IOT BASED INTEGRATED REAL TIME BUS TRACKING AND PASSENGER SEAT AVAILABILITY SYSTEM

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Introduction:

In recent years, the Internet of Things (IoT) has transformed how we interact with our environment, especially in transportation. City bus services often face issues with unreliable arrival times, causing inconvenience for passengers. As timetables lack punctuality, there's a growing need for a more accurate and efficient bus arrival information system to improve service and passenger satisfaction.

The IoT-based Integrated Real-Time Bus Tracking and Passenger Seat Availability System is a smart solution designed to enhance the commuting experience by providing real-time bus tracking and seat availability information. Through an Android based application, users can log in and input their source and destination, which then generates a list of buses currently operating on the selected route. After choosing a bus, the system provides live tracking data, including the estimated time of arrival at the source, bus number, seat availability (using ultrasonic sensors to detect seat occupancy), and fare charges.

Additionally, users can view basic information about the bus driver and conductor, along with a route map of the selected bus. The system also features distance

estimation and a helpful FAQ section to answer common queries. The admin panel offers functionalities to manage bus data, including adding, updating, finding, or deleting bus details. Data is securely stored in a Cloud Database, and communication between the application and the server is powered by a Web API, ensuring real-time updates and seamless user experience. This system leverages IoT and cloud technologies to provide more efficient and convenient public transportation options.

Objectives:

The objective of implementing a live bus tracking system using IoT components, Sensors, GPS module is to enhance the efficiency and convenience of public transportation for passengers. The system aims to achieve the following specific objectives:

Real-time Bus Tracking: The primary objective is to provide real-time tracking of buses, allowing passengers to have up-to-date information about the bus locations. This helps passengers plan their journeys more effectively, reducing waiting times and minimizing uncertainty

1. Implement GPS technology to provide live tracking of buses, allowing passengers to monitor the bus's current location and estimated arrival times.
2. Use ultrasonic sensors to detect and display real-time seat availability (occupied or vacant) for passengers on the selected bus
3. Develop an Android-based app for passengers to input source and destination, view available buses, seat occupancy, estimated arrival times, and fare charges.
4. Display the real-time bus route on a map, showing the bus's current position and upcoming stops
5. Automatically calculate and display fare charges based on the distance between the source and destination.
6. Provide key information about the bus, such as bus number, driver and conductor details, and any relevant safety guidelines.

7. Ensure real-time data synchronization between buses, the mobile app, and the cloud database for accurate and up-to-date information.

Methodology:

The IoT-based integrated real-time bus tracking and passenger seat availability system combines hardware and software to enable real-time data flow and efficient bus management. GPS modules and ultrasonic sensors collect live tracking and seat data, which is sent to a cloud database. Passengers use an Android app to log in, enter travel details, and view arrival times, seat availability, fare, and driver info, along with a live route map. A web API connects the sensors, cloud, and app for real-time updates. The admin panel allows administrators to manage bus data, routes, and sensor info using CRUD operations. This ensures the system stays synchronized. Passengers can see available buses, seat status, ETA, and fare details through the app. Admins maintain data accuracy via a web interface. The system uses GPS, ultrasonic sensors, REST APIs, and cloud platforms ie hostinger to ensure secure and scalable performance. Key features like live tracking, real-time seat updates, ETA prediction, and fare calculation enhance public transport efficiency and user experience

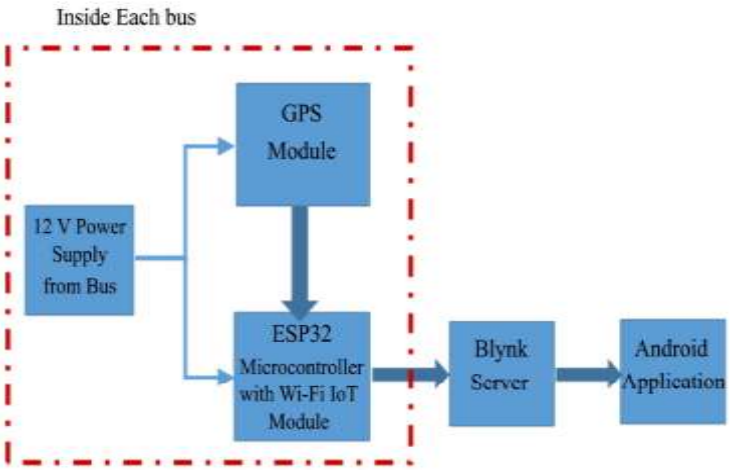

Figure 1 : Block diagram of prototype of smart public transportation system.

