

## "RFID and GPS Integration for Automated Bus Fare Calculation and Route Optimization" Trupti Shivanand Shirdhone<sup>1</sup>, Vaishnavi Manik Patil<sup>2</sup>,

Megha Babaso Kundale<sup>3</sup>, Sharvari Sanjay Patil<sup>4</sup>, Sanika Pandurang Patil<sup>5</sup>, Ashutosh Anil Patil<sup>6</sup>

<sup>1</sup>Assistant Professor(Guide) D.Y.Patil Technical Campus Talsande Kolhapur, Maharashtra. <sup>2-6</sup>Student of Electrical Engineering, D Y Patil Technical Campus, Talasande Kolhapur, Maharashtra. ghewari.trupti7@gmail.com

#### **ABSTRACT:**

Advancements in technology are transforming public bus transportation to enhance efficiency and convenience. Traditional ticketing methods, which require long queues, are being replaced by a Smart Bus Ticket System that utilizes automated ticketing with RFID tags. Each bus will be equipped with scanners at entry and exit points, allowing passengers to tap their RFID tags when boarding and alighting, while a GPS module tracks the bus location to calculate fares based on the distance traveled and automatically deduct the amount from the passenger's account. Additionally, live bus tracking helps users plan trips efficiently, and transaction data stored in a database enables authorities to analyze travel patterns and optimize routes through detailed reports. This integrated system not only reduces paper usage and saves time but also modernizes public transportation with a reliable, user-friendly solution.

Keywords: GPS, At mega 328, Wifi module ESP32, RFID module 522, smart card, link

#### **INTRODUCTION**

As the population in urban areas continues to grow, there is often uncertainty regarding the arrival time of buses at stops. Urban bus networks are frequently complex and difficult to navigate, leading to further challenges. Additionally, buses are sometimes cancelled due to breakdowns, strikes, waterlogging, or other issues, leaving passengers uninformed about such disruptions [1]. The proposed Bus Ticketing System aims to address these challenges by providing an efficient framework that enables real-time bus tracking, estimated time of arrival (ETA) updates, ticket booking in advance, and maintaining a database of ticketing transactions [2][3]. These features are accessible through a flexible application available on the Android platform (or via a website) [4]. Real-time vehicle tracking is achieved using GPS, allowing users to monitor bus routes and locations. Users can view bus routes on a map, which includes both geographic and non-geographic details. GPS and Google Maps are utilized to display the current location of buses and related route information [5]. RFID tags are integrated to identify passengers and manage data such as payment and validity [6][7]. The system uses an ATmega328 microcontroller programmed with a Real-Time Clock (RTC) for efficient operations. Based on IoT, this system enables travellers to access bus information, such as routes and ETA, tailored to their source and destination through the Android application or website [8]. A key challenge of this system is providing all tracking, ETA, and



## International Journal of Electrical and Electronics Engineers Volume 17, Issue No. 01, Jan-June 2025

ticketing functionalities directly to the user while ensuring flexibility. Although these services could be offered at bus stops, doing so would defeat the purpose of creating a mobile and user-centric solution [9]. To address this, the Android application has been developed as a User Interface that simplifies access to all features and maximizes system functionality [10]. By offering real-time updates, route tracking, and a seamless ticketing experience, the Bus Ticketing System eliminates many of the issues caused by the unpredictability of bus arrivals, making public transportation more reliable and user-friendly.

#### **RELATED WORK**

 "Mobile Enabled Bus Tracking And Ticketing System" – Suresh Shankarnarayan and Paul Hamilton, May 2014

This paper presents a mobile-based bus tracking and ticketing system that integrates GPS and RFID technologies to enhance public transportation efficiency. It enables real-time bus tracking and digital fare collection, improving convenience for both passengers and operators.

 "Gps Supported Bus Tracking And Ticketing System" – Ajay Shingare, Ankita Pendole, Nikita Choudhary, 2015

This paper presents a GPS-based bus tracking and smart ticketing system designed to improve public transportation efficiency. It provides real-time bus location updates and a digital fare collection system, enhancing convenience for both passengers and transit authorities.

