IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

Advance Toll System with Automatic Vehicle Overweight Detection

Amit Vasant Raut[1], Pritesh Sevak More[2], Irshad Shaikh[3]
Department of Automobile Engineering [1,2,3]
Theem College of Engineering, Boisar, Maharashtra, India
contact@amitraut.in[1], priteshmore05@gmail.com[2],

Abstract: *This paper presents the development of an innovative "Advance Toll System with Automatic Vehicle Overweight Detection" using Internet of Things (IoT) technology. The project focuses on integrating IoT devices like the ESP32 microcontroller, load cells, RFID scanners, and servo motors to automate and enhance toll collection processes.Key features include automatic vehicle weight calculation using load cells, seamless vehicle identification with RFID scanners, and automated barrier operations using servo motors. Centralized control enables efficient management and monitoring of toll booths through a unified platform.Through this project, we aim to revolutionize traditional toll collection systems by offering a highly accurate, efficient, and centralized approach. The findings demonstrate the practicality of deploying advanced toll collection systems leveraging IoT technology, with potential benefits including reduced traffic congestion and improved user experience for toll operators and road users.*

Keywords: Toll System, RFID based Toll Collection, Vehicle Theft Detection, Vehicle Weight Detection, Autonomous toll system

I. INTRODUCTION

The primary objective of the "Advance Toll System with Automatic Vehicle Overweight Detection" project is to respond to the evolving landscape of modern transportation and tackle the inherent challenges associated with conventional toll collection methods. This project endeavours to usher in an era of enhanced efficiency and convenience by harnessing the capabilities of Internet of Things (IoT) technology. At its core, the project seeks to design and implement a fully functional working model of a toll booth, replete with a range of innovative features aimed at transforming the way tolls are working today.

II. OBJECTIVES

The objectives of this research endeavour collectively aim to enhance efficiency, accuracy, user convenience, and sustainability in toll collection systems, aligning with modern transportation needs and addressing challenges associated with traditional toll booths.

- **Efficiency Enhancement:** The primary objective is to streamline toll collection processes by automating weight calculations, vehicle identification, and barrier operations, thereby reducing wait times and congestion at toll booths.
- **Accuracy Improvement:** This project aims to implement automated weight measurements and RFID-based vehicle identification to enhance accuracy in toll collection, minimizing errors and disputes over toll charges.
- **User Convenience:** Enhancing the user experience is crucial for both toll operators and road users. Through automation and convenience features, this system aims to simplify the toll collection process and make it more user-friendly.
- **Traffic Flow Optimization:** Contributing to overall traffic flow optimization is a key objective. By enabling quicker and more efficient toll collection, the system aims to reduce traffic backups and delays at toll points.
- **Centralized Control and Monitoring:** Establishing centralized control and monitoring allows for real-time oversight of all toll booths. This centralization enables efficient management, data analysis, and remote troubleshooting across the toll network.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

- **Cost Reduction:** Automation of toll collection processes aims to reduce operational costs for toll booth operators, including decreased Labor costs and more efficient resource utilization.
- **Environmental Impact:** Considering environmental factors, the project aims to minimize vehicle idling and physical toll booth infrastructure, contributing to reduced emissions and promoting eco-friendly transportation practices.

III. DESCRIPTION OF SYSTEM

Hardware Requirements

- **ESP32:** A 2.4 GHz Wi-Fi-and-Bluetooth combo chip featuring low-power 40 nm technology, offering robustness and versatility for various applications programable with Arduino IDE.
- **Load Cell:**A transducer that generates an electrical signal proportional to the measured force, ideal for weight measurement up to 10 Kg.
- **HX711 Module:** Load Cell Amplifier breakout board with HX711 IC, facilitating high-precision weight measurement for electronic scale designs.
- **RFID Reader (RC522):** 13.56MHz RF reader/writer module supporting ISO 14443A for contact-less communication and RFID applications.
- **RFID Tags:** 13.56MHz RFID IC Tags used for object sensing and identification in access control and automation systems.
- **Display Module:** (OLED 128x64) A small OLED display with 128x64 resolution, compatible with microcontrollers via I2C/IIC protocol.
- **Active Buzzer**: An audio signalling device that emits sound when electrified, suitable for alarms and user feedback applications.
- **Servo Motors:** Self-contained motors capable of precise rotation to specific angles and positions, providing high efficiency.
- **Lithium Batteries (18650):** Main power source for electronic components, featuring 2000mAh capacity and 3.7V nominal voltage.
- **TP4056 Module:** Li-Ion Battery Charging Board with current protection, designed for charging individual lithium-ion cells like 18650 with automatic cutoff and discharge protection.

