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REVIEW ON BUS TRACKING SYSTEM

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Abstract: The increasing number of vehicles on the roads has led to higher fuel consumption, which in turn contributes to harmful emissions and air pollution. A key factor driving this issue is the growing reliance on private cars. Public transportation plays a crucial role in daily commuting, but passengers often face long waiting times at bus stops, leading to dissatisfaction. To address this, there is a need for systems that provide real-time information on bus locations, schedules, delays, and other relevant data. This proposed system focuses on providing such information by tracking buses in real-time using GPS technology. Passengers can access details such as whether a bus is on time, delayed, or cancelled, and can also track the bus's current location. The system integrates a variety of technologies, including GPS, GSM, and the KNN (K-Nearest Neighbors) algorithm, to offer precise tracking. It also incorporates data from RFID or RF receivers at bus stops, enhancing the accuracy of the service.

Index Terms **- Android Application, Real-Time Location Tracking, Location-Based Services, IoT Integration ,Safety and Security, Bus Route Optimization, Mobile application development ,student Transport System, Google Maps API, Real-Time Notifications.**

I.INTRODUCTION

A college bus system helps students, staff, and visitors travel easily and on time. Without a proper system, people may face problems like long waiting times, missed buses, and overcrowding. Many students use public transport to reach college, but if college buses are not well-managed, they may miss their connections and face delays. This can lead to more people using private vehicles, causing traffic jams and higher travel costs. A well-planned bus system solves these issues by running on time and matching public transport schedules. This makes travel smooth, reduces waiting time, lowers costs, and helps control traffic near the campus. It also encourages more people to use shared transport, which is better for the environment.

Many studies have explored different ways to improve bus tracking and management. The Real-time On-campus Public Transportation Monitoring System is designed specifically for university buses. It updates their location every second and shows the information on Google Maps, making it easier for students to track buses in real time [1]. Another system, the Smart College Bus Transport System, not only tracks buses but also includes biometric attendance monitoring and automatic maintenance alerts. This helps improve security and keeps the buses in good condition [2]. Other research, such as the Bus Tracking System Based on Location-Aware Services, focuses on real-time arrival predictions by using GPS and mobile applications [3]. More advanced systems, like the Smart Bus Stop App with IoT Sensors, use smart sensors at bus stops to provide highly accurate arrival times [4]. Additionally, some systems prioritize safety, such as School Bus Safety Apps and Fleet Management Systems, which monitor driver behavior and alert parents about route deviations. While these systems offer many useful features, there is still room for improvement. Our proposed system aims to integrate these features and enhance them for a more reliable, user-friendly experience [5].

II. LITERATURE REVIEW

2.1 Real-time on-campus public transportation monitoring system

This paper presents the development of a real-time bus tracking system aimed at improving public transportation, particularly for university buses. The system addresses commuter concerns by providing essential information such as the bus's estimated time of arrival (ETA), current location, and occupancy (available seats). The system comprises a GPS-based tracking

device that updates the bus's location every second to a cloud database, and a web-based application that displays real-time data on Google Maps, along with bus routes, stop numbers, and ETA information. The study demonstrates that real-time updates significantly enhance commuter satisfaction by reducing waiting times and uncertainty, ultimately promoting greater public transport usage.

2.2 Smart College Bus Transport System

The Smart College Bus Transport System aims to automate bus management using GPS, map APIs, and biometric devices. This system allows real-time bus tracking for students, staff, and parents, reducing waiting times. It also monitors attendance through biometric scanners and sends alerts if a student is missing from the bus. Maintenance alerts are generated based on vehicle distance, and centralized reporting ensures efficient management. This system minimizes manual work, enhances accuracy, and improves overall transportation efficiency in colleges [2].

2.3 Bus Tracking System Based on Location-Aware Services

The proposed Smart Bus Tracking System uses GPS and Google Maps to provide real-time bus locations, arrival times, and routes, helping passengers avoid long waiting times. Previous studies, like those by Verma and Bhatia, highlighted GPS's role in tracking buses, while Gong et al. improved bus arrival predictions using real-time data. Guo et al. developed a smartphone app offering real-time information on schedules and bus capacities, and El-Medany et al. used GPS and GPRS for accurate vehicle localization. This system enhances public transport efficiency and reduces reliance on private vehicles[3].

2.4 Smart Bus Stop App with IoT Sensors

One innovative approach to bus tracking focuses on utilizing IoT sensors both at bus stops and on buses. This system predicts the bus's arrival time in real time, offering timely updates to parents, students, and school officials. Additionally, it incorporates a feature that allows students to locate nearby bus stops based on their current location, providing an accessible and practical solution for bus tracking and reducing wait times [4].

