Transport Management System for Intra-City Travel

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Abstract:- Smart Public Transportation (SPT) is a subsystem of Intelligent Transportation Systems (ITS) that intelligently controls public transportation systems to maintain their performance and provide information to travelers and leaders. Advancements in equipment, programming, and communication have led to the rise of Internet-associated devices that gather data and information. This paper reviews IoT-based smart public transport and various techniques for intelligent transport systems. While IoT currently prioritizes safety to avoid road accidents, the study suggests integrating bus scheduling, presence detection, and payment efficiency to limit congestion and waiting times. The research proposes breakthroughs combining the Internet concept with industrial actors' platforms to harness IoT power for various conveniences, particularly in public transport and create an intelligent transportation system, a key indicator of smart cities. The paper examines different ITS design and models, identifying gaps in knowledge and presenting investigations of various frameworks. Future extensions in the field are suggested to make it easier to use.

Keywords:- *IoT Sensors, ESP32 Microcontroller, IoT Cloud Platform, Embedded C, Arduino ide, Artificial Neural, IoT Networks* .

I. INTRODUCTION

The world's population continues to grow, leading to the need for public transportation for daily commuting. Buses, MRTs, LRTs, and taxis are examples of public transportation, providing low-cost, regulated alternatives for accessing jobs, education, retail, health, and recreational services. However, many company owners complain about income mismanagement due to fraud or using income for personal purposes, causing significant losses for companies and countries. The term "Internet of Things" (IoT) was first introduced in 1999 to describe supply chain management, and it has since expanded to include applications such as healthcare, utilities, and bio-sensing. This research project proposes an IoT solution to address income tracking challenges faced by company owners by enabling them to detect theft by employees. This would enhance the way companies operate and keep public transportation affordable, making it a more appealing choice for passengers. This deficiency leads to uncertainty among passengers, affecting their experience and contributing to traffic congestion. To address this issue, a system that leverages sensor data for seating on each public transport vehicle is proposed. The system allows vehicles to transmit data among themselves, providing real-time information about the exact number of standing and sitting seats in the next metro or bus. The proposed algorithm aims to provide users with real-time information about standing and sitting seat availability in buses and metro vehicles. The algorithm takes into account the location of the bus, the time of day, and the distance traveled to reach the destination. By implementing this IoT solution, public transportation systems can become more user-friendly, convenient, and amiable for citizens.

II. BACKGROUND AND LITERATURE REVIEW

A. Background Knowledge

Real-time seat availability systems for public commuters have gained attention as researchers and practitioners aim to enhance the efficiency and user experience of public transportation. This literature review explores various studies and research in this domain, including "Real-time Passenger Information Systems in Public Transportation," "Smart Public Transportation System: A Review," "Optimization of Bus Transit Operations Using Real-Time Data," "Real-time Bus Arrival Time Prediction with Artificial Neural," "IoT-enabled Public Transport," "User-Centric Decision Support Systems," "Smart Cities and Intelligent Transportation Systems," "Human-Centric Approaches in Public Transport," and "Crowdsourcing for Public Transport Information."

Real-time passenger information systems in public transportation focus on providing accurate and timely information to passengers, using sensors and communication technologies to collect and disseminate data. Smart public transportation systems integrate sensor technologies, highlighting the potential of using real-time data for improving services and passenger experiences. Real-time data can be valuable for optimizing bus schedules and capacity planning.

Real-time bus arrival time prediction with artificial neural networks demonstrates the potential for advanced analytics in optimizing and informing commuters about transportation services. IoT-enabled public transport uses sensors to collect real-time data on passenger loads, suggesting that such information can be utilized for optimizing bus routes and frequencies.

User-centric decision support systems for public transport consider user preferences, historical data, and real-time information to recommend optimal routes and vehicles. Smart cities and intelligent transportation systems use real-time data, sensor technologies, and advanced analytics to optimize public transportation services to meet urban populations' evolving needs. Human-centric approaches in public transport design incorporate user preferences into optimization algorithms to enhance the overall commuter experience. Crowdsourcing for public transport information also explores how user-generated data can be leveraged to improve the overall commuting experience.

