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# Bus Nav: A Real Time Bus Tracking Application

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**ABSTRACT:** This research focuses on developing an advanced Bus Tracking System, with the primary goal of creating a GPS tracking application that surpasses existing systems in terms of accuracy and efficiency, specifically in tracking buses. The motivation for this study stemmed from the noticeable time wastage individuals experience while waiting for buses on their designated routes, coupled with the absence of real-time information for those who have missed their bus. This research endeavor aims not only to enhance the precision and efficiency of bus tracking but also to address the common issue of people wasting valuable time while awaiting buses and those who miss their rides due to the lack of real-time information. By tackling these challenges, the developed Bus Tracking System strives to optimize the overall public transportation experience, offering users timely and reliable information to streamline their commutes and minimize inconvenience. Through innovative technological solutions and a user-centric approach, this research endeavors to significantly improve the efficiency and effectiveness of bus tracking systems, ultimately benefiting commuters and transit authorities alike.

**KEYWORDS:** Google Maps API, Firebase, Kotlin, Web-Server

## I. INTRODUCTION

In today's modern world, where the Global Positioning System (GPS) plays a pivotal role in various aspects of our lives, including transportation systems like buses, there exists a significant challenge in ensuring accurate and timely tracking of vehicles. To address this challenge, we introduce an innovative bus tracking application designed to revolutionize the market. Our application serves as a sophisticated digital assistant, seamlessly integrating real-time bus location data into the familiar interface of Google Maps. Its primary goal is to offer users precise bus positioning information and emergency alerts when necessary. The core functionality revolves around utilizing Google Maps and its robust Application Programming Interface (API).

The development process of our application centers on creating a mobile app that provides users with effortless access to real-time bus tracking. By leveraging user location data, our app facilitates seamless tracking of buses, offers route information, and integrates seamlessly with Google Maps, all within a user-friendly interface.

The app is designed with a focus on enhancing the user experience, enabling easy navigation through bus routes and tracking of buses. Our development methodology is based on utilizing Java and Kotlin programming languages for backend and frontend development, respectively. Firebase serves as the backend infrastructure, offering real-time data synchronization and storage capabilities. The integration of the Google Maps API enables the visualization of bus routes and locations on an interactive map interface.

## II. RELATED WORK

This paper [1], is based on the development of a Bus Tracking System. Its primary aim is to create a GPS tracking application capable of accurately and efficiently tracking school buses, surpassing current bus-tracking systems. The research comprises three key components. Initially, bus location data is acquired from satellites and then processed using the Kalman filter before being transmitted to dedicated web servers via cellular networks. Subsequently, the received coordinates are processed through the Google Maps API. Finally, the data obtained from the Google Maps API is further processed within the user's device to display real-time location information.

The paper [2] discusses a method for acquiring the current position of a bus by employing a GPS device installed on the bus itself. The coordinates of the bus are then transmitted using various methods such as GPRS service provided by GSM networks, SMS, or RFID. The GPS device, integrated into the tracking system, sends this information either to a

centralized control unit or directly to bus stops via RF receivers. Furthermore, this system incorporates historical average speeds of each segment to enhance accuracy, taking into account factors such as traffic volume, intersections, and time of day. Users can access tracking information through LEDs at bus stops, SMS, a web application, or an Android application. Upon transmission to the centralized server, the GPS coordinates undergo various arrival time estimation algorithms based on historical speed patterns.

The paper [3] presents a Bus Tracking system, which integrates three techniques: GPS, GSM, and RFID, creating a dynamic mobile system. While the system encompasses all three techniques, the primary focus lies on GPS for accurate bus location estimation. Despite numerous research solutions proposed for efficient bus location estimation, many suffer from scalability and efficiency limitations. In this project, a novel approach called B-T-S (Bus Tracking System) is proposed, based on adaptive location estimation method and GPS approach. Initially, a novel GPS-based location estimation method is designed. The proposed approach's experimental evaluation is conducted using a Java simulation tool, considering both simulation and real-time analysis. The results indicate that the Advanced Bus Tracking System achieves improved accuracy and performance compared to existing systems.

