Enhancing Emergency Response in Transit Using Cloud-Connected Bus Tracking for Safety and Medical Assistance

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***Abstract*— This research presents a cloud-based bus tracking and monitoring system to improve safety and provide medical assistance to bus passengers. The system uses cloud computing, GPS, and IoT to track and monitor buses in real time. GPS-enabled devices in buses, cloud-based server architecture, and a mobile app for users make up the system. GPS devices send bus position data to the cloud server, which is analyzed and made accessible to users via the mobile app. The tracking tool lets passengers plan their routes by monitoring bus locations in real-time. Speed monitoring, geo-fencing, and emergency notifications assure passenger safety in the system. The technology warns authorities and provides accurate location information in emergencies or accidents. The device also has a medical assistance option that lets passengers call for help in emergencies. The cloud server receives a distress signal from the mobile app and sends it to the nearest medical services. If passengers need immediate medical assistance, this function is essential. The proposed cloud-based bus tracking and monitoring system improves bus passenger safety and medical aid through real-time tracking, safety measures, and fast access to medical services. Bus passengers' safety and well-being could improve with the system.**

Keywords—Internet of things, Bus tracking, Cloud server, GPS, Mobile application

I. Introduction

Due to population growth, passengers require reliable bus arrival times to plan their trips from home. Bus firms need help with fuel monitoring. The administrator may use this paper's bus tracking and fuel and speed monitoring system. Arduino, GSM/GPS, and map suit ASP. MVC delivers the bus's actuated arrival time and Google map position. The design also allows bus owners to instantly monitor their buses since the system administrator may update database information on vehicles and fuel tanks at any point of the operation [1]. They presented a new public transit system that fixes its faults. The system handles bus management, scheduling, and placement. The suggested system tracks buses in real-time and sends this information to distant users. Development uses technology like GPS, Google Maps, and GPRS. The web-based application shows bus positions on Google Maps to remote users [2]. The bus tracking and student monitoring system mobile app keeps kids safe. This program builds a bus tracking system for schoolchildren. Due to rising student disappearances, parents are worried about their kids going to school. The technique solves the problem of pupils waiting longer than usual for school transport. An Internet-enabled Android app will communicate with a server. The system also authenticates, tracks attendance, and tracks vehicles.

The application's users include drivers, teachers, parents, and administrators. The app utilizes GPRS/GSM and GPS. Parents may use this Android app to track their child's bus movements [3]. The suggested solution utilizes the OBD/CAN interface to communicate directly with the bus and transmits these parameters to a centralized server through a 3G/4G connection and the MQTT protocol. This real-time data is then used to create many reports for different stakeholders about bus comfort, safety, and attendance, giving full transparency into the circumstances inside each school bus [4]. School bus drivers struggle to track and manage the youngsters they pick up and send off, which may lead to disaster or death. The school bus tracking and kid monitoring system provides comprehensive and highly reliable integrated services to track, monitor, and enquire on Google Maps in real-time. Parents and school officials may get real-time bus location, boarding, and disembarking data through online and SMS services. Children will not get lost on school buses or drop asleep [5].

These systems need help with tracking, monitoring, scheduling, and alerts. The primary functions of this system are manually controlled and difficult to access. This research automates the public transit bus tracking system. Bus stations will have RFID readers and RFID tags on the buses. Arduino runs this system. The GSM module will transmit tracking messages to authorized parties for constant monitoring. GPS locates buses. IoT will provide bus-tracking alerts to mobile devices. Arduino processes RFID reader data constantly. The cloud handles user-system communication by sending processed data [6].

This study intends to create a wireless sensor network that automatically identifies and provides visual information for public transport vehicles' real-time movement. The centralized scheduler will receive arrival and departure data from bus stops and passenger shelters along the bus route. These bus stops and passenger shelters will use Arduino-designed microcontrollers. The bus will have tags. Detected RFID information will be transferred over Arduino and GSM / GPRS shields at bus stops to the central scheduler, analyzing the raw data and submitting the resulting coordinates to Google Maps using Google Fusion tables. Web interfaces let passengers and administration observe real-time movements [7]. Smart education makes intelligent cities. Smart education uses computers in class. Many additional elements boost a child's education. The child's bus ride home is one factor. The

Internet of Things (IOT) and Android will allow us to follow a child's life. This study describes an IOT-based system that lets parents, schools, and regulators monitor bus safety and comfort in real-time. This real-time visibility gives bus convenience and attendance information [8].