Circuit Diagram

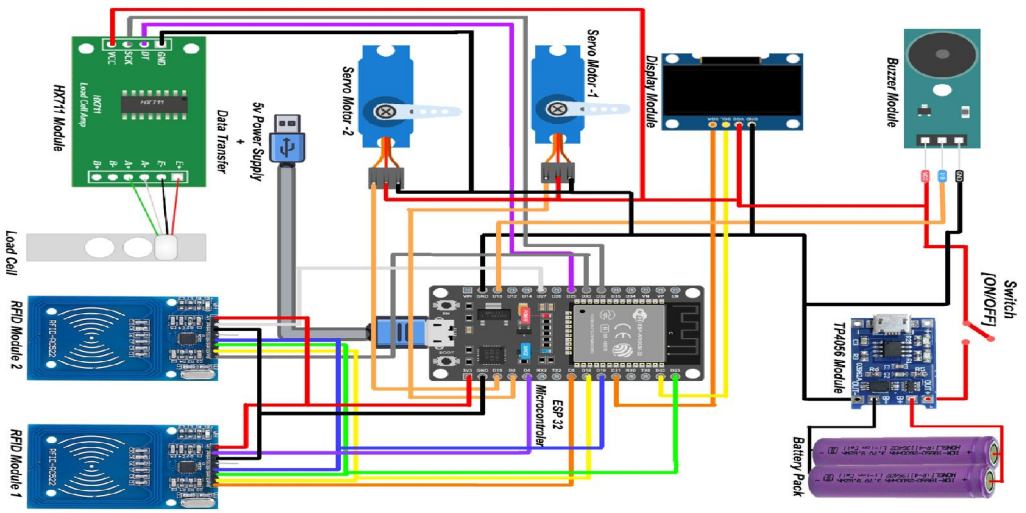

Figure 1: Circuit Diagram

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

IV. METHODOLOGY

The design of the proposed IoT-based toll system is crucial for optimizing toll operations with advanced technology, enhancing performance, and improving user experience. This section details the components and workflow of the toll system, explaining how various hardware and software elements interact to enable seamless vehicle detection, identification, weighing, and real-time data processing. The base design of the toll system features a robust plywood platform that provides a stable foundation to securely house all system components. This platform serves as the central mounting point for toll booths equipped with servo motors, RFID readers embedded in the road section with suitable grooves, a vehicle weighing system using load cells, and other essential components required for toll operations, including RFID tags affixed to the undersides of vehicles.

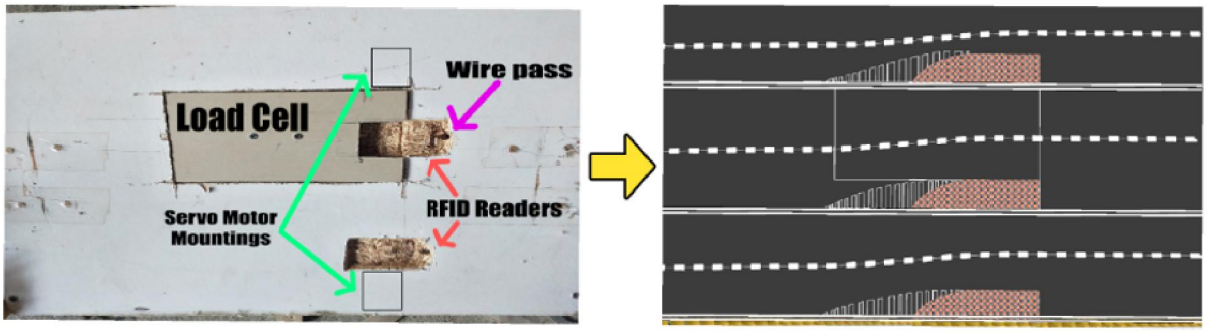

Figure 2:Base design

Operational Overview

The toll project is a sophisticated IoT-based system designed to automate toll collection and enhance traffic management using the ESP32 microcontroller and Arduino programming environment. This operational overview outlines the key functionalities and operations of our toll system, including advanced features for theft vehicle detection and vehicle overweight detection. The toll system comprises vehicle sensors, RFID readers, ESP32 microcontrollers, actuators, and a central server or cloud platform for data processing and management. The architecture enables real-time vehicle detection, identification, toll calculation, and payment processing.

