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Smart Toll Collection System

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Abstract: Toll collection is an essential part of modern transport systems, but traditional methods cause slow queues, delay, and inefficiency. Our project aims to automate toll collection through RFID (Radio Frequency Identification) technology, which will make it faster, intelligent, and efficient. In this system, each vehicle is fitted with a Radio Frequency Identification (RFID) tag containing individual identification data. When a vehicle approaches the toll booth, an RFID reader scans the tag, verifies the account balance, and automatically deducts the toll if the vehicle is authorized. If the transaction is successful, the system triggers a servo motor to open the barrier, thereby enabling the vehicle to pass without stopping. An LCD display gives real-time feedback, including balance status and transaction data.

Keywords: Radio Frequency Identification

I. INTRODUCTION

Background of Toll Collection Systems Toll collection is an essential element of road infrastructure, enabling revenues to be earned to finance construction and maintenance. The existing traditional practices employ cash payment or prepaid cards, which cause delays and congestion. RFID-based toll collection, however, offers a more efficient, automated, and contactless way of avoiding such issues.

The Requirement for Toll Collection Automation Manual tolling leads to congestions, fuel wastage, and human mistakes. An RFID system enables free flow of vehicles without stopping, avoiding congestions and improving efficiency.

Use of RFID to Collect Tolls RFID (Radio Frequency Identification) technology enables wireless identification of automobiles using distinct tags. Upon approaching the toll booth, the RFID reader recognizes the tag, checks the credentials, and charges the toll automatically.

II. RELATED WORK

Solutions Provided by Smart Toll Collection System

- Reduces Traffic Congestion Cars flow through the area uninterrupted, thus significantly reducing waiting times at booths.
- Reduces Human Interaction Reduces the need for toll operators, decreasing labour expenses and offering 24/7 operation.
- Flexible for Expansion Able to be integrated with GPS systems, license plate cameras, and mobile apps to enable intelligent transportation.
- An environmentally friendly solution that minimizes idle running for the engines and fuel use at toll points, and thus carbon dioxide emissions.
- Revenue Transparency All payments are computerized, thereby minimizing leakage and maximizing accountability of toll revenue.
- Supports Prepaid Card System Pre-load their cards with balances to pay for tolls, reducing cash handling.
- Suitable for Smart City Programs- As the data is already with the Authorities, Government can improve the digital infrastructure based on the Data.



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- Operation Efficiency- As companies own a lot of vehicles and managing a fleet is a difficult task it can be easily managed.
- Low Maintenance- As the systems are installed it requires less maintenance due to low power consumption and attention.
- Data Analytics- With the help of the data we can analyse the traffic patterns and plan the infrastructure upgrade.
- Enhanced Security- Keeps a traceable record of the each transaction to stop misuse of the Vehicle.

III. METHODOLOGY

3.1 RFID-Based Identification

- The system utilizes the utilization of RFID technology, where a unique RFID tag is attached to every vehicle.
- As the car is about to reach the toll booth, the RFID reader reads the tag, and the Arduino interprets the data to determine the car.
- Such an identification process eliminates the need for halting and manual ticketing and thus ensures a faster and more convenient toll collection process.

3.2 Deduction and Verification of Balance

- Scanning the RFID tag, the system verifies the associated balance saved in the memory.
- When the balance is sufficient, the previously specified toll amount is deducted automatically, and the entrance is provided.
- If the balance is insufficient, the system doesn't open the gate and displays a message asking the user to add balance their card.

3.3 Automatic Barrier Control Using a Servo Motor

- When payment is completed, Arduino sends a signal to the servo motor to open the gate.
- The gate is left open for several seconds, with the car driving through before automatically closing, thereby enabling effective movement of traffic as well as security.

3.4 Recharge and Balance Update System

• The system also includes a recharge function in which a recharge RFID card triggers the recharge mode of the system. Subsequently, customers can swipe their RFID cards to add a certain amount of money to their account balance, thereby making top-ups convenient without the intervention of human beings



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IV. BLOCK DIAGRAM



V. HARDWARE COMPONENTS

- Arduino Uno
- Servo Motor
- MFRC522
- LCD Display I2C 16x2

The RFID reader is connected to the Arduino, Which processes the all the input data. After processing the data it Communicates with the Servo Motor to Either Move the Gate or not.

Then the LCD Display which is connected to the Arduino Displays if Access is granted or Not.

Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P. It features 14 digital I/O pins(6 PWM), 6 analog inputs, a 16 MHz crystal oscillator, and a USB connection for programming. It can be powered via USB or an external 7-12V supply. Known for its simplicity and versatility, the Arduino Uno is ideal for beginners and professionals alike, supporting a wide range of projects, from basic electronics to robotics and IoT. Its user-friendly Arduino IDE and extensive community support make it a go-to choice for learning and prototyping. Arduino Pinouts

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RFID Reader(MFRC522)

Servo Motor

The MFRC522 is one of the widely used RFID modules that works at 13.56 MHz. It interfaces with the Arduino UNO through the SPI interface (using pins like SDA, SCK, MOSI, MISO, and RST) and is capable of reading RFID tags over a short distance. Function in the System: It reads the RFID tag that is stuck to the vehicle, reads its unique ID, and passes this information to the Arduino for processing.



Servo motors are employed for angular position control in a precise manner. They normally consist of three wires (signal, power, and ground) and are operated by PWM signals from the Arduino. The servo motor operates the physical barrier (gate) at the toll plaza. After a successful payment for toll, the Arduino provides a PWM signal to the servo, which rotates to open the barrier, thus enabling the vehicle to pass. After some time, the barrier automatically closes.

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The 16x2 LCD display has a two-line graphical interface, with each line capable of holding 16 characters. It usually employs the HD44780 controller and communicates through parallel data lines or I2C (via an I2C adapter). The LCD is employed to present user feedback in real-time. It shows messages like transaction confirmations, toll deductions, error notifications, or manual intervention requests when the RFID tag is not recognized or when there is not enough account



VI. PROPOSED METHODOLOGY IN REAL LIFE

VII. CONCLUSION

The RFID Toll Collection System is a modern, timesaving, and traffic-congestion-reducing solution to the problems faced in traditional toll collection systems. The system, by the use of RFID technology, automates the process, thus

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saving time and avoiding traffic congestion. The use of an LCD display, EEPROM as a balance controller, and a servo motor as a gate controller makes it a smooth and userfriendly process. The recharge facility also allows users to easily top up their balance, thus eliminating the use of cash transactions. The system proposed not only increases toll collection efficiency but also enhances transparency with real-time logging of data. The system minimizes human intervention to a large extent, making the toll booths more efficient and cost-effective. With additional developments, like cloud integration and IoT based developments, the system can be scaled up to highways and smart city infrastructure. The implementation of this automated toll system will allow transport authorities to automate procedures, avoid congestion, and further improve the convenience of the travel experience for the commuters.

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