2.5 School Bus Safety App with IoT Integration

The "Safe Route" application aims to ensure the safety of children during their bus rides by integrating IoT sensors and GPS technology. This system tracks the real-time location of school buses, monitors their speed, and detects deviations from the planned route. Parents receive instant push notifications about important events, such as delays, changes in the route, or emergencies, ensuring that they stay informed about their child's journey[5].

2.6 School Bus Fleet Management System

This system is designed for school administrators to monitor and manage the entire fleet of school buses. By integrating IoT sensors, it tracks various parameters such as fuel levels, engine health, and driver behavior. The app also provides insights into the punctuality and route efficiency of each bus. Parents can access real-time information about their child's bus, including the estimated arrival time, delays, and route changes, improving communication and transparency [6].

2.7 Student Attendance and Security System Using IoT and RFID

This system combines IoT and RFID technology to improve student security and attendance tracking on school buses. Each student is issued an RFID card that they scan when boarding or disembarking the bus. The system provides real-time updates to parents about whether their child has boarded or exited the bus, ensuring that students are accounted for at all times and preventing incidents of students being left behind [7].

2.8 IoT Bus Monitoring System via Mobile Application

An IoT-based Bus Monitoring System with a mobile app tracks buses in real-time using GPS. Passengers can view bus locations and arrival times, improving convenience and reducing wait times. It also helps transportation authority's manage buses more efficiently [8].

Paper Title	Work/Research	Technologies	Comment
I. Real Time On Campus Public Transportation Monitoring System	Develops Real Time Bus System For University Buses Providing Location And Occupancy Info.	Gps Tracking, Cloud Database, Google Maps, Web-Based Application.	A Good Starting Point For University Transport Systems; Can Be Expanded To Include Occupancy Tracking In More Detail.
II. Smart College Bus Transport System	Automates Bus Management With Real-Time Tracking And Biometric Devices For Attendance Monitoring.	Gps, Map Apis, Biometric Devices, Centralized Reporting	Useful For Automating College Bus Management; Could Expand To Include More Safety Features
III. Bus Tracking System Based On Location-Aware Services	Tracks Bus Locations And Arrival Times Using Gps And Google Maps, Helping Passengers Avoid Long Waiting Times.	Gps, Google Maps, Smartphone App.	Useful For Automating College Bus Management; Could Expand To Include More Safety Features.
IV. Smart Bus Stop App With Iot Sensors	Provides Real-Time Bus Arrival Predictions And Locates Nearby Bus Stops.	Iot Sensors, Real-Time Updates.	Could Be Further Enhanced By Integrating Occupancy And Predictive Models For Arrival Times
V. School Bus Safety App With Iot Integration	Tracks School Bus Locations, Speed, And Route Deviations To Ensure Child Safety.	Iot Sensors, Gps, Push Notifications	Strong Foundation For Ensuring Safety; Further Work Could Focus On Expanding Route Monitoring,
VI. School Bus Fleet Management System	Monitors and manages a fleet of school buses, tracks parameters like fuel, engine health, and driver behavior.	IoT sensors, fleet management software, mobile app	Could include more data analytics for better fleet performance optimization.
VII. Student Attendance and Security System Using IoT and RFID	Uses RFID and IoT to track student attendance on school buses, ensuring student safety.	RFID, IoT sensors, real-time updates.	Could expand to include emergency alerts and more detailed student safety features.
VIII. IoT Bus Monitoring System via Mobile Application	Monitors bus locations in real time through a mobile app to improve convenience for passengers.	GPS, mobile app, IoT sensors.	Could integrate predictive features for more accurate arrival time predictions.

III. RELATED WORK

The existing real-time tracking system presented in the papers relies on GPS to track bus locations. For our application, this concept is integrated with Google Maps API to display live bus locations for students and parents. The addition of a mobile interface allows users to view real-time bus data directly from their smartphones [1].

We have modified the biometric attendance system from this paper. Instead of using only fingerprint scanners, we have incorporated RFID student IDs to track attendance efficiently. This data is automatically sent to the admin, eliminating the need for manual records, thus enhancing efficiency and reducing human error [2].

The use of GPRS and GPS in previous works to display real-time vehicle locations is extended in our application to show the bus route, stops, and estimated arrival times. Additionally, traffic conditions are considered to provide more accurate predictions of bus arrivals, improving the user experience [3].

We are working on our Bus Tracking System by referring to the "Smart Bus Stop App with IoT Sensors" paper. We have modified and enhanced the system to improve real-time tracking, optimize server management, and extend accessibility through an Android app for better user convenience [4].