V. RESULT AND DISCUSSION

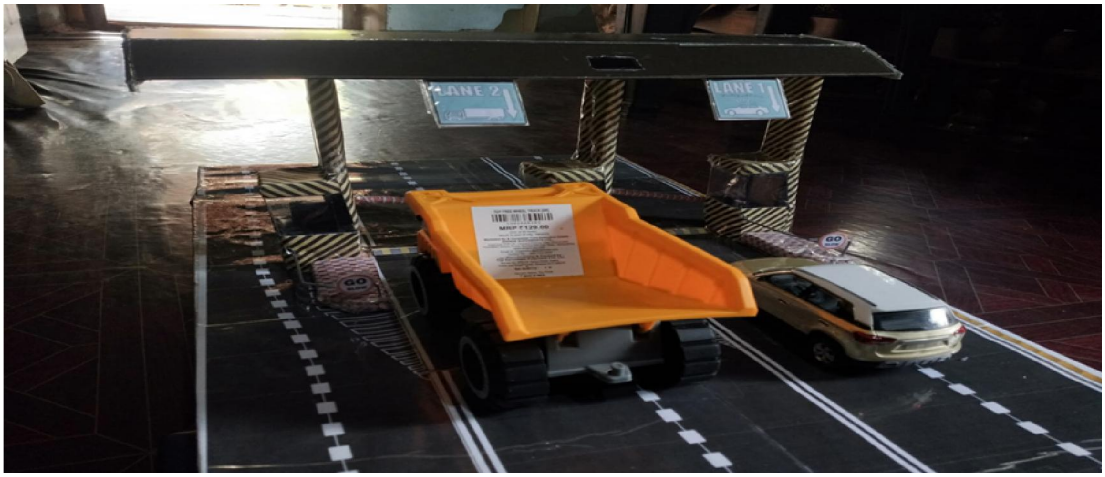

Figure 3: Toll Model

After successful construction of a working prototype of "Advance Toll System with Automatic Vehicle Overweight Detection". The implementation and testing of our toll system using Arduino IDE with ESP32 microcontrollers have yielded significant insights and outcomes. This section below presents the detailed results obtained and discusses their

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

implications for system performance and functionality. During the operational testing phase, the toll system demonstrated robust performance across key functionalities:

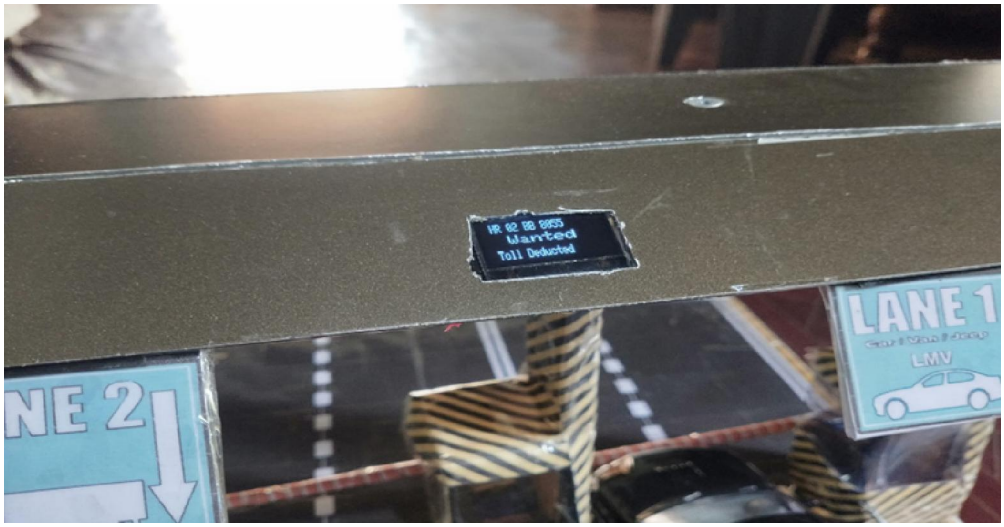

Figure 4:. Vehicle Detection

Vehicle Detection: The vehicle detection mechanism based on RFID technology achieved high accuracy, effectively identifying vehicles approaching the toll booth in real time.

