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REAL-TIME TRACKING FOR EFFICIENT PUBLIC TRANSPORT SYSTEMS

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Abstract *— The school, college bus tracking system real-time helps to enhance transport efficiency for advancing the exact GPS tracking of buses through a mobile app, a web portal. Developed using Flutter for the driver's mobile and Next.js with Node.js for the portal, this system lets administrative monitor bus locations in real-time. Firebase enables a secure, reliable authentication and data management and therefore provide convenient communication between the drivers and administrations. The online service shows a map where visitors could locate lat and long details, decreasing ambiguity of when the bus would arrive and facilitate coordination. With today's modern technologies the system improves safety, reduces waiting time and optimizes transport operations. This solution becomes more transparent, more reliable and a lot better planning of the route for school and college transportation. The user-friendly interface and real-time monitoring capabilities leads to a better-informed decision making and enhanced communication, in the end benefiting both institutions and commuters.*

***Keywords*— Real-time bus tracking, GPS tracking, Flutter mobile app, Next.js web portal, Node.js backend, Firebase authentication.**

INTRODUCTION

Schools and colleges generally face problems dealing with their transportation system properly. Uncertainty of when buses arrive considering non-current information that does not display up-to-date information can inconvenience students, parents, and school administrators. Since transportation sways greatly due to the rush hour traffic and declines during a time frame in the day, hence, to resolve these problems a real time bus tracking system is created which tracks the live location of buses so that transportation is enhanced.

This project is a straightforward solution by merging GPS tracking with the current web and mobile technologies. A mobile app built on Flutter has enabled bus drivers to signup and cover their actual location, keeping track of continuously. The system provides safe communication between drivers and administrators of operational productivity.

The web portal, built with Next.js and Node.js, acts as a webboard of administrators for administration to realize in real time bus positions. It shows latitude and longitude details on the interactive map to provide accurate information of bus movement. Firebase is also used for secure authentication & real-time data sync.

With the use of actual-time Gps monitoring, this product raises the safety and performance of college and university transportation. School Administrators can find the buses, Sight the route properly, it reduces waiting time for students. The possibility to track live locations allows for better organization and decrease in delays.

Featuring an user-friendly interface and strong combination of technologies, this system decreases cargo transport observing processes. It takes out the uncertainty about bus arrivals and helps institutions to maintain a seamless commuting experience. The system, as well as enhances the transparency and trust of the transport operations.

This in real time tracking methods turn existing transport management by exact, real-time place update. By refining bus routes and improving communication, it increases transport dependability, besides, creates less operational consequences, as well as gives way to a safer and more competent transportation system for educational establishments.

LITERATURE REVIEW

A Vehicle Tracking System was developed to fix issues in public services, especially Nigeria where transit indigestion is so much and distorting. The system is using GPS and GSM technology to get automatic vehicle monitoring using a GPS-based greedy forwarding algorithm and distance-time calculation method. The Haversine formula guarantees accurate location, the Atmega328P controller reads the data. Trialled on a university transportation route the system performed very accurately with a minimal dilution error. This technology enables fleet management and has broader applications in other urban transportation system all around the globe.

Autonomous Cooperative Transportation Systems (CTS) have difficulties in accurate tracking because of their cooperative high-order dynamics. This study presents a constraint-oriented hierarchical modelling approach, reducing complexity of the system dynamics in separating vehicle modelling and constraint abstraction. A new constraint-following control law guarantees asymptotic convergence of tracking errors. Furthermore, a payload force optimization algorithm optimizes the loading force on the payload without significantly reducing the tracking performance. Simulation results show that method makes both the accuracy and safety of autonomous cooperative transportation.

Realtime variabile traffic monitoring plays a critical role in autonomous vehicle navigation in the urban environment effectively. Also used are camera sensors but the performance is influenced by the lighting and weather conditions. This research looks into making use of LiDAR sensors that supply accurate as well as reliable localization in various settings. A novel online multi-model smooth variable structure filter is presented for tracking multiple maneuvering vehicle by using LiDAR. Real-time processes show that this approach is better than conventional tracking methods,which is in favor of precision and stability.

