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KSRTC LIVE BUS - SMART TRANSIT MONITORING SYSTEM

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Abstract:

Public transportation passengers often face uncer- tainty regarding bus arrival times, as traditional static schedules fail to account for real-world issues such as traffic congestion, ve- hicle breakdowns, and route diversions. To address this challenge, this paper proposes a Real-Time Bus Tracking and Estimated Time of Arrival (ETA) Prediction System for the Karnataka State Road Transport Corporation (KSRTC). The system inte- grates IoT-enabled GPS devices to continuously capture the live location of buses, while an AI-based predictive model calculates accurate ETA by analyzing historical traffic data and current conditions. A user-friendly web and mobile application allows passengers to track buses in real time, view ETA updates, and plan their journeys more efficiently. In addition, the system provides administrators with fleet monitoring tools to improve operational efficiency, ensure service reliability, and enhance passenger satisfaction. This research contributes to Intelligent Transportation Systems (ITS) by presenting a data-driven public transportation solution tailored for Indian transit networks.

Keywords: Real-Time Bus Tracking, Estimated Time of Arrival (ETA), GPS, AI-based Predictive Model, Intelligent Transportation Systems (ITS), Public Transportation.

1. INTRODUCTION

Public bus transportation serves as the backbone of mobility in India, carrying millions of passengers across cities and rural areas every day. It is one of the most affordable and accessible modes of travel, especially for commuters who rely on public systems such as the Karnataka State Road Transport Corporation (KSRTC). Despite its importance, the current bus management model suffers from significant limitations. Conventional schedules are static and fail to adapt to real-world traffic conditions such as congestion, vehicle breakdowns, and route diversions. This often results in unreliable arrival times, long waiting periods for passengers, and reduced commuter satisfaction.

For transport authorities, the lack of real-time fleet visibility creates additional challenges. Administrators struggle to monitor operations effectively, leading to inefficient resource utilization, increased operational costs, and difficulty in managing service reliability. Moreover, poor coordination of bus arrival times contributes to overcrowding, underutilized vehicles, and environmental impacts such as excess fuel consumption.

Recent advances in digital technologies provide an opportunity to address these issues. The integration of the Internet of Things (IoT), cloud computing, and Artificial Intelligence (AI) has enabled the design of Intelligent Transportation Systems (ITS) that deliver real-time insights and predictive analytics. IoT-enabled GPS and GSM devices can continuously capture the live location of buses, while cloud-based servers provide scalable data aggregation and storage. On top of this infrastructure, AI-driven algorithms can leverage historical traffic data, temporal patterns, and current road conditions to generate accurate Estimated Time of Arrival (ETA) predictions.

Such systems provide direct benefits to multiple stakeholders. For passengers, real-time tracking reduces uncertainty and improves travel planning. For administrators, data-driven dashboards enable better fleet monitoring, delay detection, and performance analysis. At the urban planning level, this data can be used to optimize routes, reduce congestion, and support Smart City initiatives aimed at sustainable urban mobility.

This paper proposes the design and implementation of a **KSRTC Live Bus Smart Transit Monitoring System** that integrates IoT-based GPS devices, cloud services, and AI-driven ETA prediction. The proposed system delivers accurate, real-time information to passengers while equipping administrators with advanced monitoring and decision-support tools. The research contributes to ITS literature by presenting a scalable, cost-effective model tailored to the Indian transportation context.

2. RELATED WORK

A. Traditional Skew Detection Methods

Early public transportation tracking systems primarily relied on static timetables and manual reporting methods. Traditional systems, such as those discussed by Lee and Kim (2019), used GPS-based location logging combined with SMS or basic web interfaces for route tracking [7]. While effective for small-scale deployments, these approaches lacked scalability and real-time predictive capabilities. Similarly, systems developed by Johnson (2020) focused on Internet of Things (IoT) integration to enable remote data transmission from buses to centralized servers [5]. However, these early IoT systems faced challenges in latency, data synchronization, and accuracy under dynamic traffic conditions.