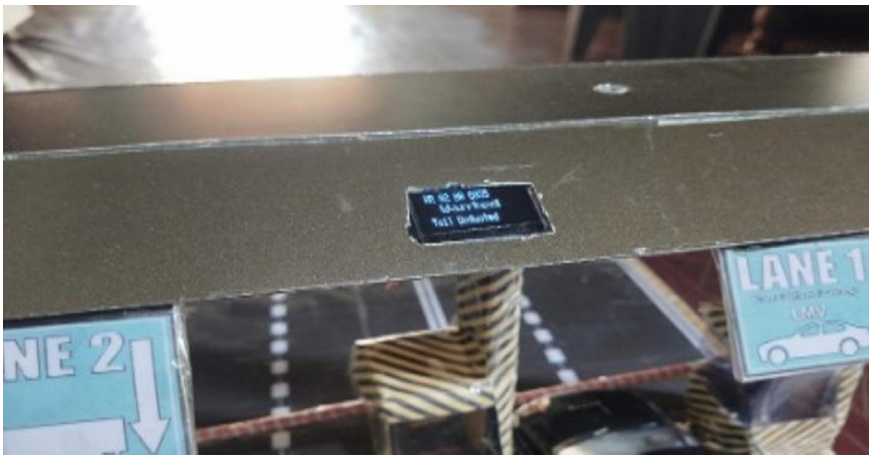

Figure 5: Wanted Vehicle

Theft Vehicle Detection: System successfully detected stolen or unauthorized vehicles based on predefined criteria, triggering immediate alerts to operators for appropriate action.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

Figure 1 Vehicle Weight Detection

Vehicle Overweight Detection: Load sensors effectively identified vehicles exceeding weight limits, ensuring compliance with regulations, and preventing potential damage.

TollData

File Edit View Insert Format Data Tools Extensions Help

A1 Sr No

	A	B	C	D	E	F	G
1	Sr No	Date and Time	Vehicle Number	Vehile Type	Weight	Toll Status	Remark
57	56	Wednesday, April 17, 2024 at 12:45:49 PM	HR02-BB-8055	LMV	_Kg	Collected	Criminal_Found
58	57	Wednesday, April 17, 2024 at 12:46:02 PM	MH48-CC-2840	LMV	_Kg	Collected	Clear
59	58	Wednesday, April 17, 2024 at 12:46:19 PM	MH48-CC-2840	LMV	_Kg	Collected	Clear
60	59	Wednesday, April 17, 2024 at 12:46:51 PM	MH04-AR-1928	HMV	2.12Kg	Collected	Clear

Figure 2 Centralized Data Collection

Data Transmission and Centralized Monitoring: Data generated by the toll system were transmitted to a centralized server for monitoring and analysis.

Centralized Data Monitoring: Real-time data transmission enabled centralized monitoring of toll booth operations, providing administrators with comprehensive insights into traffic flow, revenue collection, system performance and also facilitating proactive maintenance and operational decision-making.

Data Analysis and Insights: Data analysis highlighted peak traffic hours and traffic flow patterns around toll booths, aiding in traffic management strategies and resource allocation.

VI. CONCLUSION

The "Advance Toll System with Automatic Vehicle Overweight Detection" project has significantly modernized toll collection systems by leveraging IoT-based technologies and innovative features. Through successful implementation, the project achieved its primary objectives, paving the way for enhanced transportation efficiency and sustainability.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, April 2024

REFERENCES

[1] M. Likhita, S. Yalinidevi, K. Hanisha, and C. T. K, "TOLLZ-E (Online toll system)," pp. 755–760, 2019.
[2] S. K. Santhosh Prabhuk., Sambath Kumar A, "Theft Detection and Locatin Tracking in Electronic Toll Collection System Using RFID and AES Algorithm." IJSRCEIT.
[3] K. Talele, D. Bharambe, K. Pawar, and A. Mhaisgawali, "Automatic Toll Management System Using Nfc and Mobile Computing," Irjmets.Com, no. 09, pp. 1283–1289, 2020, [Online]. Available: https://irjmets.com/rootaccess/forms/uploads/IRJMETS620577.pdf
[4] G. K. Andurkar and V. R. Ramteke, "Smart Highway Electronic Toll Collection System," Int. J. Innov. Res. Comput. Commun. Eng. (An ISO, vol. 3, no. 5, pp. 4087–4094, 2015, doi: 10.15680/ijircce.2015.0305093.
[5] Y. Y. Yeola, A. S. Kothawade, C. D. Patil, and V. M. Birari, "RESEARCH IN ENGINEERING MANAGEMENT DESIGN AND IMPLEMENTATION OF A TOLL COLLECTION SYSTEM USING GPS AND RF TECHNOLOGY," pp. 1028–1030, 2023.
[6] B. Joshi, K. Bhagat, H. Desai, M. Patel, and J. K. Parmar, "A Comparative Study of Toll Collection Systems in India," Int. J. Eng. Res. Dev., vol. 13, no. 11, pp. 68–71, 2017.
[7] S. Ladkat, B. Sanghvi, A. Tamne, S. Rathod, and P. S. Patil, "M-Toll Using Wi-Fi Technology," pp. 2311–2315, 2016.
[8] B. O. F. Technology and C. Engineering, AUTOMATIC TOLL GATE SYSTEM. 2020.