Roadside cameras are crucial for traffic diagnosis within the integrated vehicle-road-cloud systems but have difficulty to follow it up over non-overlapping perception zones. This paper proposes a cross-camera vehicle tracking technique that combines the visual and the spatiotemporal data. By using time and visual information, a Gaussian model trained with microlevel traffic character designates vehicle detection. Results of the experiment prove the effectiveness of the system, guaranteeing correct tracking of vehicles over multiple cameras..

EXISTING SYSTEM

The traditional bus tracking systems used in schools and colleges mostly depend on manual communication or only on basic GPS tracker system that has very limited features. In many cases, administrators, students rely on phone calls, or Vio-lent schedules information to obtain information about the location of buses– erring, uncertainty and inefficiencies re-ting. Some systems have GPS devices that provide location updates at regular intervals, however they are typically absent from real-time tracking, dynamic mapping and personally interactive interaction between drivers and administrators. Further, existing lorry tracking solutions may also not integrate properly with mobile applications, or web portals meaning access of data becomes difficult. A situation where a user-friendly, centralized system is missing leads to delays, misunderstandings, and inefficient fleet operations emphasizing the need for a more precise, effective and reliable tracking system based on real- time.

PROPOSED SYSTEM

The proposed system uses the real time bus tracking system for the school and college, the mobile and web-based technology is incorporated by which the accurate and efficient monitoring. Mobile App developed in Flutter that enables bus drivers to sign In and keep on sharing their real time GPS continually. Firebase authentication guarantees safe access and real- time data synchronization, instant updates, This eliminates the requirements for manual communication and gives an automated, transparent experience of tracking to your entire stakeholder realm.

The bus locations are shown in real time on an interactive map over a web portal built by Next, js and Node, js. Firebase draws live latitude and longitude data and rewrites the Web interface dynamically. Google Maps API is incorporated to provide accurate route visualization so the admins can have the facility to Track multiple users efficiently. This encourages improved coordination, removes uncertainty on arrival times, and only aids in transport management for Schools and Colleges.

The proposed system introduces an enhanced transport reliability and safety by enabling immediate bus locations' data through live access. With actual GPS monitoring, cloud storage, and easy-to-use interface, the program reduces delays and optimizes decision making. The use of latest technologies guarantee such that schools and colleges can plan their transportation budget more easily, providing transparency, convenience and high-quality communications between drivers and supervisors.

RESEARCH METHODOLOGY

Real Time bus tracking is being carried out using a combination of mobile as well as web technologies in order

effective location tracking to be executed. The driver's mobile application is built in Flutter for them to log in securely and share their real time GPS. The app is constantly pulling location data and updating Firebase in the real time. Firebase authentication allows only genuine users to access and share data and also keeps security and makes a system safe and secure.

On next-generation web portals built from scratch using Next.js and Node.js, administrators can keep track of passenger buses in real time. The system gets live lat/long datum from Firebase and places it on an interactive map. Google Maps API is used to offer accurate route visualisation, thus establishing that all live buses have a clear and up to date view by administrators. The web portal makes it easier for monitoring and provides for route optimization to delay reduction and improves transport management.

The system has great performance and is reliable as well Firebase provides real-time synchronization of data between mobile app and web portal. The backend is efficient to deal with location updates bringing low latency and having good data transmission. Using GPS tracking, cloud storage and interactive map visualization, the project optimizes schools and colleges transportation, ensuring at all time practical and safe bus tracking for all the stakeholders.

Mobile Application Development

The driver mobile application is built in Flutter to have cross platform compatibility for Android and iOS devices. The application uses Firebase Authentication for secure login by drivers. The app runs in the background of the device requiring the driver to be logged into it, it captures the driver's real-time GPS location from the device location service at regular intervals and updates the Firebase Database at regular intervals. The user-friendly interface allows users to easily turn location sharing to be started and stopped with just a single tap, maintaining ease of operation and convenience.

Web Portal Development

Administrator web portal is constructed for the frontend with Next.js and for the backend with Node.js. The portal draws live GPS feed from Firebase and shows it on an instant interactive Google Maps interface. They can track the movement of the buses in real-time, view the latitude and longitude, even track several buses at once. The system is user friendly and in its responsive web design it is easily accessible from desktops, tablets as well as mobile phones.