- "RFID based Smart Bus using Embedded System" Mr. D. Baskaran, Mr. M. Pattumuthu, Ms. B. Priyadharshini, Mr. P. Shabab Akram, and Ms. S. Sripriya, 2016
  This paper presents an RFID-based smart bus system using embedded technology to automate fare collection and passenger authentication. It enhances public transport efficiency by enabling contactless ticketing, reducing manual intervention, and improving security and convenience for commuters.
- "Real Time Web Based Bus Tracking" Manini Kumbhar, Meghana Survase, Pratibha Mastud, and Avadhut Sakunkhe, 2016

This paper presents a real-time web-based bus tracking system that utilizes GPS and web technologies to provide live location updates of buses. It aims to enhance commuter convenience by offering real-time bus arrival information via a web platform, reducing waiting time and improving public transport efficiency.

 "Online Bus Tracking And Ticketing System" – Dipika Tidke, Vinayak Nayar, Amit Pawar, Vishakha Pagar, 2018

This paper presents an online bus tracking and ticketing system that integrates GPS technology and online booking to enhance public transportation services. It enables passengers to track buses in real time and book tickets online, improving convenience, reducing wait times, and streamlining the ticketing process.

• "Smart Bus Ticket System Using IoT Technology" – Sumit Kumar, Piyush Kumar, Kartikay Tyagi, and Ayush Kumar, 2019

This paper presents a smart bus ticketing system using IoT technology to automate fare collection and enhance passenger convenience. It integrates smart cards and real-time data processing to reduce manual intervention, improve transaction efficiency, and provide a seamless travel experience.

• "A Review on Smart Bus Ticketing and Tracking System using IoT" – Bhat Apoorva, Kavitha C, Bharath M,



# International Journal of Electrical and Electronics EngineersVolume 17, Issue No. 01, Jan-June 2025ISSN (0) 2321-2055ISSN (P) 2321-2045ISSN (P) 2321-2045

Nitesh Narayan Vaidya, and Prof. Harshitha G M, 2019

This paper reviews various smart bus ticketing and tracking systems that utilize IoT technology to improve public transportation. It discusses different approaches for automated fare collection, real-time vehicle tracking, and passenger convenience, highlighting their benefits and challenges in implementation.

 "Design of Smart Bus Ticketing System using IoT and RFID " – Shaik Saidu Masthan and Dr. Christeena Joseph, 2020

This paper presents a smart bus ticketing system that leverages IoT and RFID technology to automate fare collection and improve public transportation efficiency. It proposes an RFID-based card system for passengers, integrated with IoT to enable real-time monitoring and data management. The system aims to reduce manual ticketing errors, enhance security, and streamline the travel experience.

 "NFC Based Intelligent Bus Ticketing System" – Rajshree Hargude, Aarti Kamthe, and Prof. Vinod Badgujar, 2020

This paper proposes an NFC-based intelligent bus ticketing system to enhance public transport efficiency and security. It utilizes Near Field Communication (NFC) technology to enable contactless ticketing, reducing transaction time and minimizing manual errors. The system aims to provide a seamless and cashless travel experience while ensuring real-time data tracking for better transport management.

 "Smart Bus Monitoring And Ticketing System Using IoT" – Shanmugapriya R, Sowmya A, Sowmya S, Shriram S R, 2020

This paper proposes a smart bus monitoring and ticketing system using IoT, integrating GPS, RFID, and cloud technology to enhance public transportation. It enables real-time bus tracking, automated fare collection, and passenger monitoring, improving efficiency and increasing the impact of greenhouse gas reduction in transport systems.

• "RFID Based Smart Ticketing System For Public Transportation" – Shreya Andhale, Nirmayee Dighe, Akanksha Kore, Darshana Gaikwad, Yogesh Deshmukh, 2020.

This paper presents an RFID-Based Smart Ticketing System for Public Transportation, which uses RFID technology to automate fare collection and improve passenger convenience. The system enables cashless transactions, reduces human errors, and enhances the efficiency of public transport by streamlining the ticketing process.

