Real-Time Public Transport Tracking for Small Cities

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***Abstract*—Public transportation systems in small cities often suffer from inefficiencies such as unpredictable bus arrival times, overcrowding, and improper scheduling due to the lack of real time data. To address these challenges, this project proposes a real-time public. Transport Tracking and Crowd Analysis System for small cities using IOT and web technologies. The system integrates GPS and Arduino-based hardware installed inside buses to continuously track vehicle location and monitor passenger count. Ultrasonic sensors are placed at the entry and exit doors to automatically detect passenger movement, enabling accurate real-time crowd estimation. Based on the crowd level, indicators such as LED alerts and door control mechanisms assist in managing passenger flow. The collected data is transmitted to a centralised server for processing and storage. The proposed system improves operational efficiency, minimises overcrowding, enhances passenger safety, and supports data-driven decision-making for transport authorities. It is cost effective, scalable, and well-suited for small and medium-sized cities seeking to modernise their public transportation infrastructure.**

***Index Terms*—public transport tracking, crowd analysis, Internet of Things, GPS tracking, ultrasonic sensors, Arduino, real-time monitoring, smart transportation, web-based system, bus scheduling.**

I. INTRODUCTION

Public transportation plays a vital role in the daily mobility of people, especially in small and medium-sized cities where buses are the primary mode of transport. An efficient public transport system helps reduce traffic congestion, fuel consumption, and environmental pollution while ensuring affordable and reliable travel for passengers. However, many small cities still rely on manual monitoring and static schedules, which often leads to issues such as irregular bus timings, overcrowding, inefficient route management, and poor passenger experience. One of the major challenges faced by transport authorities is the lack of real-time information about bus location and passenger occupancy. Without accurate data, it becomes difficult to manage crowd levels, optimise bus schedules, or respond quickly to sudden increases in passenger demand. Overcrowding not only causes discomfort to passengers but also raises safety concerns and reduces overall service quality. With the advancement of the Internet of Things (IOT) and web technologies, it is now possible to automate data collection and monitoring in public transport systems. By integrating GPS for real-time vehicle tracking and sensors for passenger counting, transport authorities can gain continuous insights into bus movement and crowd conditions. When combined with a centralised web-based platform, this data can be analysed and used to make informed decisions such as rescheduling buses, assigning routes efficiently, and improving operational planning. This project introduces a real-time public transport tracking and crowd analysis system designed specifically for small cities. The system focuses on providing an affordable, scalable, and easy-to-deploy solution that improves transport efficiency, enhances passenger safety, and supports smarter management of public transportation services.

II. LITERATURE REVIEW

Sr. No.	Paper Name	Author Name	Year	Algorithm	Database	Observation
1	RFID-Based Smart Ticketing System for Public Transport System	Thangamma K. C., Ranjitha S. K., Sanjana K. J., Shreya M. G	2021	RFID-based smart ticketing and automated billing	RFID scan data, fare transaction database	RFID ticketing enhances efficiency and passenger satisfaction
2	Smart E Ticketing System for Public Transport Using RFID and Sensors	Vignesh B., Soban G., Vasanth C., A. Poornima	2021	RFID validation with sensor based occupancy monitoring	RFID records, sensor generated passenger count data	Combination of RFID and sensors improves accuracy and system automation
3	Automated Crowd Management in Bus Transport Service	Achanta V. Meghana, Vedant Sarode, Dhananjay Tambade, Abhidnya Marathe, Nadir Chaniya	2020	Sensor-driven crowd monitoring, real-time analytics	Passenger density data, occupancy datasets	Automated crowd management reduces overcrowding and improves comfort
4	Application of Cognitive Computing for Smart Crowd Management	Achanta V. Meghana, Vedant Sarode, Dhananjay Tambade, Abhidnya Marathe, Nadir Chaniya	2020	Machine learning, AI based cognitive computing models	Large-scale crowd behaviour datasets	Cognitive computing enables accurate crowd prediction and adaptive control
5	A Privacy Aware Crowd Management System for Smart Cities and Smart Buildings	Santana J. R., Sanchez L., Sotres P., Lanza J., Llorente T., Munoz L.	2020	Privacy preserving analytics, data anonymization algorithms	Anonymized crowd density and sensor datasets	Ensures effective crowd management while protecting user privacy
6	IOT-Based Crowd Detection System in City Buses	Pankaj Mudholkar,	2021	IOT sensor based crowd detection with	Real-time IOT sensor data,	IOT-based crowd monitoring

		Megha Mudholkar		real-time data analytics	passenger density data	improves passenger safety, comfort, and operational efficiency

1. RFID-Based Smart Ticketing System for Public Transport System (2021) IOT-based crowd monitoring improves passenger safety, comfort, and operational efficiency. Authors: Thangamma K. C., Ranjitha S. K., Sanjana K. J., Shreya M. G. T This system uses RFID technology to enable smart ticketing and automated fare billing in public transport. RFID scan data and fare transaction records are stored in a dedicated database. The solution enhances operational efficiency and improves overall passenger satisfaction by reducing manual intervention..