Backend and Database Management

The back-end system built using Node.js, it allows to interact between the mobile app and web portal. Firebase Realtime Database utilizes for storing and retrieval of location data in efficient manner, ensuring high-speed of synchronization and minimal latency. Role-based access control is authorized for the distinction between users and only enabling access for authorized ICT administrators to monitor the bus locations if approved by the school managements and/or students organizations/pupil government. The backend also handles the authentication, secure data transmitted between drivers and administrator.

Google Maps Integration

The system incorporates Google Maps API to enable the precise route visualization and actual location tracking. The API provides for dynamic updates available on the web portal so that bus positions are updated accurately. Administrators can zoom in on particular bus routes, track on-line and analyze route performance. This integration adds more monitoring capabilities to the system making transport management for schools better.

Security and Data Privacy

To maintain secure communication along with data privacy, Firebase Authentication is being used for user authentication. Only registered drivers and admins have access to the system, thus blocking unauthorized users from obtaining sensitive location information. End-to-end encryption and secure API calls are the measures taken in order to protect data transfer between the mobile app, Firebase, and the web portal. The system conforms to the information security best practice, providing a reliable & secure tracking solution.

Testing and Deployment

The system undergoes thorough testing, to ensure reliability and performance. Unit testing, integration testing and real-world simulation testing is done to confirm real time location accuracy and responsiveness. The mobile application is available on Google Play Store and Apple App Store, while web portal itself is hosted on cloud platform for more scalability and accessibility. Constant monitoring and maintenance is done to ensure optimum performance, better usability.

Fig.2. Block Diagram

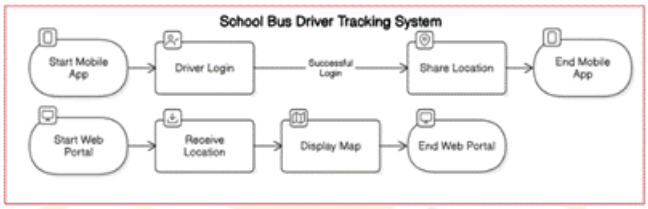

Fig.3. Workflow Diagram

Genuine real-time bus tracking system activation ends up increasing authority over pullout transportation for societies schooling centers and educational nationally accreditation by furnishing correct and continuous asset updates of pools and buses. The app allows drivers to share their current live GPS position easily, the web portal provides real time visualization of buses movement over Google Maps. The system guarantees a secure authentication, very low latency and an efficient data replication by Firebase. The test results show the correctness of location tracking, with correct latitude and longitude updates which are displayed dynamically on the web portal. The solution efficiently decreases waiting time, improves coordination between the drivers and the administrators, as well as the overall security. By utilising latest technologies, the system gives simple to utilize additionally productive record and trail framework, which truly enhances noteworthy in regards to affirmation of school transport and school transport.