- "Smart Bus: A Smartphone-based Framework for Public Transport Ticket System using QR Code and Implementing Delay Payment Method" – Ajinkya Gaikwad, 2021 This paper proposes a smartphone-based smart bus ticketing system using QR codes and a delay payment method to enhance user convenience. It allows passengers to generate and validate tickets via their smartphones, enabling cashless transactions while addressing payment delays efficiently.
- "IoT Based Efficient Contactless Bus Ticketing System" Pulla Rushika, P R Yashaswini, Peravali Sowmya Sri, Soundarya Shivakumar, Swamy Hiremath, and Roopa R. Kulkarni, 2021 This paper proposes an IoT-based contactless bus ticketing system to enhance efficiency and passenger convenience. It utilizes smart cards and real-time data processing to automate fare collection, minimize physical transactions, and improve the overall public transport experience.
- "Smart Bus Pass System Using Android" Mohammed Furkhan and H. R. Divakar, 2022



## International Journal of Electrical and Electronics Engineers Volume 17, Issue No. 01, Jan-June 2025

This paper introduces a smart bus pass system using an Android application to simplify ticketing and pass management. It enables users to apply for, renew, and validate bus passes digitally, reducing paperwork and improving convenience for both passengers and transport authorities.

- "Smart Digital Bus Ticketing System" Nik Mohd Zarifie Hashim, Muhammad Azimi Bin Mohd Zarawi, Mohd Hariz Iswan Sinuin, and Mohd Khairuddin bin Abd Karim, 2022
   This paper presents a smart digital bus ticketing system aimed at improving public transportation through cashless and paperless transactions. It leverages digital technologies like QR codes and mobile applications to streamline ticketing, enhance security, and provide a more efficient travel experience for passengers.
- "Smart Bus Ticketing System " Divya R, Pavithra C V, Kamalabharathy A, Madhumeetha K, and Sowbarnikaa K, presented at the 2023 International Conference on Intelligent Technologies for Sustainable Electric and Communications Systems (iTech SECOM)

This paper introduces a smart bus ticketing system designed to enhance public transportation efficiency using digital and automated fare collection methods. It leverages technologies like RFID, QR codes, and IoT to enable seamless transactions, reduce manual errors, and improve passenger convenience.

#### **BLOCK DIAGRAM**

In the context of a smart bus ticket system, the integration of advanced technology into the traditional bus ticket system plays a pivotal role in enhancing overall safety and minimizing fraud. We developed machines and smart cards to replace the use of paper tickets, contributing to environmental conservation by reducing increasing impact of greenhouse gases like carbon dioxide. When a passenger enters the bus, they need to swipe their card on the conductor's machine at the entry point. The entry location is automatically selected using the GPS system. The conductor's machine displays all relevant information about the passenger, such as their name, gender, RFID number, balance on the card, and photo. A buzzer gives a single indication. However, if the card is not swiped or if the balance on the card is insufficient, the buzzer gives a single indication. However, if a passenger does not have a card, the conductor can create a new passenger profile. The conductor interacts with the database to edit profiles, check previous payment activity, and maintain passenger history. A link is established, allowing the conductor to view the history of all passengers Before reaching their destination, passengers are required to swipe their card again on the machine at the exit point. The destination location is selected automatically using the GPS system.

The machine calculates the distance between the entry and exit locations and deducts the appropriate fare from the card. This fare calculation works on a category basis, where women and children under five years of age are charged half the ticket fare, while men are charged the full fare. This system reduces fraud, minimizes losses, and eliminates the problem of spare money. It also enhances efficiency and convenience for both passengers and conductors, ensuring a seamless and eco-friendly ticketing process paper usage and saving trees, which helps mitigate the These protocols collectively enhance the system's reliability, efficiency, and real-time functionality.