B. Literature Review

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These studies emphasize the importance of providing accurate and timely information to passengers, using sensors and communication technologies to collect and disseminate data. They also discuss the challenges of implementing such systems and emphasize the need for effective algorithms to process dynamic data.

C. Existing Methods

The proposed method aims to revolutionize public transportation by providing real-time seating information to commuters and enabling authorities to optimize service capacity. This system uses sensor data and vehicle-to-vehicle communication to provide accurate and up-to-date information about standing and sitting seats in buses and metro systems. Existing methods may lack efficient real-time data integration, especially considering the dynamic nature of public transportation systems. Understanding and predicting dynamic passenger behaviour is crucial for optimizing frequency and capacity in real-time. The reliability and calibration of sensors providing seating information may be a concern, as variability in sensor accuracy could lead to incorrect seat availability information, impacting the effectiveness of the optimization algorithm. The advantages of the existing system include improved commuter experience, data-driven decision-making, reduced overcrowding, and enhanced efficiency, as the system can reduce waiting times and enhance the overall efficiency of the public transportation network..

- *Disadvantages*

The implementation of sensors and communication systems in vehicles can be costly for transportation authorities, raise privacy concerns due to anonymized passenger data, require regular maintenance for system functionality, and have limited coverage in smaller cities or regions. Additionally, the system's dependability on technology may lead to disruptions due to technical issues or communication equipment failures.

D. Proposed Methods

The proposed methodology for creating a public transportation information system using a toy bus with seat sensors and route data transfer involves a structured approach. This includes project planning, identifying stakeholders, integrating hardware and sensors, selecting a wireless module for data transmission, setting up a server infrastructure, and designing a database structure for storing route data, seating information, and real-time updates. The mobile app should be developed using a platform like Android or iOS, and the user interface should be designed to be intuitive and user-friendly. The project's objectives and scope should be clearly defined, and all stakeholders, including users, transportation authorities, and project team members, should be identified. The microcontroller should be configured and programmed to collect and process data from seat sensors. The app integrates real-time data from the server, including seat availability, and performs sensor calibration and testing to ensure accurate occupancy detection. System testing verify functionality and app performance. User testing gathers feedback and identifies issues or improvements. User training teaches users how to use the app effectively. Overall, the app aims to improve user experience.

- *Advantages*

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III. METHODOLOGY

A public transportation information system using a toy bus with seat sensors and route data transfer can be achieved using a structured methodology. This involves project planning, identifying stakeholders, implementing hardware and sensor integration, selecting a wireless module, implementing a data transmission protocol, setting up a server, and designing a database. The mobile app should be developed using a platform like Android or iOS, with an intuitive interface and real-time data integration. Sensor calibration and testing are also essential for accurate seat and occupancy detection. System testing is conducted to verify the functionality of seat sensors, data transmission, and app performance. User testing and feedback are conducted to

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gather feedback and identify any issues or improvements needed. User training is also provided to train users on how to use the app effectively. The process of creating a public transportation information system using a toy bus with seat sensors and route data transfer requires careful planning, careful planning, and careful execution. The project's objectives and scope should be clearly defined, and all stakeholders, including users, transportation authorities, and project team members, should be identified. The microcontroller should be configured and programmed to collect and process data from seat sensors..

IV. SYSTEM DESIGN AND IMPLEMENTATION

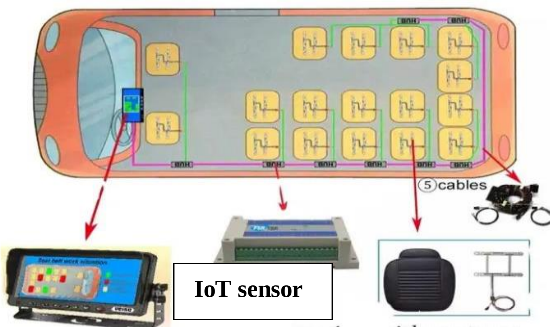

Fig 1 Architecture Diagram

The system allows users to plan routes based on their boarding point and destination, check seat availability, receive real-time updates, adjust frequency/capacity, and optimize user experience. The system includes "Plan Route," "Check Seat Availability," and "Receive Real-time Updates" use cases, which are aimed at improving the overall system based on user feedback. The "Adjust Frequency/Capacity" feature uses real-time data and analytics to make informed decisions. The system also includes "Optimize User Experience" to extend interactions with users and make informed decisions based on user feedback. Future optimizations are planned.