II. Literature Survey

The IoT-based bus monitoring system shows bus position and seat availability in incoming buses. RFID technology with the Thingspeak web server offers bus position and seat availability in Android smartphone applications. This method lets passengers know the bus's precise position and capacity level, so they can decide whether to catch it or wait. This lowers bus stop waiting and congestion. It minimizes theft and accidents [9]. Bus tracking apps determine the distance to each visit on a bus's route. Tracking System includes installing electronic devices in a bus and using an Android App on a smartphone to track the vehicle's whereabouts. IoT-based Android application. The client application shows a bus position. It maps bus whereabouts and updates students and staff using RTC. The database will hold the server's location data. This technology provides GPS data to a system/SMART phone in real-time. The software lets students and employees organize bus travel. Software and hardware module programming use an Arduino UNO microcontroller. It's cloud-connected and tracked using the Android app [10].

IoT-based scholar bus monitoring is described in this study. Telematics technology has allowed numerous Intelligent Transport Systems. These are not ITS services, however. This paper introduces an IoT-based scholar bus monitoring system that uses localization and speed sensors to allow parents, the government, the school, and other stakeholders to monitor scholar bus behavior in real-time, resulting in a better-controlled scholar bus [11]. The authors describe the system's architecture and implementation, which enables users to keep track of where buses are right now. By giving bus riders accurate and current information, the system seeks to increase efficiency and convenience. The paper details the tools and procedures for creating this real-time bus monitoring system [12].

This study implements a smart bus monitoring system to address existing issues. This system tracks buses using RFID and integrated sensing technologies, including GPS, GPRS, and GIS. The system uses novel theoretical frameworks and ruled-based decision engines. Prototype implementation requires an experimental setup. The findings suggest that the system's integrated technologies are appropriate for vehicle transportation system monitoring and management [13]. This bus tracking system displays real-time journey starts and finishes. It uses phones every day. Now more than ever, buses tracking systems are employed. The tracking system combines GPS, GSM, and RFID. Bus tracking is mobile. We concentrate on GPS. Bus location prediction must be precise. Scalability and efficiency have limited recent research on bus location and position estimates. Also developed B-T-S (Bust Tracking System) using adaptive position estimate and GPS in this research [14]. This study monitors students on college buses using RFID technology. It features minimal cost, effective tracking, and simple maintenance. Student tracking uses RFID tags. This work also detects fires using a fire sensor. GSM can determine bus speed and notify parents. Bus, parent, and college components comprise the system. RFID cards detect student entry/exit from the bus. Parent and college units that identify Students get this information. IOT tracking alerts the system if the college bus exceeds the speed limitation [15]. A smart transportation system and real-time luggage tracking are discussed in [16-17].

III. Proposed Methodology

The technology provides real-time tracking, speed monitoring, and geo-fencing functions to increase the safety of bus passengers. These steps support accident avoidance, monitor driver conduct, and ensure adherence to safety rules. The technology intends to make it possible for users to get emergency medical help right away. Passengers may rapidly inform local law enforcement and emergency services through the mobile application by sending out a distress signal, which will result in timely help. The system tracks Buses in real-time, enabling passengers to know their exact position and expected arrival time.

As a result, waiting times are cut down, and overall travel convenience is increased. This aids travelers in making more efficient travel plans. Emergency services and other transportation management systems are smoothly integrated into the system. Because of this connectivity, different users can coordinate effectively and react quickly to crises or other situations. The system delivers scalability, dependability, and data storage capabilities by using cloud computing infrastructure. By doing this, the system can manage an increase in the number of buses and customers while preserving its functionality and accessibility.

The system has proactive safety features, including emergency alarms and speed tracking. The device assists in preventing accidents and assures prompt response by keeping track of bus speeds and providing notifications in the event of violations or crises. The technology automatically alerts the appropriate authorities with precise location information to speed up crisis reaction times. In doing so, it makes it possible for emergency personnel to get to the location quickly, saving lives and limiting damage.

The system aims to improve the entire experience of bus passengers by offering precise monitoring, safety measures, and medical support. It provides convenience, security, and peace of mind, which raises people's satisfaction with and faith in the transportation system. The system's overall goal is to use innovative technology to provide a holistic solution that improves safety, offers medical aid, increases tracking accuracy, and makes it easier to coordinate and respond quickly in the bus transportation system. Figure 1 shows the block diagram of the proposed method.