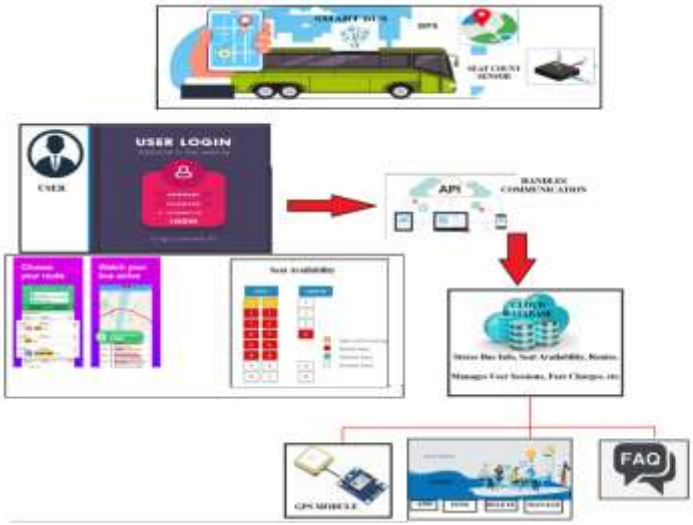

Figure 2 : Prototype of smart public transportation architecture.

Result and Conclusion:

The IoT-based real-time bus tracking and seat availability system offers a smart, user-friendly platform to enhance public transport. Using IoT sensors, it enables live tracking, seat status updates, and seat reservations via a mobile app or website—improving route planning, reducing wait times, and boosting passenger satisfaction. A prototype using a GPS unit and ESP32 was tested in Mosul, with real-time data sent to a Blynk server and displayed in an Android app. The system combines GPS, ultrasonic sensors, and cloud/mobile tech for accurate tracking and efficient management via an admin panel. Despite challenges like internet dependency and hardware costs, it significantly improves urban transport planning and resource utilization.

Figure 3 : Main Page Of Web Part

Figure 4: Mobile Application Front Page

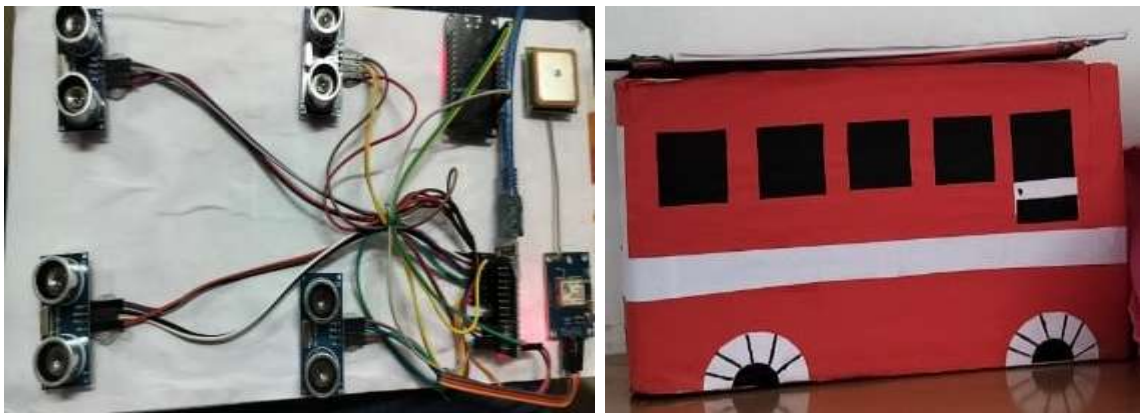

Figure 5 : IOT devices and the bus mode

Project Outcome & Industry Relevance:

The IoT-based Real-Time Bus Tracking System enhances urban mobility with smart features. It offers live bus tracking, real-time seat availability, and automated fare calculation. Passengers benefit from reduced waiting times and better trip planning via a mobile app. Admins gain centralized control over routes, schedules, and seating capacity .Overall, it improves service quality, operational efficiency, and user convenience.

This system aligns with the growing demand for smart city infrastructure, offering scalable solutions for public transit optimization. It improves passenger experience, operational efficiency, and data-driven transit management—key priorities in modern intelligent transportation systems (ITS).

Working Model vs. Simulation/Study :

This project involved the development of a physical working model, including hardware components such as GPS modules, microcontrollers , sensors, and a connected mobile application to demonstrate real-time bus tracking and seat availability.

Project Outcomes and Learnings:

The project delivered a functional system for real-time bus tracking, seat availability, and automated fare calculation, enhancing passenger convenience and transit management. We gained practical skills in IoT integration, cloud connectivity, and app development, along with insights into system design, data flow, and user-focused solutions.

Future Scope:

1. Use machine learning algorithms to forecast bus delays, traffic jams, and passenger load for better travel planning.
2. Add voice-enabled features to assist visually impaired users in accessing bus information and seat availability.
3. Add offline support to enable users to view stored bus schedules and routes in low-connectivity areas
4. Support automatic SOS notification to alert authorities in the event of accidents or emergencies.
5. Provide biometric or facial recognition for safe passenger identification and enhanced safety.
6. Introduce digital wallet support for cashless payments and enhanced payment convenience.
7. Incorporate features to track and analyse fuel consumption and emissions for encouraging environmentally friendly practices.