Fig.1. Block diagram of IOT- Based smart bus ticketing system

#### WORKING

The supply comes from an adapter it goes to the voltage regulator and then to the microcontroller, and if from transformer then the supply gives to rectifier to converts AC Into DC. This process is called rectification. The output of the rectifier is DC, but it is not pure DC. To obtain pure DC, we use a filter. The voltage at this stage is typically 12V, but microcontrollers require only 5V. For this conversion, we use a 7805 voltage regulator .A reset circuit is used as a functional switch. A resistor is connected across the reset switch to ground, and a second resistor is placed across the LED with its negative terminal. If we need to restart the microcontroller, the reset circuit allows us to do so .The crystal circuit is used to provide oscillation to the microcontroller. A crystal oscillator is placed across two ceramic capacitors to achieve this .For interfacing an RFID reader, we use an SPI (Serial Peripheral Interface) communicator. A smart bus ticketing system utilizes four communication protocols for efficient operation. SPI (Serial Peripheral Interface) is used to interface the microcontroller with the RFID reader, enabling data transfer between smart cards, readers, and displays. When a passenger taps their smart card, SPI facilitates the exchange of balance and ticket details. MQTT (Message Queuing Telemetry Transport) is employed to connect the server with the WiFi module, ensuring real-time updates for ticket sales and route tracking while operating efficiently in areas with weak internet. UART (Universal Asynchronous Receiver-Transmitter) is used for GPS integration, allowing the GPS module to communicate with the microcontroller via TX and RX pins to provide real-time bus location tracking. Lastly, I2C (Inter-Integrated Circuit) is used to connect the LCD display, RFID reader, and microcontroller, allowing the display to show fare details, balance, and confirmation messages with minimalwiring.

The flowchart outlines the process of an RFID-based ticketing system. It begins with initializing all switches and the display, followed by initializing the RFID reader. The system then reads the RFID tag and checks if the card matches a registered user. If no match is found, it displays "No card found." If the card matches, a buzzer activates once, and passenger details appear on the LCD. The system then checks if the balance is greater than



100. If not, the process stops. If sufficient balance is available, the passenger selects an entry location, scans the RFID tag again for the destination, and selects the destination. The system calculates the total distance traveled and deducts the ticket amount from the balance, completing the process.



Fig.2. Flow chart of IOT based smart bus ticket system

#### **KEY ASPECTS OF THE PROJECT**

In an IOT-based smart bus ticketing system, passengers can use a card to pay for their bus rides. Before using the card, they need to go through a simple registration and login process. Once registered, passengers can check their card balance, see how many passengers are currently on a bus, view their travel history, and even recharge their card easily through a provided link or platform. This system makes bus travel more convenient and efficient by reducing the need for cash and offering real-time information.

This is the link: <u>https://ceh89kzzbdqevztrwepkzr.streamlit.app/</u>



#### Login interface

#### Interface for recharge card

RFID-Based Bus Ticket	Please log in from the sidebar to access the system.	RFID-Based Bus Ticket System	Recharge Card Check Live Status Check History Register Passen
System		Please log in to continue.	Recharge card
Please log in to continue.		Username	Redirecting to Recharge Card
Username		admin	Click here if not redirected
		Password	
Password		····· 0	
Ø		Login	
Login			

Bus passenger's registration form interface

# BusPassangers Registration Form

Live bus passenger interface

0.00

Drag

Interface for update passenger balance

### **Update Passenger Balance**

Enter RFID and additional balance to update the passenger's balance.

Enter Additional Balance:

Enter RFID:

Update Balance

Bus history and passenger's data viewer

1	e Bus Pa	sseng	ers			
uri	ent Passenger	s from Bu	s			
id	DataTime	RFidNo	inLat	inLon	outLat	outLon
:4	5 2025-01-05 10:02:51	6C3D6C6E	17.6746147	73.9770612	0	0
tR	FID No					
C3D	6C6E					~

MSRTC sends a text message to passenger informing them about the balance. The message includes details on how much balance has been deducted and how much is remaining



#### **RESULT AND ANALYSIS**

An IoT-based smart bus ticketing system modernizes public transportation by replacing cash and paper tickets with smart cards. Passengers can register online, check their balance, and recharge their cards digitally, eliminating the need for physical transactions. The system also provides real-time bus occupancy details, allowing passengers to choose less crowded buses for a more comfortable journey. Additionally, it tracks travel history, helping users monitor their expenses and travel patterns.

