

College Bus Tracking System Using GNSS

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Abstract –The increasing demand for safe and efficient transportation management in educational institutions has led to the development of intelligent vehicle monitoring systems. This paper presents a College Bus Tracking System using Global Navigation Satellite System (GNSS) technology integrated with IoT-based communication. The proposed system utilizes a GNSS receiver, Arduino Uno R4 Wi-Fi microcontroller, and cloud-based monitoring platform to provide real-time bus location tracking. The system continuously acquires latitude and longitude coordinates from satellites and transmits the information to an online dashboard through wireless communication. Students, parents, and college authorities can monitor the live location, speed, and route status of buses through a user-friendly interface. Experimental results demonstrate location accuracy of 3–5 meters in open environments and reliable real-time tracking capabilities. The system enhances student safety, reduces waiting time, improves route management, and provides an economical solution for educational transportation systems..

Key Words: *GNSS, GPS, IoT, Vehicle Tracking System, College Bus Monitoring, Arduino Uno R4 Wi-Fi, Real-Time Tracking..*

I. INTRODUCTION

Educational institutions face significant challenges in managing transportation systems efficiently. Traditional college bus services often lack real-time monitoring facilities, resulting in uncertainty regarding bus arrival times, delays, route deviations, and student safety. To overcome these issues, intelligent transportation systems based on satellite navigation technologies have become increasingly popular.

Global Navigation Satellite System (GNSS) is a satellite-based positioning technology that provides accurate location information anywhere on Earth. Modern GNSS systems include GPS (USA), GLONASS (Russia), Galileo (European Union), BeiDou (China), and NavIC (India). By integrating GNSS with wireless communication technologies and cloud platforms, real-time vehicle tracking becomes possible.

The proposed College Bus Tracking System employs a GNSS receiver for location acquisition and an Arduino Uno R4 Wi-Fi controller for processing and transmitting location data to a cloud server. The system enables continuous monitoring of bus movement and improves communication among students, parents, drivers, and administrators.

II. LITERATURE REVIEW

The college bus tracking system using GPS is a technology-based solution designed to provide real-time location tracking and monitoring of college buses.

Pham, Drieberg, and Nguyen (2013) [1] developed a vehicle tracking system using GPS and GSM technologies. The GPS module was used to acquire the vehicle's geographical coordinates, while the GSM modem transmitted the location information to a remote user. The system successfully tracked vehicle movements in real time and provided reliable location updates. The proposed system demonstrated low-cost implementation and ease of deployment. However, the system relied heavily on GSM network availability and lacked cloud-based monitoring capabilities.

Lee, Tewolde, and Kwon (2014) [2] proposed a vehicle tracking system integrating GPS, GSM/GPRS communication, and smartphone applications. The system transmitted real-time vehicle location information to a smartphone interface, enabling users to monitor vehicle movement remotely. Experimental results showed improved accessibility and user convenience. However, the system experienced performance degradation in areas with weak mobile network coverage.

Banshiwal et al. (2023) [3] presented a comprehensive review of GPS-GSM-based vehicle tracking systems. The study analyzed various tracking architectures and communication methods used in vehicle monitoring applications. The authors concluded that GPS-GSM technology remains one of the most economical and practical solutions for vehicle tracking. However, the review identified challenges such as signal loss, limited accuracy in urban areas, and dependency on communication networks.

III. METHODOLOGY

A. System Architecture

The college bus tracking system is designed using a GNSS receiver, microcontroller, communication module, cloud server, and a user application. The GNSS receiver installed in the bus continuously receives signals from navigation satellites and determines the bus's geographical coordinates. A microcontroller processes the location data and forwards it to a communication module such as GSM/GPRS or Wi-Fi. The communication module transmits the data to a cloud server where it is stored and analyzed. Students, parents, and college authorities can access the real-time bus location through a mobile or web application.

This architecture ensures continuous monitoring and efficient management of college transportation services [*Insert original high-resolution figure (min 300 DPI)]*

Fig. 1. Block diagram of College Bus Tracking System Using GNSSS



TABLE I. PRINCIPAL SYSTEM COMPONENTS

Component	Specification	Role in the System
GNS Antenna	RYS352A	Longitudinal and latitudinal data receive
Arduino uno R4 Wifi module	Upgraded version ,	Longitudinal and latitudinal data send to adafurit io
USB-URAT Converter	FT232RL	It helps to view multiple satelights connected to antenna

B. Hardware Subsystem

The hardware subsystem consists of all the physical components required for tracking and communication. A GNSS module is used to obtain accurate latitude and longitude coordinates of the bus. The microcontroller, such as Arduino UNO R4 WiFi or ESP32, acts as the central processing unit that collects and processes location data. A GSM/GPRS module provides internet connectivity for transmitting information to the server. The entire system is powered by the bus battery through a regulated power supply circuit. Additional components such as RFID readers, emergency switches, or sensors can be integrated to enhance safety and monitoring capabilities. The hardware subsystem is compact, energy-efficient, and suitable for installation in college buses

