

# Real-Time Government Bus Tracking and Monitoring System Using Kalman Filter

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**Abstract**—Public transportation systems play a crucial role in urban and rural mobility, especially in developing countries like India. Government bus services are widely used due to their affordability; however, passengers often face difficulties due to the lack of real-time bus tracking and accurate arrival information. This project proposes a Real-Time Government Bus Tracking and Monitoring System using Kalman Filter, Internet of Things (IoT), GPS, GSM communication, and cloud technology. The system continuously tracks bus location using a GPS module and transmits the data to a cloud server through a GSM network. To overcome GPS inaccuracies caused by noise and signal disturbances, a Kalman Filter is implemented to provide smooth and accurate position estimates. Passengers can access real-time bus location and Estimated Time of Arrival (ETA) through a web or mobile application integrated with map services. The proposed system improves passenger convenience, enhances safety, and provides transport authorities with better monitoring and control of bus operations.

**Index Terms**—IoT, GPS, Kalman Filter, Real-Time Tracking, Government Bus Monitoring, ESP32

## I. INTRODUCTION

Public bus transportation is one of the most essential services in India, supporting daily commuting for millions of people. Despite its importance, government bus services often lack real-time information systems that inform passengers about bus location, arrival time, and delays. This results in increased waiting time, uncertainty, and dissatisfaction among commuters. Unlike private transport services that offer live tracking and ETA features, government buses still rely on fixed schedules.

Recent advancements in IoT, GPS, and mobile communication technologies enable the development of intelligent transportation systems. By integrating GPS modules with microcontrollers and cloud

platforms, real-time tracking of vehicles becomes feasible. However, raw GPS data is often affected by noise, signal blockage, and environmental conditions, leading to inaccurate location estimation. To address this issue, Kalman Filter techniques are used to improve the accuracy and stability of GPS data.

This project focuses on designing an IoT-based real-time bus tracking and monitoring system enhanced with Kalman Filter to ensure accurate, reliable, and smooth tracking of government buses. The system benefits both passengers and transport authorities by improving transparency, safety, and operational efficiency.

## II. SYSTEM OVERVIEW

The proposed system consists of a GPS module, ESP32 microcontroller, GSM communication module, cloud server, and a user interface application. The GPS module continuously collects real-time location data from satellites. This data is processed by the ESP32, where the Kalman Filter algorithm is applied to reduce noise and improve accuracy. The filtered data is transmitted to a cloud server via GSM. Passengers can access this information through a web or mobile application to view live bus location and ETA.

## III. METHODOLOGY AND WORKING PRINCIPLE

### 3.1 GPS Data Acquisition

The GPS module mounted on the bus receives signals from satellites and provides raw latitude, longitude, speed, and time information. Due to atmospheric disturbances and urban obstructions, this raw data may contain errors.

### 3.2 Kalman Filter for Noise Reduction

The Kalman Filter is applied to eliminate noise and improve the accuracy of GPS readings. It works on a prediction–correction mechanism:

- Predicts the next position based on previous data
- Compares predicted value with actual GPS measurement
- Generates an optimal estimated position
- This ensures smooth and reliable tracking even in weak signal areas.

### 3.3 Data Transmission Using GSM

The filtered GPS data is transmitted to the cloud server using a GSM module. Mobile communication ensures continuous connectivity, even in remote locations.

### 3.4 Cloud Server and Application Interface

The cloud server stores and processes real-time bus data. The application fetches this data and displays it on a map interface. Passengers can view the live location of the bus, route details, and ETA.

## IV. APPLICATIONS

The proposed system has several practical applications:

1. Real-time tracking of government buses
2. Reduced waiting time for passengers
3. Improved fleet monitoring for transport authorities
4. Enhanced passenger safety through monitoring
5. Route optimization and schedule management
6. Data analysis using historical trip information

## V. ADVANTAGES OF THE PROPOSED SYSTEM

- Provides accurate and real-time bus location
- Reduces GPS errors using Kalman Filter
- Improves passenger convenience and satisfaction
- Enables efficient fleet management
- Scalable and cost-effective solution
- Enhances transparency in public transport systems

## VI. CONCLUSION

This paper presents a real-time government bus tracking and monitoring system using IoT and Kalman Filter techniques. The system effectively overcomes

the limitations of conventional GPS-based tracking by reducing noise and improving positional accuracy. By providing real-time bus location and ETA information, the proposed solution enhances passenger experience and operational efficiency for transport authorities. The system is scalable, reliable, and suitable for implementation in smart transportation infrastructures.

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