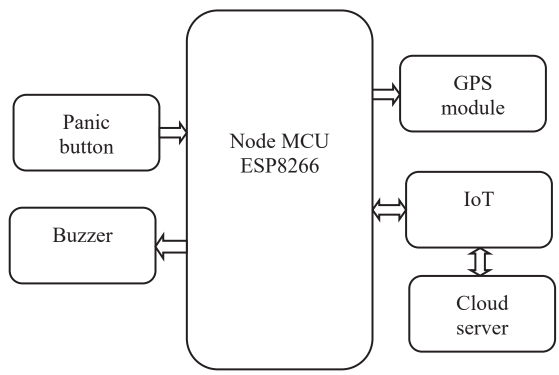

Fig. 1. Block diagram

The system's main control component is the NodeMCU ESP8266. It is designed to manage data exchange, sensor integration, and component interaction. The GPS module collects signals from satellites to determine the exact latitude and longitude coordinates of the bus's position. The NodeMCU ESP8266 retrieves this position information from the GPS unit. Through Wi-Fi, the NodeMCU ESP8266 connects to the cloud server. It continuously tracks and monitors the bus's position by sending the GPS coordinates of the bus in real time to a cloud server.

When a passenger touches the panic button, an electrical signal is sent. This signal is detected as an input by the NodeMCU ESP8266, which interprets it as an emergency warning. The NodeMCU ESP8266 notifies the cloud server of panic button activation by sending an alarm signal. This signal comprises details regarding the emergency incident, including the bus ID and the fact that an emergency has occurred. The NodeMCU ESP8266 transmits an alarm signal to the cloud server. Depending on the emergency, it analyses the data and responds appropriately. For instance, it might alert law enforcement, sound the buzzer alarm, and provide the GPS location of the bus.

The cloud server responds quickly shortly after getting the emergency alert and the relevant data. This may include alerting emergency agencies, such as medical help or law police, and giving them the exact position of the bus to ensure a prompt response. To turn on the bus's buzzer in an emergency, the cloud server may send a command to the NodeMCU ESP8266. To ensure a quick and integrated reaction, this causes an audible alarm to be generated, warning both passengers and bus workers of the situation. A mobile application for bus passengers and authorities communicates with the cloud server. The app offers capabilities for reporting problems and obtaining medical assistance, as well as real-time bus monitoring and emergency contact information. Users may utilize it to remain up to date on the whereabouts of the bus and any active emergencies.

The system combines the different parts to provide real-time bus tracking, fast emergency alerts, and improved safety measures. The NodeMCU ESP8266 collects and sends data, the cloud server analyses and reacts to the data, and the GPS module gives precise position data. This seamless connection in the bus transportation system provides effective coordination, increased safety, and quick emergency response.

A. *Workflow*

This step powers on the NodeMCU ESP8266, GPS module, panic button, buzzer, and cloud server. It prepares all gear and software for use. NodeMCU ESP8266's GPS module continually obtains bus GPS coordinates. The cloud server receives these coordinates live. This enables the cloud server to monitor the bus's whereabouts. In an emergency, the NodeMCU ESP8266 detects a passenger pressing the panic button. The panic button alerts the cloud server.

The cloud server recognizes emergency events from NodeMCU ESP8266 panic button alerts. It analyzes data and takes emergency-specific actions. It may call emergency services, alert, or tell authorities. In emergencies, the cloud server may trigger the bus buzzer through the NodeMCU ESP8266. The buzzer alerts passengers and bus employees to the emergency and ensures a prompt response.

Emergency events trigger cloud server actions. It alerts medical and law enforcement officials. The cloud server also locates the bus, allowing them to respond quickly. Bus passengers and authorities use the cloud server's mobile app. The smartphone app lets users follow buses, get medical help, and report accidents. This interaction informs users of the bus's position and emergency circumstances. The cloud server maintains GPS locations, panic button presses, and emergency notifications. Reporting and system improvement may use this data. It provides for system monitoring, pattern identification, and safety and efficiency improvements. Figure 2 shows the workflow steps of the system.