The paper [4] introduces a system designed to track the current position of buses and dynamically inform passengers about arrival and departure times, either through display boards at terminuses or via a smartphone app. The system utilizes a GPS system to track the bus's position, with data transmitted via a GSM modem to the bus terminus. At the terminus, the receiver component of the system processes the received data to calculate arrival and delay times for each bus. Initial testing suggests that this system will greatly benefit commuters who often experience boredom and anxiety due to uncertainty about bus arrival times. For optimal tracking results, the paper suggests the use of GPS and GSM technology, as a combined GPS and GSM-based system can provide all necessary specifications for vehicle tracking.

The paper [5] presents a project aimed at automating public transport bus services to provide real-time tracking experiences. Buses are equipped with RFID tags, while RFID readers are installed at bus stops. The central controller of the system is Arduino. A GSM module is employed to send tracking messages to authorized individuals for continuous monitoring, and GPS is utilized to obtain bus locations. Users receive bus tracking details as notifications on their mobile devices through IoT. Input from RFID readers is continually updated to Arduino for data processing, after which the processed data is transmitted to the cloud, acting as the interface between users and the system. Mobile phones are selected as the communication medium with passengers to ensure easy access. The project focuses on bus tracking, sending SMS to authorized individuals, updating passengers through notifications, and enhancing system accessibility.

The paper [6] introduces a proposed smart school bus tracking system, comprising an easy-to-use software with both web-based and mobile application components. Its primary function is to enable parents, students, and school service providers to accurately track the location of school service vehicles. Such a system is deemed essential within the framework of smart city initiatives. Additionally, bus service companies can conveniently register new students and dynamically determine bus routes. The system boasts scalability, flexibility, low cost, security, and reliability. All shared location information and users' private data are stored in encrypted form, ensuring that parents only receive information about buses related to their children. Implemented as an interactive application, the system operates on both web and mobile platforms.

In paper [7], the primary aim of the application is to provide users with the precise location of their respective buses on Google Maps, along with the added feature of triggering an alarm signal to the driver when the user is near the bus stop. This system operates in real-time, updating the bus's current location continuously in the form of latitude and longitude coordinates, which are then received by the user through their application with the assistance of the Google Maps API. The project highlights are connected to the Android application through the utilization of IoT (Internet of Things) technology. IoT involves sensors or devices that communicate through the cloud, enabling a range of connectivity options. Once the information reaches the cloud, software processes can determine actions to be taken, such as triggering an alarm or automatically adjusting sensors or devices as required by the user. NodeMCU is employed to integrate the GPS module and buzzer for real-time location tracking and notification for the user. This setup enables seamless communication between the bus's GPS location, the user's application, and the alarm system. In paper [8], the system is divided into two main components: an on-board tracking unit and a tracking server unit. The on-board tracking unit is installed within the bus and is responsible for recording the boarding and disembarking status of students. This includes capturing the boarding and disembarking times, locations of students, and the real-time GPS location of the school bus. An on-board RFID reader is used to read the RFID card number of students. The real-time location is tracked using a GPS tracking device. All data regarding boarding and disembarking activities is uploaded to the tracking server for storage in the database. Upon upload, the data undergoes verification for authenticity by

comparing it with the student and bus information already stored in the database. Once verified, the data is permanently stored in the database for further analysis and reference.

In paper [9], a Real-Time Campus University Bus Tracking Mobile Application is developed to serve as a platform for users to access data transmitted from a central database. The application provides students with information regarding the arrival time of buses and the current occupancy levels, enabling them to avoid waiting unnecessarily for crowded buses. Additionally, students can submit complaints and feedback through the platform. The project utilizes PhoneGap as a development tool platform for creating the application. The GPS tracker device is implemented using Arduino, while an IoT-based people counter is employed using Raspberry Pi to transmit data. The project employs reusability techniques and Agile methodology to complete the system, which involves four interactions to ensure the full functionality of the system as expected.

In paper [10], a real-time bus tracking system designed for students using Android smartphones is proposed. This system utilizes the Global Positioning System (GPS) for tracking and positioning buses in real-time. The Android-based application allows students to determine the precise location of buses, ensuring they neither arrive too early nor late at the bus stop. Through this application, students can view the exact location of their respective buses on Google Maps. The system enables users to track the buses controlled by drivers through GPS on Google Maps from the server. Additionally, the admin is responsible for maintaining and updating all relevant information, such as bus routes, driver contact information, and the number of buses, on the server.