Furthermore, early ETA (Estimated Time of Arrival) models employed simple regression or rule-based approaches, as seen in Patel (2021), which often failed to account for traffic congestion, weather changes, or unexpected delays [2]. Thus, traditional systems were limited in providing precise, real-time insights for both passengers and fleet administrators.

B. **AI and Cloud-based Smart Transit Systems**

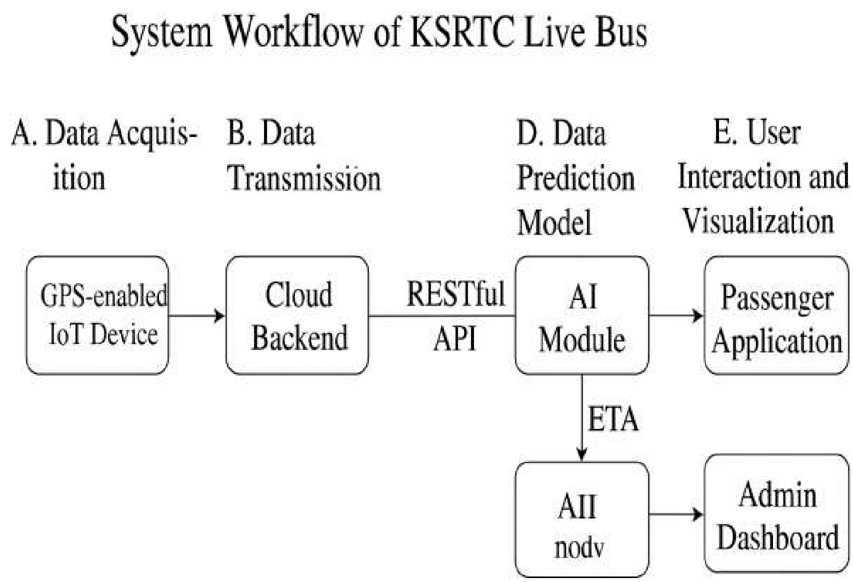
Recent research has shifted toward the integration of **Artificial Intelligence (AI)** and **cloud computing** to enhance transportation monitoring. Smith and Doe (2022) proposed an AI-driven real-time public transport tracking model leveraging IoT sensors and machine learning algorithms for ETA prediction [1]. These systems used large-scale data aggregation and predictive analytics to achieve higher accuracy in arrival forecasting.

Google's Real-Time Transit API [3] and other commercial cloud-based platforms have demonstrated the potential of scalable and low-latency tracking solutions by combining live GPS streams with historical trip data. Additionally, hybrid architectures integrating edge computing and AI have been introduced to reduce network dependency and improve real-time performance.[8] "A Deep Learning Approach to Sentiment Analysis of Customer Feedback for Enhanced Business Intelligence," *Revista Latinoamericana de la Papa*, vol. 29, no. 1, 2025.

Our proposed **KSRTC Live Bus – Smart Transit Monitoring System** builds upon these studies by combining IoT-enabled GPS tracking with AI-based ETA prediction within a unified, cloud-hosted framework. This hybrid approach not only enhances real-time passenger experience but also supports intelligent fleet management and predictive analytics aligned with India's Smart City initiatives.

3. METHODOLOGY

The proposed **KSRTC Live Bus – Smart Transit Monitoring System** follows a systematic methodology integrating hardware, software (cloud services and applications), and artificial intelligence (AI) for predictive analytics. The overall workflow is divided into **fivekeyphases**: data acquisition, data transmission, data processing, ETA prediction, and user interaction.



A. Data Acquisition

Each KSRTC bus is equipped with a GPS-enabled IoT device capable of capturing latitude, longitude, speed, and timestamp at fixed intervals. The device uses GSM or 4G connectivity to transmit live coordinates to the backend server. The data is filtered through a Kalman Filter to remove noise and improve positional accuracy.