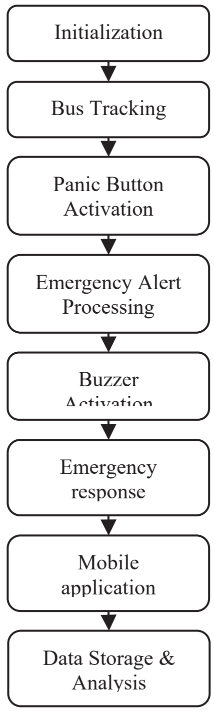

Fig. 2. Workflow diagram

IV. Result And Discussion

The system allows real-time bus monitoring and emergency detection via the panic button. Passenger safety and security may benefit from the quick reaction and support made possible by this. This method allows for prompt information to be sent to authorities and emergency services, giving them the exact position of the bus. Faster reaction times and better emergency management are the results. Passengers, drivers, and the central server could communicate without any problems because of the mobile app's integrated design. Users get access to real-time bus monitoring, emergency contact information, and reporting options, which strengthens communication channels in times of crisis. The NodeMCU ESP8266, with its built-in GPS module, makes precise, real-time monitoring of the bus's location possible. With this data, the cloud server can provide current data to the mobile app's users in real-time.

The system stores and analyzes Information like GPS locations, panic button presses, and emergency warnings. The collected information may improve the system's efficiency and security by producing reports, spotting trends, and implementing changes. Because it is stored in the cloud, the system can easily be expanded to support an increasing number of vehicles and passengers. Modifying and developing the system may accommodate any transportation network or need.

Regular maintenance and oversight may significantly increase the system's dependability and lifespan. Routine maintenance and security enhancements may maintain the system's durability and efficiency. Remembering that the outcomes may differ based on the implementation specifics, system setup, and operational variables are vital. User and stakeholder review and input at regular intervals may assist in further modifying and improving the system's functioning.

This Cloud-based Bus Tracking and Monitoring System circuit schematic is shown in Figure 3. It consists of NodeMCU ESP8266, GPS, buzzer, and panic button.

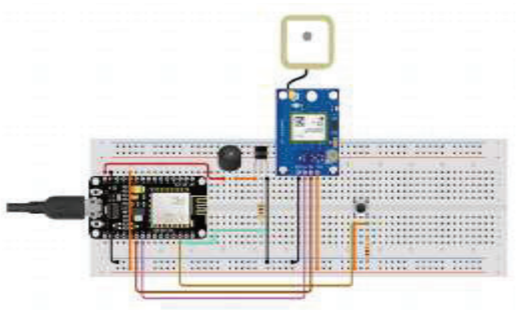

Fig. 3. Circuit diagram

Cloud-based bus tracking and monitoring system circuit diagram components include NodeMCU ESP8266, GPS module, panic button, and buzzer. The VCC pin is related to the power supply, and the GND pin is connected to the ground to provide power to the NodeMCU ESP8266. The NodeMCU ESP8266 is connected to the GPS module to transmit and receive data; specifically, the NodeMCU RX pin is wired to the GPS module's TX pin. One terminal of the panic button connects to the NodeMCU's GPIO pin, while the other terminal is connected to the ground. One buzzer terminal is wired to a NodeMCU pin, while the other terminal is linked to the ground via a current-limiting resistor. These connected circuits allow the system to monitor the bus's position, respond to panic button presses, and sound the alarm.

The Cloud-based Bus Tracking and Monitoring System's data storage in a cloud server allows for different sorts of information about bus tracking, panic button activations, and emergency occurrences. Table 1 show that GPS Data keeps track of the bus's position at various timestamps. The GPS coordinates were recorded at the time indicated by the Timestamp column. The bus's position coordinates are kept in the Latitude and Longitude column.

TABLE I. GPS DATA

Timestamp	Latitude	Longitude
2023-04-13 09:30:00	37.7749	-122.4194
2023-04-13 09:35:00	37.7751	-122.4192
2023-04-13 09:40:00	37.7753	-122.4190

Table 2 shows when a panic button is pressed on a bus; it is noted in the Panic Button Activation. Look at the Timestamp column to identify when someone pressed the panic button. The Bus ID column details which bus has its panic button pressed. The status of the panic button is shown in the corresponding column.

TABLE II. PANIC BUTTON ACTIVATION

Timestamp	Bus ID	Panic Button Status
2023-04-13 09:30:00	Bus001	Active
2023-04-13 09:35:00	Bus002	Inactive
2023-04-13 09:40:00	Bus003	Active

Table 3 provides Emergency Alert and keeps track of emergencies that the system detects or that bus crew members or passengers report. The moment that the emergency warning was created is shown in the Timestamp column. The Bus ID column identifies the bus connection with the emergency incident. The emergency type field specifies the kind of emergency, such as a safety danger or medical emergency.

