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City Transit AI: Intelligent Transport Monitoring System

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Abstract: This paper presents the design and implementation of CityTransit AI, an intelligent public transportation monitoring system based on Internet of Things (IoT) technology. The proposed system aims to reduce passenger waiting time and improve public transportation efficiency by providing real-time bus tracking and arrival time prediction. The system uses a GPS module and ESP32 microcontroller to collect real-time bus location data such as latitude, longitude, and speed. The collected data is transmitted to the cloud server using Wi-Fi connectivity and displayed to users through a mobile application.

The system calculates the distance between the bus and passengers using the Haversine formula and estimates the arrival time based on average speed. The proposed system was implemented and tested in real-time conditions, and the results show acceptable accuracy and reliable performance. The system is low-cost, easy to deploy, and suitable for smart city transportation applications.

Keywords — IoT, GPS, ESP32, Smart Transportation, Bus Tracking, Real-Time Monitoring

I. INTRODAUCTION

Public transportation refers to shared passenger transportation services such as buses, trolleybuses, trains, ferries, and express transportation such as metro systems. Public transportation plays a crucial role in reducing traffic congestion, fuel consumption, and environmental pollution.

Intelligent Transportation Systems (ITS) introduce smart technologies for improving transportation efficiency. Smart Public Transportation (SPT) is a subsystem of ITS that monitors public transport networks and provides real-time information to passengers.

Smart public transportation systems rely on technologies such as:

• Geographic Information Systems (GIS) • Automatic Vehicle Location Systems (AVLS) • Traveler Information Systems (TIS) • Internet of Things (IoT) • Wireless Communication.

The Internet of Things (IoT) connects physical devices such as sensors, GPS modules, and microcontrollers through the internet. Bus transportation is the backbone of public transport systems in urban areas. However, issues such as delays, congestion, and long waiting times reduce service reliability.

Therefore, this paper proposes CityTransit AI, an intelligent transport monitoring system using IoT and AI technologies.

II. LITERATURE REVIEW

Several researchers have proposed different smart public transportation systems using Internet of Things (IoT) and wireless communication technologies. These systems aim to improve efficiency, reduce waiting time, and provide real-time tracking services for passengers.

Parmeshwar et al. (2017) proposed a smart bus transportation system using GSM, GPS, and Arduino. The system sends notifications to passengers about bus arrival times and automatically counts passengers waiting at bus stops. This system helps reduce waiting time and improves passenger convenience.

Kiran et al. (2017) developed a smart bus tracking system using Wi-Fi and a real-time mobile application. The system collects bus location data and sends it to a cloud server, where users can access the information through a mobile application. The application also notifies users when the bus is approaching a particular station.

Another proposed system used an Android application for vehicle tracking and monitoring. This system provides real-time location updates and passenger count information. Technologies such as

GPS, Android, MySQL, and RFID were used to reduce passenger waiting time and improve transportation efficiency.

Several researchers also developed systems using GPS, Real-Time Clock (RTC), and Arduino UNO to track bus locations. In these systems, Raspberry Pi was used to process GPS data and send it to cloud servers via Wi-Fi. The processed data was then displayed to users through mobile applications.

Other studies proposed smart transportation systems using RFID, GPS, and Wi-Fi technologies. These systems allow passengers to track bus location, routes, and estimated arrival times using mobile applications. Additionally, some systems used GSM and GPRS technologies for communication and real-time data transmission.

Some researchers implemented IoT-based systems using NodeMCU ESP8266, GPS modules, ultrasonic sensors, and temperature sensors to enhance safety and monitoring capabilities. These systems also included features such as automatic ticket booking, passenger alerts, and real-time bus tracking.

Another proposed system used RFID and GPS technologies to track buses and manage passenger payments through mobile wallets. The system calculates the distance traveled and automatically deducts fares from passengers' accounts.

Many researchers also developed Android-based bus tracking systems that provide detailed information such as bus number, route, location, speed, and estimated arrival time. These systems improve public transportation efficiency and reduce passenger waiting time.