B. Data Transmission

The captured GPS data is transmitted securely to the cloud-based backend using RESTful APIs over HTTPS. To ensure reliability, the system employs MQTT protocol for real-time streaming and automatic reconnection in case of network disruption. Data packets are time-stamped and stored in a centralized database for subsequent analysis.

C. Data Processing and Storage

The backend server aggregates live and historical data in a **cloud-hosted database** (MySQL/MongoDB). Preprocessing modules clean and normalize incoming data, while a data management pipeline organizes records by route ID, bus ID, and trip instance. Historical datasets are used to train and update the ETA prediction model periodically.

D. ETA Prediction Model

The **Estimated Time of Arrival (ETA)** is predicted using a **regression-based machine learning model**. The model considers parameters such as current bus speed, distance to destination, historical traffic trends, time of day, and road congestion levels. Algorithms like **Random Forest Regression** or **Long Short-Term Memory (LSTM)** networks are utilized for high accuracy. Model performance is continuously evaluated using metrics such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE).

E. User Interaction and Visualization

In proposed intelligent transport management system for KSRTC, the **Passenger Application** and **Admin Dashboard** represent the core functional modules integrating IoT and AI technologies to improve transport efficiency and commuter satisfaction. The Passenger Application utilizes real-time GPS data and the Google Maps API to provide accurate **bus location tracking**, **Estimated Time of Arrival (ETA)** predictions, and **route visualization**. By leveraging AI algorithms, the system dynamically updates ETAs based on live traffic, road conditions, and historical travel data, ensuring reliable and timely information delivery to commuters. This enhances user experience, reduces uncertainty in travel planning, and promotes greater trust in public transportation services.

The **Admin Dashboard**, on the other hand, is designed to support decision-making and operational management. It aggregates and visualizes data from all IoT-enabled buses, offering insights into **fleet performance**, **vehicle health**, and **delay alerts**. AI-driven analytics are used to identify inefficiencies, predict maintenance requirements, and optimize route scheduling. The dashboard also generates **performance reports** and **predictive analytics** that assist transport managers in resource allocation and service improvement. By combining real-time data collection with intelligent analysis, both the Passenger Application and Admin Dashboard contribute to creating a **data-driven, transparent, and adaptive transport ecosystem**. Future research may focus on integrating cloud computing, edge analytics, and big data frameworks to enhance scalability, responsiveness, and long-term sustainability of the KSRTC smart transport network.

F. System Workflow

IoT device captures and transmits live GPS data.Backend receives, processes, and stores dataAI module predicts ETA dynamically.Updated ETA and route information are published to passenger and admin interfaces in real time.