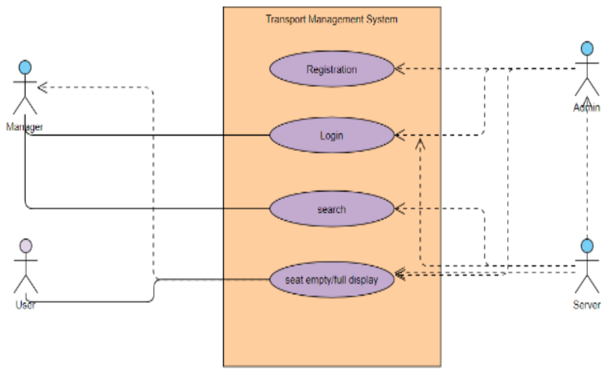

Fig 2 State Diagram

The state diagram displays key bus/metro operations, triggered by external factors like user boarding/de-boarding and scheduled stops. It allows the system to dynamically update and recommend vehicles based on real-time seating availability and passenger load, ensuring efficient operation.

➢ *Objectives for Input Design-*

The public commute optimization application's input system should capture both static and dynamic information to provide accurate real-time seat availability data. The objectives include capturing route information, bus make and seating capacity, passenger boarding/de-boarding data, and vehicle-to-vehicle communication. The application should also display real-time information about the bus, including the number of vacant seats and show the bus moving along a predefined route updating seat availability dynamically.

Future optimizations should include user information integration, allowing passengers to input their boarding point and destination for personalized recommendations, and automatic counting of boarding and deboarding passengers. These objectives aim to create a comprehensive input system that captures both static and dynamic data, enabling the application to provide accurate and real-time information about seat availability. Future optimizations should focus on enhancing user experience and minimizing manual input requirements for improved system efficiency. Overall, the input system should aim to provide accurate and real-time information about seat availability.

V. SYSTEM MODEL

The proposed public commute optimization system consists of sensor-enabled vehicles that monitor the number of standing and sitting seats in buses or metros. These sensors transmit real-time seating data to a central system, which manages a database of static and dynamic data. The algorithm for recommending vehicles is based on real-time seating availability and considers factors like available seats and current passenger load.

The user interface/application provides a user-friendly interface for passengers to input their boarding point and destination, displaying real-time information about buses on a predefined route. The algorithm then recommends the most suitable vehicle based on user input and current conditions.

The authority dashboard presents relevant analytics for transport authorities, allowing them to make informed decisions about adjusting frequency or passenger capacity at certain stops. A secure and efficient data communication protocol ensures reliable transmission of real-time data and commands.

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Future optimizations include users allowing for more personalized seating, integration with user profiles for frequent commuters, and utilizing machine learning to predict future demand and optimize routes and schedules dynamically. This system model addresses current inefficiencies in public transportation by providing real-time information to passengers and empowering authorities to make data-driven decisions for better service optimization.

VI. HARDWARE REQUIREMENTS

- IoT Sensors
- ESP32 Microcontroller
- Wi-Fi
- IoT Cloud Platform
- Blink App
- Power Supply
- Jumper Wires

IoT sensors are essential data collection units in the IoT ecosystem, designed to sense, measure, and capture environmental data like temperature, humidity, motion, and light. The ESP32 microcontroller, developed by Express if Systems, is a pivotal component of IoT networks, managing communication between sensors and the IoT cloud, processing collected data, and executing programmed tasks. Wi-Fi connectivity facilitates seamless communication between the ESP32 microcontroller and other connected devices, enabling data transmission and data management.

