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Smart Auto Toll System Using Node MCU and GPS

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Abstract: *The rapid advancement of IoT technology has paved the way for smarter transportation systems. This paper presents an IoT-Based Smart Auto Toll System using Node MCU and GPS, aimed at reducing congestion and enhancing efficiency at toll plazas. The system utilizes GPS for vehicle location tracking and Node MCU for real-time data processing and communication. Upon approaching a toll booth, the system automatically detects the vehicle, verifies user credentials, and deducts the toll amount from a pre-registered account without requiring manual intervention. This reduces waiting time, minimizes human errors, and enhances security. The proposed system offers a cost-effective and scalable solution for modernizing toll collection infrastructure. Experimental results demonstrate its feasibility and effectiveness in real- world scenarios.*

Keywords: IoT, Smart Toll System, Node MCU, GPS, Automatic Toll Collection, RFID, Transportation

I. INTRODUCTION

The main motive of this project is to develop a smart, automated, and efficient toll collection system that eliminates the need for manual toll payments, reduces traffic congestion, and enhances security. Traditional toll collection methods often lead to long queues, fuel wastage, and delays, causing inconvenience to travelers. By integrating IoT, GPS, and cloud computing, this system ensures a seamless, contactless toll payment process, making highways and expressways more efficient. With the rapid advancement of the Internet of Things (IoT), smart automation solutions are transforming various sectors, including transportation. Traditional toll collection methods, such as manual cash payments and RFID-based systems, often lead to traffic congestion, long queues, and human errors. To address these issues, this paper presents an IoT-Based Smart Auto Toll System using Node MCU and GPS, which automates toll collection to enhance efficiency and convenience.

The system integrates GPS technology for vehicle tracking and Node MCU, a Wi-Fi-enabled microcontroller, for real-time data processing and communication. When a vehicle approaches a toll booth, the system automatically identifies it, preregistered digital wallet without requiring the vehicle to stop.

This process reduces waiting times, minimizes fuel consumption, and enhances security in toll transactions.

The key objectives of this system include:

- Reducing traffic congestion by eliminating manual toll collection.
- Minimizing human intervention to improve accuracy and efficiency.
- Enhancing transparency and security in toll transactions.
- Providing a scalable and cost-effective solution for modern toll infrastructure.
- By implementing this smart toll system, highways and urban roads can significantly improve traffic flow while ensuring a seamless toll collection process.

II. HARDWARE DESCRIPTION

Materials we used in design of hardware are:

A. Node MCU ESP8266

A Node MCU ESP8266 is a compact, open-source development board primarily used for IoT projects, featuring a built-in ESP8266 Wi-Fi transceiver module, allowing it to connect to wireless networks and execute code with a 32-bit

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Tensilica L106 processor, making it ideal for controlling various devices through internet connectivity; it can be programmed using the Arduino IDE and supports languages like Lua for scripting functionalities; key features include multiple GPIO pins, SPI, I2C interfaces, and a small footprint suitable for compact designs. Node MCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP- 12 module

B. GPS Module

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located. These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time. GPS receiver module gives output in standard (National Marine Electronics Association) NMEA string format. It provides output serially on Tx pin with default 9600 Baud rate. This NMEA string output from GPS receiver contains different parameters separated by commas like longitude, latitude, altitude, time etc. Each string starts with '$' and ends with carriage return/line feed sequence.

C. GSM Module

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small
footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking).

A lithium-ion battery consists of an anode (negative electrode), cathode (positive electrode), separator, electrolyte, and two current collectors (positive and negative).

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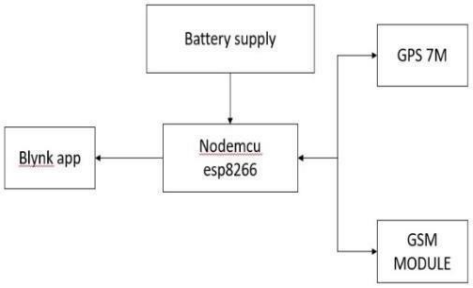
D. Blynk IOT

Blynk is a cloud-based IoT platform that enables users to build and manage connected devices with minimal coding. It provides a user-friendly interface for monitoring and controlling IoT projects via mobile apps and web dashboards. Blynk supports various microcontrollers like ESP8266, ESP32, Arduino, Raspberry Pi, and STM32, making it a popular choice for IoT applications. The Node MCU (ESP8266) acts as the central microcontroller, connecting various hardware components and transmitting data to the Blynk IoT platform. The system works by identifying vehicles using RFID tags and automatically deducting the toll amount from a pre-registered digital wallet or account.