Although many smart transportation systems have been developed, most of them have limitations such as high implementation cost, complex hardware requirements, or limited real-time accuracy. The proposed system in this paper addresses these issues by providing a low-cost, IoT-based, real-time transportation monitoring system using GPS and ESP32 with Wi-Fi connectivity. The system is easy to implement and provides accurate real-time bus tracking and arrival time prediction.Activity recognition focuses on identifying human actions in videos. It is widely used in surveillance, healthcare, and sports analytics.

Techniques includes-

a. 3D CNNs
b. LSTM Networks
c. Spatio-temporal modeling

These methods analyze motion patterns and temporal dependencies**.**

III. SYSTEM ARCHITECTURE

The proposed Smart Public Transportation Monitoring System is based on Internet of Things (IoT) technology. The system is designed to track buses in real-time, calculate the distance between buses and passengers, and estimate arrival times. The architecture of the proposed system consists of four main components: GPS Module, ESP32 Microcontroller, Cloud Server (Blynk Platform), and Mobile Application.

The GPS module is installed inside the bus to collect real-time data such as latitude, longitude, speed, and direction. This data is continuously transmitted to the ESP32 microcontroller. The ESP32 processes the received data and sends it to the Blynk cloud server using Wi-Fi connectivity.

The cloud server stores the received data and makes it available for users through a mobile application. The mobile application displays real-time bus location on Google Maps, calculates the distance between the bus and passengers, and estimates arrival time using the Haversine formula.

The system architecture ensures real-time communication between buses and passengers. The overall workflow of the system is described as follows:

- GPS module collects real-time bus location data
- ESP32 microcontroller processes the GPS data
- Data is transmitted to Blynk cloud server via Wi-Fi
- Mobile application retrieves data from cloud server
- User views bus location and arrival time in real-time

Components Used in the System:

- GPS Module
- ESP32 Microcontroller
- Wi-Fi Communication
- Blynk Cloud Platform
- Mobile Application
- Google Maps API

Advantages of Proposed Architecture:

- Real-time bus tracking
- Low-cost implementation
- Easy to deploy
- Scalable system
- Reduced waiting time
- Accurate distance calculation

The proposed architecture improves public transportation efficiency and provides a reliable solution for smart city transportation systems.

IV. METHODOLOGY

The proposed Smart Public Transportation Monitoring System is developed using Internet of Things (IoT) technology to provide real-time bus tracking, distance calculation, and arrival timeprediction. The methodology of the proposed system consists of data collection, data transmission, data processing, and user interface display.

- ***Data Collection***

The GPS module is installed inside the bus to collect real-time data such as latitude, longitude, speed, and direction. The GPS continuously captures the location of the bus and sends the data to the ESP32 microcontroller.

- ***Data Transmission***

The ESP32 microcontroller processes the received GPS data and transmits it to the Blynk cloud server using Wi-Fi connectivity. The ESP32 acts as a communication bridge between the GPS module and the mobile application.

- ***Data Processing***

The received data from the cloud server is processed to calculate the distance between the passenger and the bus. The system uses the Haversine formula to calculate the shortest distance between two geographical locations using latitude and longitude values.

- ***User Interface Display***

The processed data is displayed on the mobile application. The application provides the following features:

- Real-time bus location
- Estimated arrival time
- Distance between passenger and bus
- Bus speed information
- Google Maps integration

- ***E System Workflow***

The working process of the proposed system is described below:

1. GPS module collects real-time bus location
2. ESP32 receives GPS data
3. Data transmitted to Blynk cloud server
4. Mobile app retrieves data from server
5. Distance calculated using Haversine formula
6. Arrival time calculated
7. Results displayed to user in real-time

The proposed methodology ensures accurate bus tracking, reduces waiting time, and improves public transportation efficiency.

V. RESULT & ANALYSIS

The proposed Smart Public Transportation Monitoring System was implemented and tested in real-time conditions to evaluate its performance and accuracy. The system was installed on a bus, and the GPS module collected real-time data, including latitude, longitude, and speed. This data was transmitted to the ESP32 microcontroller and then sent to the Blynk cloud server using Wi-Fi connectivity.

The mobile application successfully displayed the real-time location of the bus on Google Maps. Users were able to track the bus movement, view the estimated arrival time, and monitor the distance between the bus and their location. The system showed stable performance during testing and provided continuous updates without significant delays.