### III. METHODOLOGY

For driver functionality, we implement a secure login system using Firebase Authentication SDK, allowing drivers to log in with their credentials. Once authenticated, the app requests the necessary location permissions and utilizes Android's LocationManager or FusedLocationProviderClient for accurate GPS tracking. The driver's current location is continuously monitored, and when the driver presses the volume up key, the app triggers an update that sends the bus's location data to Firebase Realtime Database in real-time.

For user functionality, users also log in via Firebase Authentication and can then view a map displaying the real-time locations of various buses based on the driver's shared data. We integrate the Google Maps API to present these locations visually and provide an option for users to select a specific bus. Upon selection, users are directed to Google Maps, which calculates and displays the bus's approximate arrival time, considering current traffic conditions. This integration ensures users receive accurate and up-to-date information, enhancing their overall commuting experience.

### IV. EXPERIMENTAL RESULTS

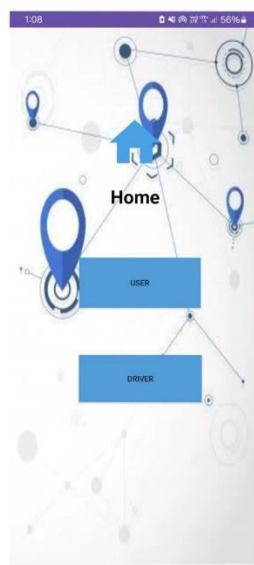


Fig.1 Home page

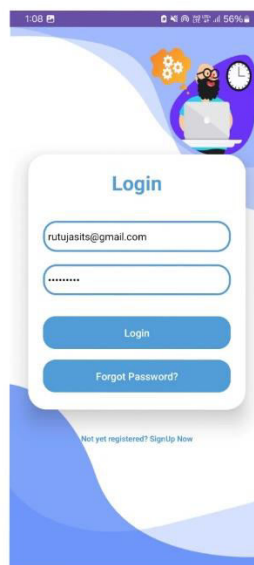


Fig.2 User Login Page

**Home Page and User Login Page:** The bus tracking app's homepage features a simple interface with options for "Driver Login" and "User Login," along with a brief welcome message. For user login, commuters enter their email and password on a dedicated screen with Firebase Authentication SDK verifying their credentials. Successful login redirects users to the main interface where they can view real-time bus locations, select buses to track, and use Google Maps for navigation. This design ensures a smooth and secure login process for both drivers and users.

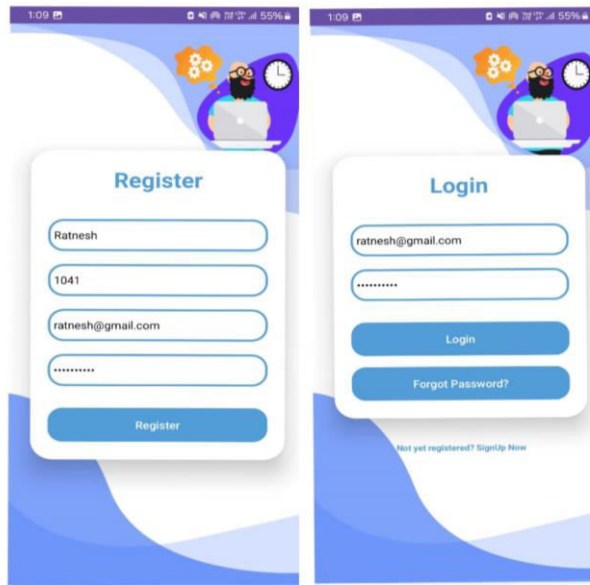


Fig. 3 Driver Registration Page      Fig.4 Driver Login Page

**Driver Registration and login:** The driver login and registration pages are designed to provide a secure and user-friendly authentication process. When a driver accesses the app for the first time, they are presented with the registration screen where they can enter their details, such as name, email, and password. This data is then securely sent to Firebase Authentication for account creation. Once registered, the driver can use the login page for subsequent entries into the app. On the login screen, the driver inputs their email and password, which are authenticated using Firebase Authentication SDK. If the credentials are valid, the driver is granted access to the main tracking interface. Error messages are displayed for incorrect credentials or failed login attempts, guiding the user to correct any mistakes. This process ensures that only authorized drivers can access the system, maintaining the security and integrity of the location data they provide.