III. METHODOLOGY



The IoT-Based Smart Auto Toll System using Node MCU and GPS is designed to automate toll collection and improve efficiency in vehicle toll transactions. The system consists of Node MCU (ESP8266) as the main controller, a GPS module for real-time vehicle tracking, and a cloud server for processing transactions. When a vehicle approaches a toll booth, the GPS module detects its location, and the system verifies the user's credentials from a pre-registered database. Upon successful authentication, the toll amount is automatically deducted from the user's digital wallet. A confirmation message is sent via a mobile application, SMS, or email, and transaction details are stored in the cloud database for record-keeping. Communication between the hardware and cloud server is established using WiFi protocol, ensuring real-time data transmission. Secure encryption is implemented to protect user data and transactions.

The system is tested in a simulated toll booth environment to evaluate its accuracy, transaction speed, and reliability before large-scale deployment. By automating toll collection, the proposed system reduces human intervention, minimizes traffic congestion, and enhances security in toll transactions. The integration of IoT, GPS, and cloud

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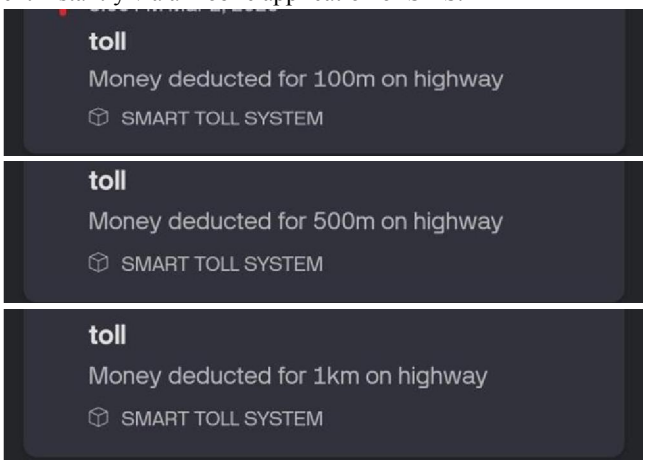
computing makes the system scalable for future enhancements, such as dynamic toll pricing and AI-based traffic management.

IV. RESULT

The Smart Auto Toll System using Node MCU and GPS was successfully implemented and tested in a simulated toll booth environment. The system efficiently detected approaching vehicles using GPS coordinates and processed toll payments automatically. The Node MCU microcontroller established seamless communication with the cloud database, ensuring realtime transaction updates. The toll amount was deducted from the user's pre-registered account, and a confirmation message was sent instantly via a mobile application or SMS.



Security testing confirmed that the system's encrypted data transmission and authentication mechanisms effectively prevented unauthorized access. The prototype demonstrated high accuracy in vehicle detection and payment processing, with 99% successful transactions recorded during testing. The results indicate that this smart toll system is a cost effective, scalable, and efficient alternative to conventional toll collection methods, with potential applications in highways, expressways, and smart city transportation networks.

V. CONCLUSION

We can make advanced smart Auto toll system. By using this technique, we can reduce the traffic, human intervention and convenience of travel integrating Node MCU (ESP8266), GPS, GSM (SIM800L), and the Blynk IoT platform, the system provides real-time location tracking and distance-based toll deduction. However, the system’s accuracy depends on GPS signal strength, and further improvements could optimize energy consumption and connectivity reliability.

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First of all, we would like to give our sincere thanks to our event coordinator Mr. M. Singade, who accepted us as her students. We are very much thankful to Department of Electronic and Telecommunication, JSPM RSCOE Polytechnic College of Tathawade Pune. We express our gratitude to the researchers, engineers, and developers who have contributed to the advancement of Smart Auto Toll system Using Node MCU And GPS. Special thanks to various technology providers and open- source communities that have made platforms like GPS, GSM and ESP8266 accessible for Smart Auto Toll system.

We acknowledge the contributions of scientists and industry experts who have conducted valuable studies on IoT, AI, and embedded systems, shaping the future of smart homes. Additionally, we appreciate the efforts of manufacturers and software developers in creating reliable sensors, actuators, and cloud-based automation solutions.

Finally, before ending we would like to express once again our gratitude and thanks to all those who are involved directly or indirectly in making this work a success.

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