2. .Smart E-Ticketing System for Public Transport Using RFID and Sensors (2021) Authors: Vignesh B., Soban G., Vasanth C., A. Poornima. The proposed system integrates RFID validation with sensor-based passenger occupancy monitoring. RFID records and sensor generated passenger count data are used to improve accuracy in ticket validation. The combination of RFID and sensors increases system automation and reliability.

3. Automated Crowd Management in Bus Transport Service (2020) Authors: Achanta V. Meghana, Vedant Sarode, Dhananjay Tambade, Abhidnya Marathe, Nadir Chaniya. This study focuses on automated crowd management using sensor-based monitoring and real-time analytics. Passenger density and occupancy datasets are analyzed to manage crowd levels efficiently. The system helps reduce overcrowding and enhances passenger comfort during travel.

4. Application of Cognitive Computing for Smart Crowd Management (2020) Authors: Varghese E. B., Thampi S. M. This research explores the use of machine learning and AI-based cognitive computing models for smart crowd management. Large-scale crowd behavior datasets are analyzed to predict crowd patterns accurately. The approach enables adaptive control mechanisms and improves crowd prediction accuracy.

5. A Privacy-Aware Crowd Management System for Smart Cities and Smart Buildings (2020) Authors: Santana J. R., Sanchez L., Sotres P., Lanza J., Llorente T., Munoz L. This research proposes a privacy-aware crowd management framework designed for smart cities and intelligent buildings. The system employs privacy-preserving data analytics along with anonymization algorithms to process crowd information without revealing individual identities. Anonymized crowd density data collected from sensors is used for analysis. The study demonstrates that effective crowd monitoring and control can be achieved while ensuring strong protection of user privacy.

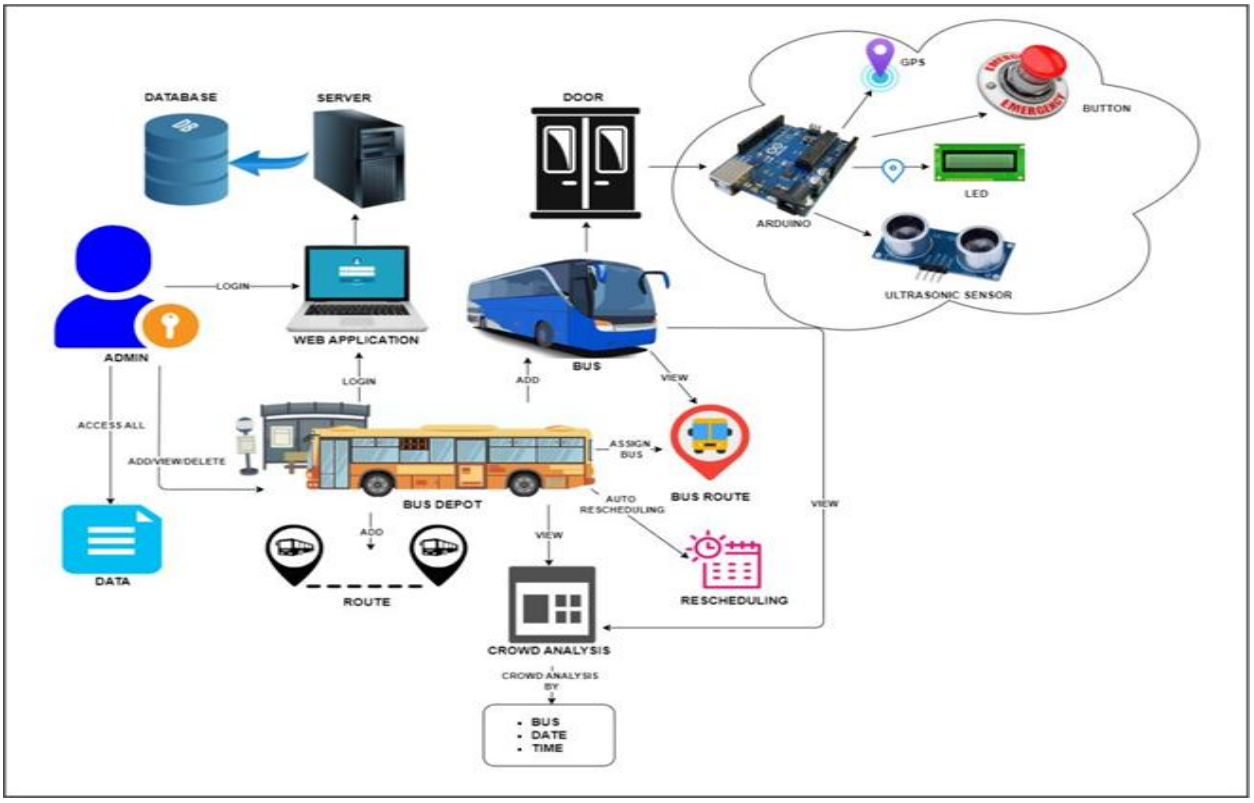
6. IOT-Based Crowd Detection System in City Buses (2021) Authors: Pankaj Mudholkar, Megha Mudholkar. This paper presents an IOT-based crowd detection system specifically designed for city buses. The system utilizes IOT sensors combined with real-time data analytics to monitor passenger density inside buses. Real-time sensor data is continuously processed to assess crowd levels. The proposed approach improves passenger safety, travel comfort, and operational efficiency by enabling better crowd monitoring and decision-making