The IoT cloud platform, such as AWS IoT, Azure IoT Hub, or Google Cloud IoT, provides a robust and scalable environment for collecting, storing, processing, and analysing massive amounts of data generated by the sensors. These platforms offer data management, security, analytics, and visualization tools, facilitating efficient data handling and decision-making.

The "Blink App" is a mobile interface that allows users to monitor and manage their Blink security camera system remotely. It enables live streaming of video feeds from installed cameras, real-time access to surveillance footage, notifications for motion detection, storage and retrieval of recorded video clips, and features like arming/disarming cameras, adjusting camera settings, and managing multiple Blink devices.

A stable and adequate power supply is crucial for the system's reliable operation. A DC power supply providing the required voltage and current powers the ESP32, sensors, relay, and water pump. Power sources can be solar panels, batteries, or AC adapters based on the system's energy requirements and availability in the deployment area.

Jumper wires are used to create electrical connections between hardware components, facilitating seamless interconnection and data and control signal transmission. They are available in various gauges and materials, crucial for establishing secure and efficient electrical connections within the IoT system.

- *Software Requirements*
- Embedded C
- Arduino ide

Embedded C is a programming language designed for embedded systems, including microcontrollers like the ESP32. It optimizes memory usage and execution speed, making it suitable for IoT applications. It allows developers to write firmware for microcontrollers, enabling control over hardware peripherals and efficient system resource utilization. Embedded C's low-level control capabilities make it suitable for tasks requiring precise control and real-time operations, essential for smart irrigation systems' functionality and responsiveness

The Arduino Integrated Development Environment (IDE) is a user-friendly software tool used to write, compile, and upload code to Arduino-compatible microcontrollers. It offers libraries and pre-built functions, making it accessible for beginners and experienced developers. It includes a code editor, compiler, and uploader tools, streamlining the development process for IoT applications like smart irrigation systems. These software requirements are essential for developing firmware and code for controlling the ESP32 microcontroller, managing sensor data, and executing control logic.

VII. TESTING

Feasibility studies are essential for identifying the strengths and weaknesses of a business or project, as well as the opportunities and threats presented by the environment. They are based on cost required and value to be attained, and should include historical background, product description, accounting statements, operations details, marketing research, policies, financial data, legal requirements, and tax obligations.

There are three types of feasibility: economic, technical, and operational. Economic feasibility involves an outline design of system requirements in terms of input, processes, output, fields, programs, and procedures. Technical feasibility checks the technical requirements of the system, ensuring it does not have a high demand on available technical resources. Operational feasibility examines the level of user acceptance of the system, including training users to use it efficiently.

System testing is the least creative phase of the whole cycle of system design, but it helps bring out the creativity of other phases. Unit testing is a method by which individual units of source code, sets of computer program modules, and associated control data, usage procedures, and operating procedures are tested to determine if they are fit for use. Unit testing involves designing test cases that validate that internal program logic is functioning properly and that program inputs produce valid outputs.

Functional testing is a quality assurance (QA) process that bases its test cases on the specifications of the software component under test. It usually describes what the system does and differs from system testing in that functional testing is a black box test, focusing on the functionality of the software component.

In summary, feasibility studies are crucial for assessing the strengths, weaknesses, opportunities, threats, resources required, and prospects for success in a business or project.

VIII. CONCLUSION

In conclusion, The system offers real-time seating information for buses and metros, enhancing the commuter experience by providing accurate and timely data about available seats. This transparency reduces uncertainty and inconvenience, allowing passengers to make informed decisions and avoid crowded or uncomfortable journeys. The system also optimizes transportation capacity by enabling authorities to dynamically manage vehicle capacities and service frequencies, facilitating efficient resource allocation during peak hours or areas with higher demand.

Data-driven insights from the system enable authorities to make informed decisions, such as route adjustments or service improvements, to better align transportation services with commuter demand. This increases the utilization of public transport, potentially reducing reliance on personal vehicles and contributing to more sustainable urban mobility.

Access to real-time seating availability minimizes the rush or uncertainty associated with finding a seat during transit, promoting a safer travel environment by minimizing congestion and the need for passengers to stand during the journey.

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