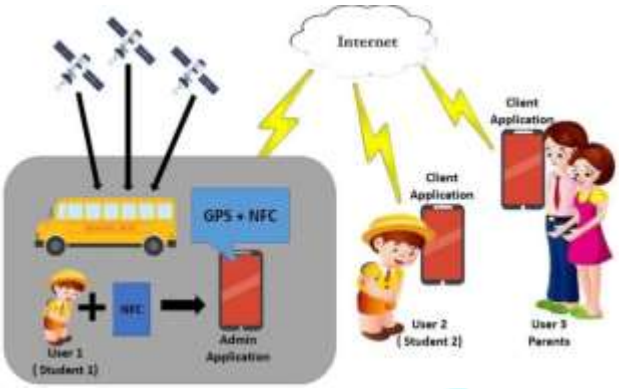
We are working on our Bus Tracking System, considering the concepts from the School Bus Safety App with IoT Integration paper. With necessary modifications, we have enhanced real-time tracking, optimized server performance, and developed an Android app to provide students with a more reliable and convenient commuting experience [5].

We are using the GPS tracking method from this paper in our project to provide real-time updates on bus locations through an Android app. This allows passengers to easily track buses, reducing waiting times and improving the overall experience [6].

Inspired by this paper, we are integrating RFID technology to detect when buses reach a stop. By combining it with GPS tracking, we can provide more accurate bus location updates, enhancing the reliability and effectiveness of our system [7].

This paper's approach to IoT bus monitoring through a mobile app is being applied to our project. Android app will send live notifications and alerts to passengers, allowing them to track buses in real-time, thus improving convenience and reducing waiting times [8].

Many current bus tracking solutions focus on basic GPS tracking and scheduling but often miss out on advanced functionalities like real-time traffic updates, route optimization, and predictive arrival times. While some systems do offer alerts about delays or the current location of buses, they fail to adapt to changing traffic conditions or provide actionable insights to improve decision-making. Incorporating AI, IoT, and other emerging technologies could significantly enhance the efficiency, reliability, and user-friendliness of bus tracking systems.[5]



IV. METHODOLOGY

The methodology outlines the essential steps to prepare for developing a bus tracking system. It covers problem identification, feasibility studies, gathering system requirements, and designing the infrastructure for implementation. Here's the simplified approach:

4.1 Identifying the Problem:

Recognize the issues the system need to solve .Gather feedback from students, parents, and staff about common problems, such as delays, safety concerns, and lack of tracking. Set the objectives for the system, such as enhancing safety, offering timely updates, and improving tracking accuracy.

4.2 Evaluating Feasibility:

Asses if the system can be developed technically, operationally. Technical Feasibility: Examine current devices (GPS, smartphones) and infrastructure to support the system. Operational Feasibility: Check if the system will be easily adopted by users (students, parents, and staff). Financial Feasibility: Estimate the total cost of hardware, software, and ongoing maintenance against available resources**.**

4.3 Analysing Requirements:

Specify what the system will deliver. Collect input from stakeholders to understand their needs (e.g., real-time location, notifications, and route management). Define both functional (e.g., bus tracking) and non-functional (e.g., security, performance) requirements.

4.4 Designing the System:

Hardware Setup: Plan the devices (GPS, mobile phones) and server requirements. Software Design: Develop layouts for the app, backend structure, and notification system. Data Flow Planning: Outline how information will move from buses to servers and user devices. Database Setup: Design how to store data related to bus schedules, student information, and tracking.

4.5 Choosing Technologies:

Select suitable technologies for system development. Choose GPS systems, mobile app development tools (e.g., Flutter, React Native), and server .Technologies (e.g., Node.js), and databases (e.g., MySQL).Opt for cloud solutions (e.g., AWS, Google Cloud) to ensure scalability and data storage.

4.6 Assessing Risks and Planning Mitigation:

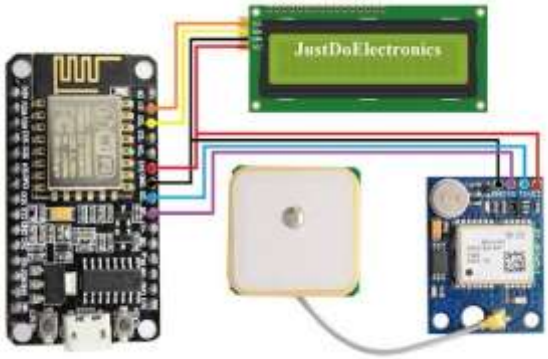
Identify potential risk and create mitigation strategies.
Technical Risks: Plan for issues like GPS inaccuracies and network failures by implementing backup systems.
Operational Risks: Ensure smooth adoption by providing user training and support.
Financial Risks: Track expenses to avoid budget overruns and maintain financial control.