III. EXISTING SYSTEM

In small cities, public bus transport is mostly managed manually using fixed routes and schedules, without considering real-time passenger demand. There is no automatic system to monitor passenger entry, exit, or crowd levels inside buses. Because of this, buses often become overcrowded during peak hours while remaining underutilized at other times. Decision-making depends on human supervision and delayed reports, leading to inefficient resource use. Bus tracking is either unavailable or limited to basic GPS without real-time access or centralized analysis. Poor communication between drivers, depots, and authorities further affects operations. Overall, the lack of real-time data, crowd monitoring, and intelligent scheduling results in reduced passenger comfort,

safety issues, higher operational costs, and inefficient public transport services.

IV. PROPOSED METHODOLOGY



The methodology of the proposed system focuses on integrating IOT hardware with a web based application to achieve real-time public transport tracking and crowd analysis. The overall process is divided into data collection, data transmission, data processing, and system monitoring.

The bus is equipped with IOT components such as an Arduino microcontroller, a GPS module, and ultrasonic sensors. The GPS module continuously tracks the current location of the bus, while ultrasonic sensors installed at the entry and exit doors monitor passenger movement. Passenger count is updated for every boarding and deboarding activity, which allows accurate real-time estimation of the crowd inside the bus.

The system collects real-time bus location and passenger count data and transmits it to a centralized server through a communication network. This data is securely stored in a database and analyzed to monitor crowd levels using predefined threshold values. When overcrowding is detected, visual indicators such as LED alerts are activated to help manage passenger flow. A web-based application is developed for data visualization and control, using HTML, CSS, and JavaScript for the frontend, and Java with MySQL for backend processing and storage. The application provides role-based access for Admin and Bus Depot users, enabling live monitoring, route management, bus allocation, and automatic rescheduling to improve efficiency, safety, and overall public transport management.

The proposed system introduces a Real-Time Public Transport Tracking and Crowd Analysis solution to improve public transportation in small and medium-sized cities. It uses Internet of Things (IOT) and web technologies to enable continuous monitoring and intelligent transport management. GPS and Arduino-based hardware installed in buses track real-time location and control data collection. Ultrasonic sensors placed at bus entry and exit points automatically detect passenger movement, allowing accurate counting of onboard passengers and eliminating manual methods. The collected data is transmitted to a centralized server, where it is processed and stored in a database.

A web-based application provides role-based access through modules such as Admin and Bus Depot. The admin module manages depots and monitors overall system performance, while the Bus Depot module handles route management, bus allocation, live crowd monitoring, and automatic rescheduling based on passenger demand.

V. CONCLUSION

The Real-Time Public Transport Tracking and Crowd Analysis System provides an effective solution to the challenges faced by public transportation systems in small and medium-sized cities. By integrating IOT-based hardware with a centralized web-based platform, the system enables continuous monitoring of bus location and passenger occupancy in real time. Automated passenger counting using ultrasonic sensors and GPS-based tracking eliminates manual processes and improves the accuracy of transport data. The proposed system supports intelligent scheduling and efficient resource utilization through real-time crowd analysis and data-driven decision-making. Role-based access for administrators and bus depots ensures secure and organized management of transport operations. Overall, the system enhances operational efficiency, reduces overcrowding, improves passenger safety, and increases the reliability of public transport services. Its cost effective and scalable design makes it a practical solution for modernizing public transportation infrastructure in small cities.

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