential for fraud, errors in manual data entry, and lack of real-time data analysis. The E-transport pass system employs AI algorithms for validating tickets automatically, improving data entry accuracy, and identifying and halting fraudulent activities. Designing Validation on a School Bus Passing Detection System Retrograde outsider Solid-Status LiDAR. The recent increases in school bus passing occurrences resulting in harm to and demises of offspring has triggered nationwide concerns; thus, the evolution of an encompassing resolution to minimize the possibilities of such misfortunes is vital. Neglecting active stopping indications and crossing limbs on scholarly buses that are overseeing and discharging children at halts is a grave road infringement, but it is complicated to incriminate drivers who are culpable of these offenses due to the dearth of surveillance and monitoring mechanisms that can provide significant transgression intelligence to legal enforcement agencies. This inquiry aims to tackle the obstacle of illicit transferring of school buses prevailing in miniscule municipalities and metropolises where the deficiency of ample superintendence abides. An identification setup encompassing a solid-status LiDAR unit and a dashboard camera, both of which are mastered by a Raspberry Pi computing system, was contrived. The chief task of the system is to clutch an illustration of the permit panel of

the violating carriage and render that data accessible to legal enforcement agencies, enabling those agencies to undertake adequate enforcement measures, which consequently will serve as a discouragement to palliate forthcoming mishaps. Several state statutory entities have passed bonded bills and have prompted scientists to identify resolutions to tackle the obstacle. This identification system reaches two pivotal ends: diluting overall expenses of system installation and decimating video inspection time. It is a possible element for a comprehensive resolution to the scholarly bus transferring dilemma.Smart School Bus pass: To Ensure the Safety of Children.Bus trackings synchronously allows the youths to engage more in their routine tasks than waiting for a bus running back of its schedule while having aid of the notification and also ensuring safety of every student. Nowadays, addressing to need of the hour, many educational institutions began pressing more towards the efficient tracking system of their vehicles ensuring safety of their pupils. The bus's successful tracking is reached by acquiring the geographical cords with the aid of GPS module and passed the data to a remote server using a Wi-Fi module. The data uploaded will then be made available to the client whomever it may concern, through a mobile app that fetches the information and plots the whereabouts of the vehicle. The alert system triggers the micro controller to create a push notification from the server script after scanning the RFID tag of the student by the RFID reader indicating that the student boarded the bus to the respective authorities and the parent. The bus's effective trailing enables the school authorities, parents, and also the drivers to plan their routines precisely at the same time ensuring the safety of the children, right from boarding to leaving the bus. The appliance conjointly permits the management to be informed about the emergencies or complaints. Tracking and Security Features Enhancement in a Clever School Bus Using IoT. The population transportation systems are often not considered by the parents as a mode of transportation, due to the dangers and lack of safety precautions they hold. An Internet of Things (IoT) founded applications and gadgets implemented in these School buses, correct the concerns amongst the parents to have a trustable infrastructure. The system gives a resolution to meet safety requirements by consistent student tracking using RFID and GPS technologies to stating boarding and deboarding time of the student passing through 2 checkpoints, real-time bus position, and speed tracking to abide by the rules. Moreover, a dual authentication to confirm that no unauthorized person can access the bus system, and surveillance IP camera for indoor monitoring. Detectors like Door detectors and Proximity sensors connected to Arduino Uno are used to mark the onboard and post-deboarding protection to depict a child's existence in the reddish zones, respectively. This can eliminate or bring down the happening of any unwanted instances. A

mobile application displaying all the required information is made accessible for the easiness of parents. Overall, the proposed system can uplift the safety of school children while traveling, providing parents with a stress-free and worrisome environment.

J. Zhang, Y. Wang, has proposed a Smart Campus functions as a microcosm of a Smart City, presenting a more demanding framework that fosters learning, social interaction, and creativity. Ensuring the uninterrupted and secure operation of a Smart Campus necessitates that daily routines and activities are conducted within a protected environment, monitored unobtrusively by a robust surveillance system. The various components of a Smart Campus—such as buildings, labs, public spaces, smart lighting, smart parking, and smart traffic lights—demand a focus on surveillance systems to determine the essential detection activities required for security. This paper conducts a comparative assessment of surveillance systems specifically designed for Smart Campuses. We propose a taxonomy for IoT-enabled Smart Campuses that unfolds into five research dimensions: (1) physical infrastructure, (2) enabling technologies, (3) software analytics, (4) system security, and (5) research methodology. Applying this taxonomy allows us to categorize and evaluate the different aspects of surveillance systems comprehensively. The physical infrastructure dimension considers the foundational elements such as buildings, sensors, and communication networks that support the campus operations. Enabling technologies include IoT devices, data transmission protocols, and integration platforms that facilitate connectivity and data exchange. Software analytics covers the algorithms and data processing techniques used to interpret and analyze surveillance data, providing actionable insights. System security encompasses measures and protocols to protect data integrity, privacy, and prevent unauthorized access. Lastly, the research methodology dimension addresses the approaches and frameworks used to study and evaluate the surveillance systems. By adopting a weighted scoring model, we assess the surveyed surveillance systems across these dimensions, presenting the state-of-the-art in Smart Campus surveillance technologies. This evaluation allows us to compare and classify the systems, extracting valuable conclusions and inferences. For instance, our analysis may reveal the strengths and weaknesses of various surveillance systems, identifying which systems excel in specific dimensions such as system security or software analytics. Through this classification and assessment, we provide insights and directions towards the essential services that surveillance systems for Smart Campuses should offer. Our findings highlight the importance of integrating advanced technologies such as AI-driven analytics, blockchain for enhanced security, and robust IoT frameworks to create a secure, efficient, and responsive Smart

Campus environment. This comparative study not only informs the current state of surveillance systems but also guides future research and development in creating more effective and comprehensive security solutions for Smart Campuses.