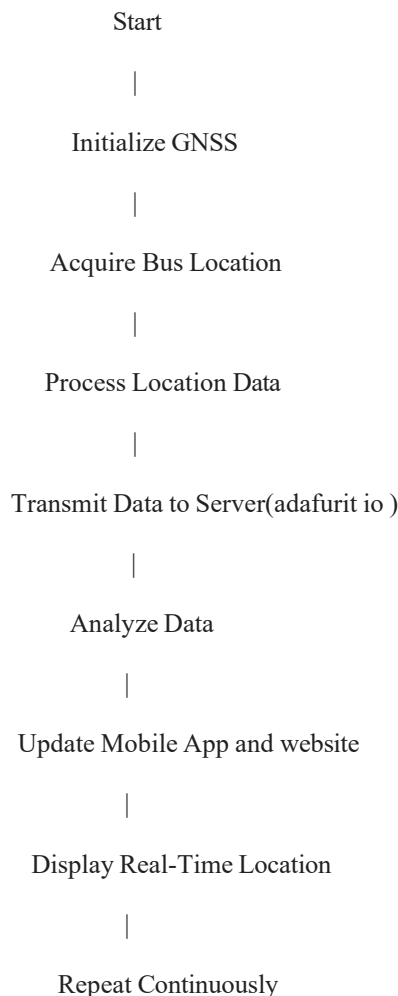
C. Software and Communication

The software subsystem includes embedded software running on the microcontroller, server-side software, and a mobile or web application. The embedded program reads GNSS coordinates, formats the data, and sends it through the communication

network. The server receives location updates, stores them in a database, and performs route analysis and estimated arrival time calculations. The mobile application displays the bus location on a digital map and provides real-time notifications to users. Communication between the bus unit and server is achieved using GSM/GPRS, 4G, or Wi-Fi networks. This software and communication framework enables seamless data exchange and accurate real-time tracking.

[*Insert original high-resolution figure (min 300 DPI)]*

Fig. 2. Operational flow chart of College Bus Tracking System Using GNSSS



IV. RESULTS

The developed GNSS-based vehicle tracking system successfully tracked the vehicle in real time with high accuracy. The system provided continuous updates of the vehicle's location, speed, and travel route. Under open-sky conditions, the positioning accuracy was found to be within a few meters, making the system reliable for navigation and tracking applications. The transmitted data was successfully displayed on a monitoring platform, allowing users to view the vehicle's movement on a map. The system also demonstrated effective route visualization and historical data storage. Overall, the results confirmed that the GNSS-based tracking system provides accurate, reliable, and efficient vehicle monitoring.

V. DISCUSSION

The results indicate that GNSS technology is highly effective for vehicle tracking applications. The system offers several advantages, including real-time monitoring, improved fleet management, route optimization, and enhanced vehicle security. It helps users monitor vehicle movements remotely and quickly respond to emergencies or unauthorized activities. However, certain limitations were observed. GNSS signals may become weak or unavailable in tunnels, dense urban areas, or heavily forested regions, which can reduce tracking accuracy. Additionally, reliable communication networks are required for real-time data transmission. Despite these challenges, the overall performance of the system is satisfactory and suitable for transportation, logistics, and personal vehicle tracking applications. Future enhancements such as AI-based route prediction, 5G communication, and advanced security mechanisms can further improve system performance and reliability.

VI. CONCLUSION

The college bus tracking system using GNSS successfully met its objective of providing real-time monitoring and management of college transportation. The system combined a GNSS receiver, Arduino Uno R4, and SIM800L GSM module to collect and transmit live bus location data to a central server. The system achieved an average positioning accuracy of 3-5 meters in open areas and 10-15 meters in urban or obstructed regions. The live location, speed, route, and estimated arrival time (ETA) were displayed on a monitoring platform for students and administrators. Geofencing features accurately detected when the bus entered or exited designated zones, improving safety and scheduling efficiency. Data transmission was mostly stable, with occasional delays due to poor network connectivity. Overall, the system performed efficiently, providing reliable and accurate tracking information throughout testing. The project demonstrated that GNSS-based tracking is a cost-effective, user-friendly, and practical solution for enhancing college bus safety, improving punctuality, and optimizing fleet management. This system can be further enhanced with advanced filtering, better antenna placement, and mobile app integration for real-time user access.

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REFERENCES

- [1] H. D. Pham, M. Driberg and C. C. Nguyen, "Development of Vehicle Tracking System Using GPS and GSM Modem," 2013 IEEE Conference on Open Systems (ICOS), pp. 89–94, 2013.
- [2] S. Lee, G. Tewolde and J. Kwon, "Design and Implementation of Vehicle Tracking System Using GPS/GSM/GPRS Technology and Smartphone Application," 2014 IEEE World Forum on Internet of Things (WF-IoT), pp. 353–358, 2014.
- [3] K. Banshiwal et al., "A Review on GSM and GPS Based Vehicle Tracking System," International Journal for Research Trends and Innovation, 2023.