TABLE III. EMERGENCY ALERT

Timestamp	Bus ID	Emergency Type
2023-04-13 09:30:00	Bus001	Medical Emergency
2023-04-13 09:35:00	Bus002	Safety Threat

The system should be able to monitor the bus's position in real-time and accurately using GPS coordinates. The performance may be evaluated by checking how reliable the location updates received from the buses are. Any time an emergency occurs, such as a panic button being pressed or an alarm going off, the system should react quickly. The reaction time may be calculated from when an event occurs and the time that the relevant action is done, such as sending alerts or activating alarms.

The system must be very dependable to ensure that data is continuously collected, saved, and processed without significant disruptions or downtime. System uptime, error rates, and data integrity are all reliability indicators. The system should be able to accommodate more buses and people without significantly slowing down. Assessing scalability involves counting the number of simultaneous tracking requests or panic button presses, for instance, and analyzing how the system functions.

Historical monitoring data, panic button activations, and emergency event recordings indicate the system's data storage and retrieval capability. User feedback should also be considered while assessing the system's efficacy. This includes aspects like the mobile app's responsiveness, the app's simplicity of use, and the satisfaction of users communicating with the system. To evaluate the efficacy of the system, it is possible to set up several metrics and benchmarks and utilize several performance testing and monitoring techniques. Using these steps can precisely the source of any performance issues, improve individual parts of the system, and ensure the system meets users' requirements.

The system enables real-time bus tracking, which improves route management and monitoring. This can help detect abnormalities or risky actions, allowing immediate response and improving passenger security. Quick action may be taken in an emergency due to the availability of panic buttons and other forms of emergency notification. Bus drivers or passengers may activate alarms during a security or medical emergency, ensuring prompt response. Real-time monitoring and precise tracking data may improve bus service. Bus routes, timetables, and resources may be better organized to save time and money.

The Bus Tracking and Monitoring System in the Cloud help bus companies, drivers, and government agencies stay in touch. This allows for improved communication in times of crisis, quicker responses, and more efficient operations overall. A mountain of data may be gleaned from the system's functions. Trends can be found, routes can be optimized, maintenance schedules can be improved, and overall bus transportation operations can be improved using this data. The system encourages responsibility and openness by keeping a detailed log of all the bus's movements, panic button presses, and emergency procedures. Problems may be resolved, events can be investigated, and safety procedures can be followed using technology.

Any problems or possibilities for improvement may be detected via continuous monitoring and analysis of system performance. This enables continuous tweaking of the system to increase its efficiency, precision, and users' overall satisfaction. The deployment of the Cloud-based Bus Tracking and Monitoring System has several benefits, including enhanced security, faster reaction times in case of an emergency, more effective use of available resources, more effective lines of communication, more in-depth insights based on collected data, more personal responsibility, and continuous possibilities for system enhancement. Bus transportation can be improved more secure, efficient, and emergency-ready with the use of innovative technology and an efficient cloud infrastructure.

V. Conclusion

The cloud-based bus tracking and monitoring system is a helpful tool for maintaining the safety of bus passengers and enabling emergency medical assistance. A cloud server, GPS, a buzzer, a Node MCU ESP8266, and a panic button are among the technologies the system uses to handle emergency alerts, provide real-time bus monitoring, and panic button activations. Due to the performance, significant consideration should be made to the circuit's design, component integration, and communication protocols of implementation. As part of its operation, the system collects GPS data, keeps track of panic button presses, and responds to crises. Information may be accessed, evaluated, and maintained straightforwardly when stored in the cloud. For the system to work well, dependability is crucial. GPS accuracy, signal interference, data transmission, filtering, and system calibration are a few variables that might impact bus tracking accuracy. Comparisons with ongoing real-world data may be used to assess and enhance system correctness. The cloud-based Bus Tracking and Monitoring System's primary goal is to make it safer to drive and provide that needing medical attention quicker access to it in an emergency. The system's effectiveness depends on its usability, adaptability, and performance. Bus tracking and emergency response systems can only live up to their promise of dependability and accuracy by continuous evaluation, analysis, and improvement.

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