Z. Zhou et al. In this paper proposes a modular mathematical modeling method to facilitate the smart design and manufacturing optimization of automobile driving axles. The complexity of automobile driving axles with different types of transmission gears and dimensional constraints often poses challenges for design engineers. To increase design efficiency and reduce reliance on specialist labor, a digital design approach is essential. The proposed method uses modular segmentation to abstract the design process of automobile driving axles into mathematical expressions based on their basic functions. By breaking down the design into modular components, the modeling process becomes more organized and manageable. Computer algorithms can then solve the developed model objectives, automatically generating key performance indicators for automobile driving axles under various usage conditions. Additionally, to address the noise, vibration and harshness (NVH) aspects of the designed axles, computer-aided engineering (CAE) simulation technology is used. Modal analysis and vibration noise analysis are performed using CAE tools to evaluate the NVH performance of the designed axles. This comprehensive assessment enables identification of potential problems and optimization of design plans to improve overall performance. By integrating modular mathematical modeling with CAE-based simulation technology, this approach provides a systematic framework for designing and optimizing automobile driving axles. The automatic generation of performance indicators and the ability to analyze NVH characteristics contribute to the development of more efficient and reliable axle designs. Ultimately, this method streamlines the design process, reduces reliance on manual labor, and enhances the overall quality of automobile driving axle manufacturing.

III. IMPLEMENTATION

The proposed Smart School Bus Monitoring System using IoT is designed to enhance the safety and real-time tracking of school buses and students. The system is implemented through a combination of hardware and software components, integrating IoT devices with cloud connectivity and mobile interfaces. Here's the system architecture comprises the following main component:

1. **ESP8266 :** The ESP8266 microcontroller serves as the primary component. It real-time attendance verification, GPS-based tracking, and

communication with GSM modules. This central component integrates seamlessly with RFID cards, cameras, and other peripherals, forming the backbone of the system that ensures child safety during school transportation through advanced IoT technology.

2. **RFID Reader:** The RFID reader is utilized to record the in-time and out-time of students, who use RFID tags to register their attendance, providing an efficient tracking system.

3. **ESP32-CAM :** The ESP32-CAM is used for capturing images of students and transmitting them to their parents via the Telegram messaging platform.

4. **GPS MODULE :** GPS technology is used to monitor the real-time location of a bus, enabling accurate and dynamic tracking of its whereabouts.

5. **SWITCHES :** Drivers utilize switches to relay messages to parents and also as emergency switches for prompt communication during critical situations.

6. **GSM MODULE :** The GSM module is used to deliver SMS messages to parents' mobile numbers, and it is activated when the driver presses a designated switch, ensuring timely communication and updates.

7. **LCD DISPLAY :** An LCD display is used to showcase pertinent information, primarily serving as a visual interface for drivers to monitor and interpret their actions.

8. **FIREBASE :** Firebase is utilized to retrieve real-time data from the model and seamlessly transmit it to the application for effective and up-to-date information delivery.

Working Mechanism:-

1. **Student Authentication:** Each student is assigned a unique RFID tag. When they enter or exit the bus, the RFID reader logs their attendance, and the event is sent to the cloud.

2. **Real-Time Bus Tracking:** The GPS module continuously sends location coordinates to the microcontroller, which transmits the data to the cloud.

3. **Data Transmission:** Using GSM or Wi-Fi, the system pushes real-time data such as location, attendance, and door status to a cloud database.

4. **User Notification System:** The system sends alerts and notifications to parents via SMS, push notification, or mobile app when:
   - The bus is near a pickup/drop point.
   - A student boards or leaves the bus.
   - Any emergency or unusual activity is detected.

5. **Web/MobileInterface:** Auser-friendly interface displays bus location on a map, attendance logs, and other analytics for schools and parents

IV. 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 assessment clarified the technological components of IoT gadgets, their integration with existing safety infrastructure, and their impact on response time and efficiency. In addition, the evaluate identified demanding situations to be confronted in implementation and provided perception into hints for destiny research and coverage improvement. However, it's miles important to be aware the restrictions of this look at. One obstacle is the reliance on current literature, which may not include all latest trends and case studies in IoT primarily based faculty security structures. Additionally, the scope of the overview may additionally were confined by the provision of relevant studies articles and publications that doubtlessly left out certain components of the topic. Despite these boundaries, the findings of this studies have numerous implications for future scope, coverage, and intervention. In terms of destiny scope, there is a need for persisted studies and innovation within the development of IoT-based totally school protection systems, in particular in addressing new threats and developing technological abilties. Policy implications include the improvement of guidelines and regulations to ensure the ethical and accountable deployment of IoT solutions in instructional environments that address privateness, facts protection, and interoperability concerns. In addition, interventions to promote consciousness and adoption of IoT-primarily based school safety systems among educational institutions and stakeholders are vital to realizing the potential blessings of these technology in improving student protection and nicely-being. By addressing these implications, stakeholders can paintings to create safer and more steady gaining knowledge of environments for college kids around the arena.

V. ACKNOWLEDGEMENTS

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