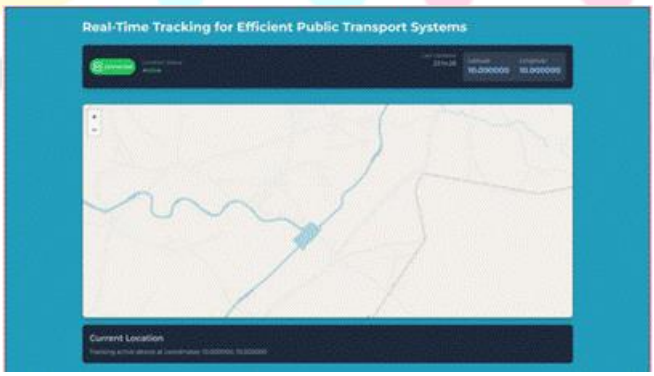

Fig. 4. Real time tracking using Webapp

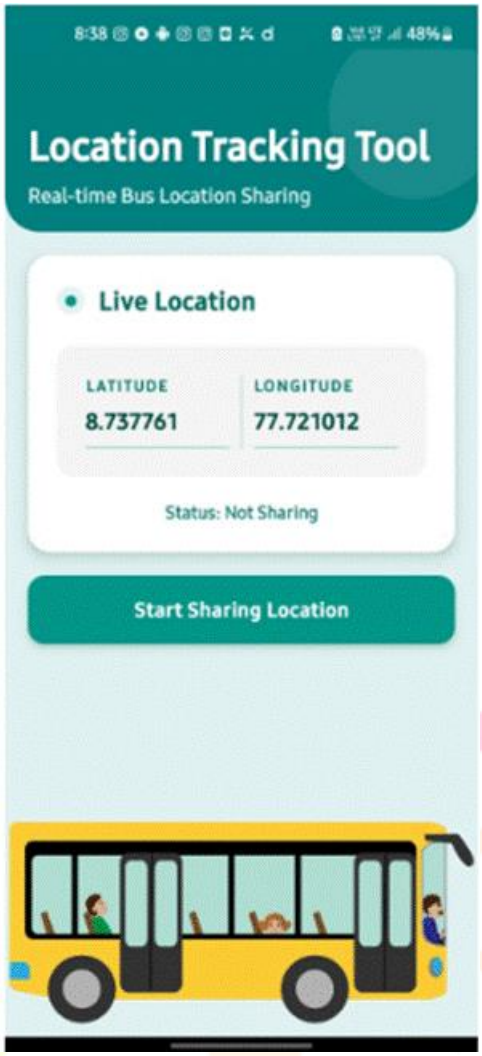

Fig. 5. Live location Start Sharing

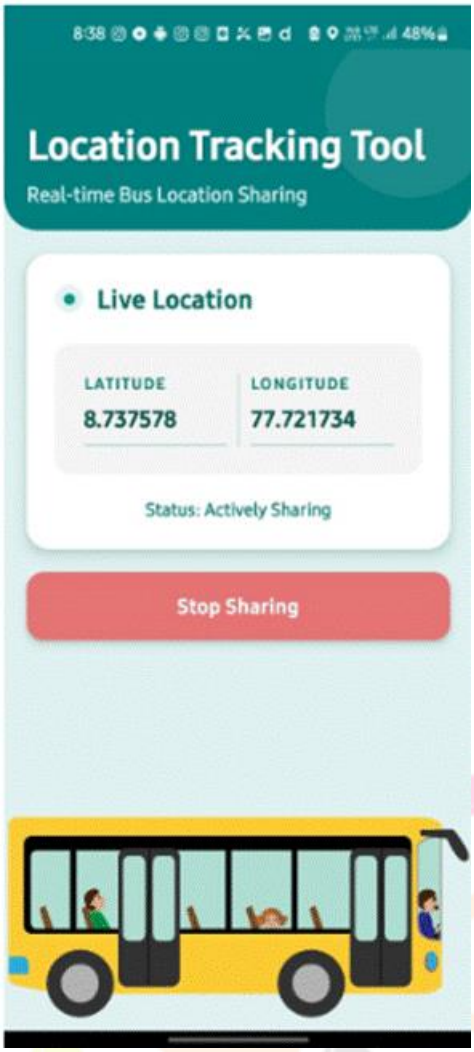

Fig.6. Live location Stop Sharing

CONCLUSION AND FUTURE ENHANCEMENTS

School and college bus tracking system is the real time tracking system which provides an efficient and effective solution for transport management of schools and colleges. With the aid of contemporary technologies for instance Flutter, Next.js, Node.js, Firebase, Google Maps API, the system renders perfect location tracking, highly secure authentication, and time based synchronization of data. The mobile app enables bus drivers to easily share their live GPS tracking information with the web application for admin to track bus movement accurately. It reduces the uncertainty of where buses are arriving, improves the flow for smarter coordination and better transport efficiency for schools and other educational institutions.

With real-time monitoring, administrators can also make adjustments to the school bus rides, decrease waiting times and ensure best safety for students and teachers. Dynamic location update enabled by the interactive web interface also makes tracking of multiple buses at the same time. Secure data transaction and encryption securely protects user privacy and ensures that unauthorized do not obtain access. The introduction of cloud based storage will encourage scalability, meaning the system can easily support many users and a large number of buses without any performance of the system being affected.

As a whole project, the project implements traditional transportation management smoothly by bringing in smart, automation and intelligent tracking. The system also secures and optimizes, but also develops better communication between driver & administrator. Possible upgrades will be predictive analytic to be able to provide expected showtimes and geofencing alerts to track transport, manage it better. This actual-time bus tracking device creates a new benchmark for the running of school and premises transport

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