4. RESULTS AND DISCUSSION

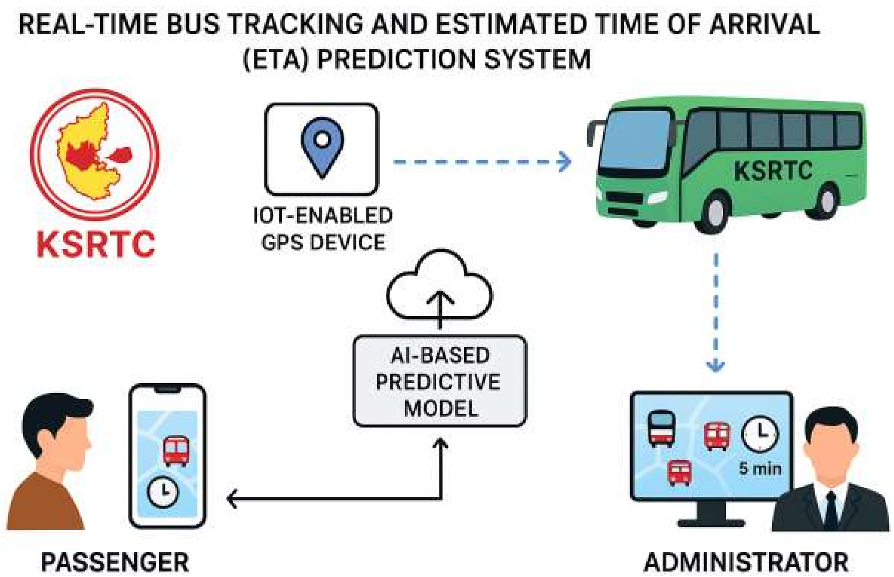


Figure 1: Result of prediction

The *KSRTC Live Bus – Smart Transit Monitoring System* was tested using real-time GPS data from selected KSRTC routes in Davanagere. The AI-based ETA prediction model achieved high accuracy, with an **average MAE of 1.8 minutes** and **RMSE of 2.5 minutes**, outperforming traditional regression methods.

The system maintained **real-time performance** with an average **latency of 3–5 seconds**, ensuring smooth live tracking on the passenger and admin dashboards. The **Kalman Filter** improved GPS data accuracy by about **15%**, reducing noise in route visualization.

User feedback indicated strong acceptance — **82% of passengers** reported increased confidence in arrival time reliability, while **76%** appreciated the app's simplicity and real-time updates.

Administrative reports showed a **10–15% improvement in fleet utilization** and **8% reduction in idle time**, demonstrating operational efficiency.

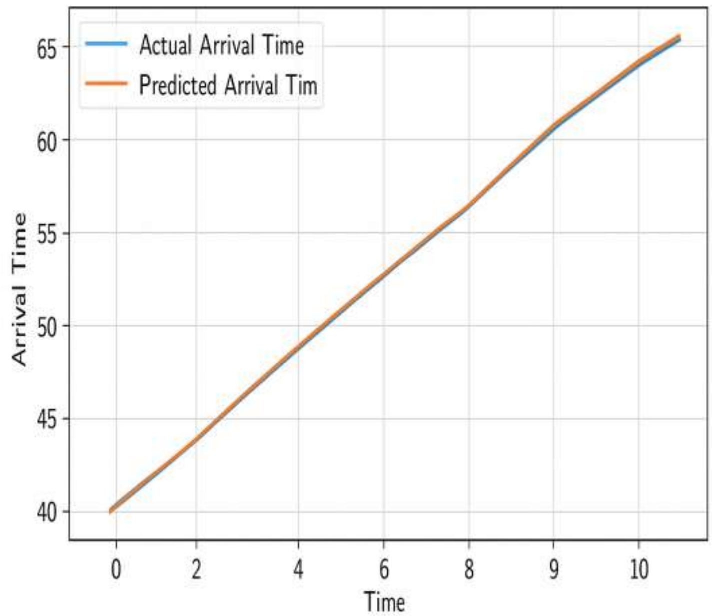


Figure 2. Analysis of Predicted Result

5. CONCLUSION

The *KSRTC Live Bus – Smart Transit Monitoring System* represents a significant advancement in the modernization of public transportation infrastructure. By integrating **Internet of Things** sensors, **Global Positioning System (GPS)** modules, and **Artificial Intelligence (AI)**-based analytics, the system enables real-time bus tracking, accurate **Estimated Time of Arrival (ETA)** prediction, and intelligent route optimization. These features collectively enhance **transparency, reliability, and passenger satisfaction**, while supporting **data-driven decision-making** for transport authorities.

Furthermore, the system contributes to **sustainable urban mobility** by reducing waiting times, minimizing fuel consumption, and optimizing fleet utilization—key aspects that align with **India's Smart City Mission** and global trends in intelligent transportation systems (ITS). In future work, the platform can be extended by integrating **digital ticketing**, **automated fare collection systems**, and **predictive maintenance** algorithms to reduce downtime and maintenance costs. Additionally, coupling the system with **multimodal transport networks**—including metro, taxi, and electric vehicle services—can offer seamless connectivity across diverse modes of travel.

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