V. HARDWARE REQUIREMENTS

To effectively implement the bus tracking system, a combination of hardware components is required to ensure seamless operation, accurate monitoring, and real-time communication. Below are the essential hardware components:

5.1 Wi-Fi Module (ESP8266)

The ESP8266 is an affordable Wi-Fi module for adding internet connectivity to devices. With a built-in TCP/IP stack, it supports wireless network access and can host applications or assist other processors. Its small size, low power use, and GPIO pins make it perfect for IoT projects, allowing it to connect with sensors and controllers. It’s ideal for tasks like real-time bus location tracking and sending alerts to mobile devices or servers.



5.2 GPS Module (GY-NEO6Mv2)

The GY-NEO6Mv2 GPS module is a compact and high-performance GPS receiver that utilizes the u-blox 6 positioning engine. It is designed for applications that require precise location tracking. With its advanced features, this module provides reliable and accurate location data even in challenging environments where signal interference or multipath errors may occur. This GPS module is well-suited for real-time vehicle or asset tracking, allowing the system to monitor the location of buses with high precision. It continuously updates the bus's coordinates, making it a crucial part of the tracking functionality.

5.3 Microcontroller (Arduino/Raspberry Pi)

The Microcontroller, such as an Arduino or Raspberry Pi, acts as the central processing unit for the system. It integrates all hardware components, processing data from the GPS, ultrasonic sensor, and Wi-Fi module. It coordinates communication between these components, ensuring that the system functions smoothly. The microcontroller processes incoming location data, controls the flow of information to and from the Wi-Fi module, and manages sensor operations, such as monitoring bus occupancy. This unit is essential for real-time data processing and system control.

VI. SOFTWARE REQUIREMENT

The bus tracking system relies on various software tools for its development, testing, and deployment. These tools help in creating an intuitive, functional, and responsive system. Below is a detailed overview of the key software components required for the system:

6.1 Android Studio:

Android Studio is the primary integrated development environment (IDE) for building mobile applications for Android devices. In the context of the bus tracking system, Android Studio is used to develop an application that provides real-time information to users, such as bus locations, arrival times, and schedules. The app integrates with Google Maps API, allowing users to track the buses on an interactive map. Android Studio also supports push notifications, which inform users about bus arrivals and delays. Its built-in tools for managing APIs, backend integration, and debugging ensure a seamless user experience and efficient app performance.

6.2 XAMPP :

XAMPP is a comprehensive software package that includes Apache (web server), MySQL (database), PHP, and Perl. It creates a local server environment essential for testing and simulating the backend of the bus tracking system. With XAMPP, developers can set up a local database to manage the GPS data, bus schedules, and user details. The **MySQL database** stores the real-time location data, while **PHP scripts** process the information and serve it to users via a mobile app or web portal. XAMPP helps simulate the entire backend system before deployment, ensuring smooth functionality once the system is live.

6.3 The Google Maps API:

The Google Maps API provides mapping and location-based services, essential for the bus tracking system. It allows users to view the current location of the bus on a map, track its route, and see estimated arrival times at different bus stops. Google Maps API is integrated into the mobile app to provide accurate, up-to-date navigation and traffic information, ensuring a smooth and informative user experience. The API's ability to display traffic data and route optimizations enhances the overall efficiency of the bus tracking system.

6.4 MySQL database:

MySQL database is used for storing and managing all the data associated with the bus tracking system, such as GPS coordinates, schedules, user data, and real-time updates. The relational database organizes and retrieves information efficiently, ensuring the accuracy of bus locations and schedules displayed to the users. MySQL enables the system to handle large amounts of data generated in real-time, making it an essential component for ensuring that the tracking system remains scalable and responsive as the number of buses and users increases.

VII. CONCLUSION

The real-time bus tracking system leverages GPS technology and a mobile app to provide live tracking of buses, real-time arrival updates, and route details. It significantly improves the transportation experience by addressing issues such as uncertainty in travel times, safety concerns, and lack of communication. Students can track buses and receive timely updates, allowing them to plan their

day efficiently. Parents benefit from notifications about bus status and delays, ensuring peace of mind. Administrators can optimize bus routes, monitor fleet performance, and access analytics to improve operational efficiency. With features like maintenance tracking and real-time reporting, the system ensures smooth operations and scalability. The use of cloud-based technology guarantees data reliability and supports long-term growth. This solution not only enhances convenience and safety but also sets the stage for smarter, data-driven urban transportation systems in the future.

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