Fig 5. Location Sharing page

**Location sharing page:** In the bus tracking app, the volume up key is repurposed to update the driver's location. When the driver presses the volume up key, the app detects this using an event listener in the `onKeyDown` method. The app then retrieves the current GPS coordinates via `FusedLocationProviderClient` and sends this data to Firebase Realtime Database or Firestore in real-time. This method allows drivers to quickly update their location without navigating through menus, ensuring accurate and current bus location data with minimal distraction.

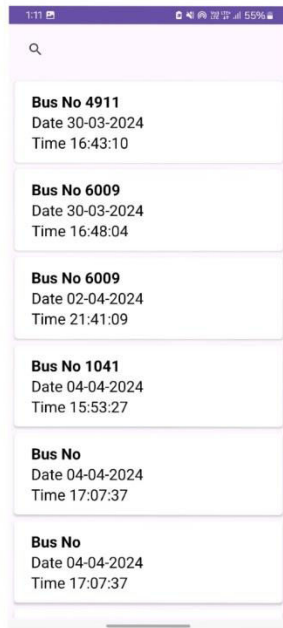


Fig.6 Buslist

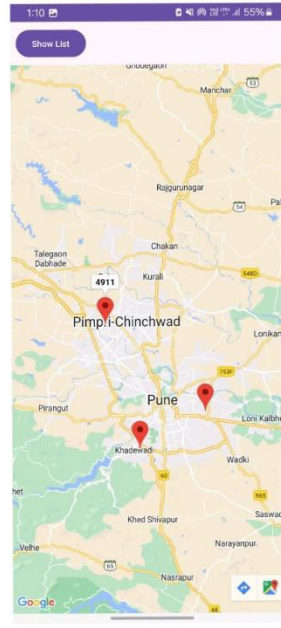


Fig.7 Google Maps Interface

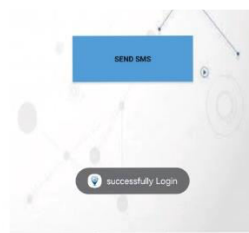
**Buslist and Google Maps Interface:** In the bus tracking app, the Bus List Interface presents users with a comprehensive list of available buses. This interface dynamically updates based on real-time data sourced from Firebase, allowing users to conveniently browse and select their desired bus. Upon selection, users are seamlessly directed to the Google Maps Interface. Here, the Google Maps API facilitates the visualization of selected buses' real-time locations on an interactive map. This interface offers users navigation functionalities and estimates arrival times based on current traffic conditions, ensuring a smooth and informed commuting experience.



Fig. 8 User Dashboard



Fig.9 SMS sending Functionality



**User Dashboard and SMS sending Functionality:** The User Dashboard in the bus tracking app offers users a comprehensive view of their journey, displaying real-time information like bus locations and estimated arrival times. It also provides customization options and notifications for a personalized commuting experience. In parallel, the Emergency SMS Sending Functionality ensures user safety by enabling quick distress message transmission from the app. With a dedicated button, users can promptly alert predefined contacts or authorities with their current location and emergency details, facilitating swift assistance during critical situations. Together, these features enhance user confidence and safety throughout their transit experience.

## V. CONCLUSION

In conclusion, the development of the bus tracking app marks a significant advancement in improving public transportation services. By offering features such as real-time bus tracking, accurate route information, and enhanced user experiences, this project presents a valuable solution for passengers and transit authorities alike. The app's ability to reduce wait times, improve efficiency, and aid in urban mobility planning underscores its importance in the realm of public transit.

With a focus on user satisfaction, seamless data integration, and stringent security measures, the bus tracking app aims to revolutionize the commuter experience. Its potential integration with Smart City initiatives aligns with the ongoing trend of urban digitalization. By providing real-time data to city planners and policymakers, the application can contribute to optimizing transportation routes, mitigating congestion, and enhancing overall efficiency in urban areas. Overall, the bus tracking app represents a pivotal step towards modernizing and streamlining public transportation systems, ultimately leading to improved accessibility, efficiency, and sustainability in urban environments.

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