When a passenger swipes their smart card, the fare is automatically deducted, and a confirmation message is sent to their mobile, ensuring transparency. This system improves efficiency, reduces fraud, and enhances the overall



transportation experience. By embracing digital solutions, it supports India's move toward complete digitalization and contributes to a more advanced and user-friendly public transport system.



#### **PERFORMANCE PARAMETERS**

The performance parameter used for the system evalution are shown in below

- 1. Real-time tracking accuracy (RT)-How accurately the system provides location updates.
- 2. System stability & communication (SC)-Whether the system is prone to crashes or network issues.
- 3. Automation in ticketing (AT)-How efficiently reduce the manual ticketing processes.
- 4. Payment & ticketing flexibility (PT)-The number of ticketing options available ( QR , RFID ,Smart card ,etc.)
- 5. Passenger data management (PD)-whether the system maintains a passenger database for history tracking.
- 6. Hardware & scalability (HS)-The efficiency and expandability of the hardware used in the system

#### **Calculating performance rating**

For each system, we calculate the performance rating (PR) using a weighted formula:

PR=(W1\*RT)+(W2\*SC)+(W3\*AT)+ (W4\*PT)+(W5\*PD)+(W6\*HS)

Where:

W1 to W6 are weight factors (important of each metric) Default weightage:

RT=20 % (W1=0.2), SC=20 % (W2=0.2), AT=15 % (W3=0.15), PT=15 % (W4=0.15), PD=15 % (W5=0.15) HS=15 % (W6=0.15)

We assign scores (1-10) to each existing project and our project, then compute their overall performance rating (PR).

The comparison between the Mobile Enable Bus Tracking (2014) system and Our Project (loT-Based Smart Bus Ticketing System) highlights significant improvements in various features. The SH feature in the Mobile Enable Bus Tracking system has a value of 4, whereas Our Project scores 10, indicating a substantial enhancement. Similarly, for PD, the Mobile Enable Bus Tracking system holds a value of 2, while Our Project achieves 10, showcasing better performance. In terms of PT, the values are 3 for the older system and 6 for Our Project, reflecting notable progress. The AT feature, rated 3 in the Mobile Enable Bus Tracking system scores 4, whereas Our Project improves it to 6. Finally, for SC, the Mobile Enable Bus Tracking system scores 4, whereas Our Project improves it to 6. Finally, the RT feature has a value of 5 in the Project achieves a perfect score of 10. This comparison clearly demonstrates that the loT-Based Smart Bus Ticketing System surpasses the older Mobile Enable Bus Tracking (2014) system in all evaluated aspects, offering superior efficiency and



functionality.

PR calculation:

For the Mobile enable bus tracking (2014):

PR=(0.2\*5) + (0.2\*4) + (0.15\*3) + (0.15\*3) + (0.15\*2) + (0.15\*4) PR=1 + 0.8 + 0.45 + 0.45 + 0.3 + 0.6 = 3.6

For our project (IOT based smart bus ticketing system): PR=(0.2\*10)+(0.2\*9)+(0.15\*10)+(0.15\*9)+(0.15\*10)

#### **Comparative analysis**



Fig.3.Comparative analysis

#### CONCLUSION

The IOT-based smart bus ticketing system offers a transformative approach to public transportation, enhancing operational efficiency, user experience, and environmental sustainability. By enabling cashless and paperless transactions, the system significantly reduces paper waste, conserving natural resources and promoting greener practices. Additionally, real-time data collection facilitates optimized route management and fleet operations, leading to reduced fuel consumption and lower carbon emissions, which helps mitigate urban air pollution and combat climate change .Looking ahead, the future scope of IOT-based smart bus ticketing systems is vast. With on-going technological advancements, these systems can be further integrated with smart city infrastructure, leveraging AI and big data analytics to predict passenger demand more accurately, optimize bus schedules, and reduce energy consumption. The potential for multi-modal transport network integration can provide passengers with a seamless travel experience across various public transport options, further enhancing urban mobility .Moreover, by adopting renewable energy-powered IOT devices and sustainable manufacturing sustainability, convenience, and efficiency in urban transport.