A. *Distance Accuracy Analysis*

The distance between the bus and the passenger was calculated using the Haversine formula. The system was tested across multiple locations and at different times of the day. The calculated distances were compared with actual distances measured using Google Maps.

The results showed that:

- The average error in calculated distance was approximately177 meters
- The minimum error recorded was **8 meters**
- The system maintained acceptable accuracy for real-time tracking

These results indicate that the proposed system provides reliable distance estimation for public transportation monitoring.

B. *Arrival Time Estimation*

The arrival time of the bus was calculated using the distance and average speed of the bus. The system dynamically updated arrival times as the bus moved. The arrival time prediction was found to be reasonably accurate, especially during normal traffic conditions.

However, slight variations in arrival time were observed during:

- Heavy traffic conditions
- Signal delays
- Sudden stops

Despite these challenges, the system maintained good performance in estimating arrival time.

C. *System Performance*

The proposed system demonstrated the following performance features:

- Real-time bus tracking
- Accurate location updates
- Low delay in data transmission
- Stable Wi-Fi communication
- User-friendly mobile interface

D. Overall Analysis

The experimental results show that the proposed IoT-based transportation monitoring system is effective in reducing passenger waiting time and improving transportation efficiency. The system provides real-time tracking, accurate distance calculation, and reliable arrival time prediction. The low-cost implementation and easy deployment make the system suitable for smart city transportation applications.

VI. DISCUSSION

The proposed Smart Public Transportation Monitoring System demonstrates the effectiveness of Internet of Things (IoT) technology in improving public transportation services. The system successfully provides real-time tracking, distance calculation, and arrival time prediction, which helps passengers reduce waiting time and plan their travel more efficiently.

During system testing, the GPS module provided accurate location data, and the ESP32 microcontroller efficiently transmitted the data to the cloud server using Wi-Fi. The mobile application displayed real -time bus location and other important information without significant delay. This confirms that the proposed system performs reliably under real-time conditions.

However, some limitations were observed during system implementation. The accuracy of the GPS module may vary due to environmental factors such as tall buildings, poor weather conditions, and signal interference. These factors can slightly affect the distance calculation and arrival time estimation. Additionally, the system performance depends on stable internet connectivity, and poor network conditions may cause delays in data transmission.

Despite these limitations, the proposed system offers several advantages compared to existing systems. The use of ESP32 reduces hardware cost and power consumption. The system is easy to implement and scalable for large transportation networks. Moreover,

the integration with mobile applications enhances user accessibility and convenience.

Future improvements can include integrating machine learning algorithms to improve arrival time prediction accuracy. Additional features such as passenger counting, route optimization, and traffic condition monitoring can also be added. Furthermore, integration with smart city infrastructure can enhance the overall efficiency of the transportation system.

Overall, the proposed system provides an efficient, low-cost, and reliable solution for smart public transportation monitoring. The system improves passenger experience and contributes to the development of smart city transportation systems.

VII. CONCLUSION & FUTURE WORK

Conclusion:

In this paper, a Smart Public Transportation Monitoring System based on Internet of Things (IoT) technology has been proposed and implemented. The system uses a GPS module and ESP32 microcontroller to track buses in real-time and transmit location data to a cloud server using Wi-Fi connectivity. The mobile application displays the real-time bus location, distance between the bus and passengers, and estimated arrival time.

The proposed system successfully reduces passenger waiting time and improves the efficiency of public transportation services. The implementation results show that the system provides reliable performance with acceptable accuracy. The distance between the bus and passengers was calculated using the Haversine formula, and the average error observed during testing was approximately 177 meters, with a minimum error of 8 meters. The system also demonstrated stable performance in real-time conditions.

The proposed solution is low-cost, easy to implement, and suitable for smart city transportation systems. It improves passenger convenience, enhances transportation efficiency, and provides real-time information to users.

Future Work

Although the proposed system performs effectively, several improvements can be made in future work. Machine learning algorithms can be integrated to improve arrival time prediction accuracy based on traffic conditions and historical data. Passenger counting systems can also be added to monitor bus occupancy levels.

Future enhancements may also include route optimization, traffic monitoring, and automatic delay notification features. Additionally, the system can be expanded to support multiple buses and integrated with smart city infrastructure. A web-based dashboard for transport authorities can also be developed for better monitoring and management.

In the future, the system can also be enhanced by using advanced communication technologies such as 5G for faster data transmission and improved system performance. These improvements will further enhance the reliability, accuracy, and scalability of the smart transportation monitoring system.

VIII. REFERENCES

[1] M. A. Jabbar, K. S. Khan, and M. A. Ahmed, “Smart public transportation system using IoT,” International Journal of Engineering Research and Technology, vol. 8, no. 6, pp. 112–118, 2019.

[2] H. M. Elassy, A. A. Al-Azzawi, and M. A. Ahmed, “Design of intelligent real-time public transportation monitoring system based on IoT,” Transportation Engineering, vol. 12, pp. 100–110, 2024.

[3] S. Kumar and R. Patel, “Smart transportation system using IoT and GPS tracking,” International Journal of Computer Applications, vol. 175, no. 10, pp. 25–30, 2018.L. Atzori, A. Iera, and G. Morabito, “The Internet of Things: A survey,” Computer Networks, vol. 54, no. 15, pp. 2787–2805, 2010.

[4] K. Ashton, “That ‘Internet of Things’ thing,” RFID Journal, vol. 22, no. 7, pp. 97–114, 2009.

[5] Parmeshwar, R. Singh, and P. Sharma, “Smart bus transport system using GSM and GPS,” International Journal of Advanced Research in Computer Science, vol. 8, no. 5, pp. 215–219, 2017.

[6] Patel, Mayank, Neelam Badi, and Amit Sinhal. "The role of fuzzy logic in improving accuracy of phishing detection system." International Journal of Innovative Technology and Exploring Engineering 8.8 (2019): 3162-3164.

[7] A. K. Jain and P. Singh, “Vehicle tracking system using GPS and GSM technology,” International Journal of Innovative Technology and Exploring Engineering, vol. 8, no. 9, pp. 120–125, 2019.

[8] R. Sharma and D. Gupta, “IoT-based smart transportation system,” International Journal of Computer Science and Mobile Computing, vol. 7, no. 4, pp. 45–50, 2018.

[9] S. R. Das, “Smart bus tracking system using GPS and IoT,” International Journal of Scientific Research in Computer Science, vol. 6, no. 2, pp. 70–75, 2020.

[10] M. Patel and J. Shah, “RFID based smart transportation system,” International Journal of Engineering Research, vol. 5, no. 8, pp. 33– 38, 2018.

[11] N. Gupta and P. Verma, “Real-time vehicle tracking using Arduino and GPS,” International Journal of Electronics and Communication Engineering, vol. 9, no. 3, pp. 144–149, 2019.

[12] A. Verma, “IoT based smart bus tracking system,” International Journal of Computer Science Trends and Technology, vol. 7, no. 2, pp. 12–17, 2019.

[13] S. Patel, "Smart transportation monitoring system using IoT," International Journal of Advanced Engineering Research, vol. 10, no. 1, pp. 89–94, 2020.

[14] R. Kumar and V. Sharma, "Real-time public transportation tracking system," IEEE International Conference on Smart Cities, pp. 120–125, 2021.

[15] P. Singh, "IoT-based vehicle monitoring system," International Journal of Engineering Research and Applications, vol. 9, no. 5, pp. 67–72, 2019.

[16] A. Mishra and K. Pandey, "Smart bus tracking system using NodeMCU," International Journal of Computer Engineering and Technology, vol. 11, no. 2, pp. 150–156, 2020.

[17] R. Mehta, "RFID and GPS based smart transportation system," International Journal of Engineering Science, vol. 6, no. 3, pp. 80–85, 2018.

[18] S. Gupta and R. Jain, "Android-based bus tracking system," International Journal of Computer Applications, vol. 182, no. 15, pp. 20–25, 2020.

[19] A. Sharma, "IoT-based smart city transportation monitoring system," IEEE International Conference on Smart Systems, pp. 210– 215, 2022.