#### REFERENCES

- [1] "RFID-Based Ticketing for Public Transport System: Perspective Megacity Dhaka" by Haque Khandokar, A. Ul Alam, Kafil Islam, Golam Tangim, and Md.F.M. Hasan, published in 2010.
- [2] "GPS Based Automated Public Transport Fare Collection Systems Based on Distance Travelled by



# International Journal of Electrical and Electronics EngineersVolume 17, Issue No. 01, Jan-June 2025ISSN (0) 2321-2055ISSN (P) 2321-2045ISSN (P) 2321-2045

Passenger Using Smart Card" by Arun Das S. V and K. Lingeswaran, published in 2014.

- [3] "GPS Based Bus Tracking System" by Singla and P. Bhatia, published in 2015.
- [4] "Smart Bus Station-Passenger Information System" by Cemil Sungur, Ismail Babaoglu, and Aysegul Sungur, published in 2015.
- [5] "Survey of Smartphone-Based Sensing in Vehicles for Intelligent Transportation System Applications" by Jarret Engelbrecht, Marthinus Johannes Booysen, Gert-Jan van Rooyen, and Frederick Johannes Bruwer, published in 2015.
- [6] "An Internet-of-Things Enabled Connected Navigation System for Urban Bus Riders" by Marcus Handte, Stefan Foell, Stephan Wagner, Gerd Kortuem, and Pedro José Marrón, published in 2016.
- [7] "RFID-Based Automatic Bus Ticketing: Features and Trends" by Oudah, published in 2016.
- [8] "RFID and Android Based Smart Ticketing and Destination Announcement System" by P. Chowdhury,
- [9] P. Bala, D. Addy, S. Giri, and A. R. Chaudhuri, published in 2016.
- [10] "IoT Enabled Intelligent Bus Transportation System" by Geetha and D. Cicilia, published in 2017.
- [11] "Implementation of RFID Based Raspberry Pi for User Authentication and Offline Intelligent Payment System" by Z. B. Noer, B. Hasanuddin, and D. Djamaluddin, published in 2017.
- [12] "Fool Proof Ticketing System for Public Transport" by Kaushik and P. Suhas, published in 2018.
- [13] "Automated Bus Ticketing System Using RFID" by Telluri, S. Manam, and J. M. Oli, published in 2019.
- [14] "RFID Based Smart Transportation System with Android Application" by Akter, M. J. H. Khandaker, S. Ahmed, M. M. Mugdho, and A. K. M. B. Haque, published in 2020.
- [15] "Smart Shuttle System: An IoT and Machine Learning Based Approach" by M. Divya Teja, Nuthalapati Ganesh, and Keerthi Uppalapati, published in 2023.
- [16] "IoT Based Smart Cashless Ticketing Bus System" by Vasanthamma H, Meghana M Kulkarni, Pavani Y.V, Ramya E, and Supriya P, published in 2024.\*.
- [17] "Design of Smart Bus Ticketing System using IoT and RFID" by Shaik Saidu Masthan and Dr. Christeena Joseph, published in 2020.
- [18] "NFC Based Intelligent Bus Ticketing System" by Rajshree Hargude, Aarti Kamthe, and Prof. Vinod Badgujar, published in 2020.
- [19] "Smart Bus Pass System Using Android" by Mohammed Furkhan and H. R. Divakar, published in 2022.
- [20] "Smart Bus Ticket System Using IoT Technology" by Sumit Kumar, Piyush Kumar, Kartikay Tyagi, and Ayush Kumar, published in 2019.
- [21] "A Review on Smart Bus Ticketing and Tracking System using IoT" by Bhat Apoorva, Kavitha C, Bharath M, Nitesh Narayan Vaidya, and Prof. Harshitha G M, published in 2019.
- [22] "Smart Bus: A Smartphone based Framework for Public Transport Ticket System using QR Code and Implementing Delay Payment Method" by Ajinkya Gaikwad, published in 2021.
- [23] "Smart Bus Ticketing System" by Divya R, Pavithra C V, Kamalabharathy A, Madhumeetha K, and Sowbarnikaa K, presented at the 2023 International Conference on Intelligent Technologies for Sustainable Electric and Communications Systems (iTech SECOM).