

Review on Smart toll gate system using image processing, RFID system, IOT and database verification

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Abstract - *The Smart Toll Gate System represents a significant advancement in the global shift towards automation. It minimizes the need for human involvement and reduces human errors. The primary benefit of integrating automation into society is the increased reliance on machines and hardware while decreasing reliance on humans. This leads to the conclusion that incorporating automation into everyday life will simplify and ease lifestyles. Currently, most toll plazas on highways are manually operated, where an attendant collects cash from the driver and issues a receipt. This process can be slow, often resulting in traffic congestion at toll plazas on busy roads. Automated toll collection can save costs, conserve energy, and reduce the need for manpower. In this project, we propose a cost-effective and efficient method known as Electronic Toll Collection. It utilizes RFID modules to automatically gather toll fees from vehicles as they pass through the toll plaza. This initiative aims to tackle the challenges faced at toll plazas and also presents an identification device for vehicles*

Key Words: Unique Identification, Image Processing, OCR, RFID, IoT, API, Database Verification.

1. INTRODUCTION

Transport is universally recognized as a crucial element for the economy of any nation. Enhancing transportation networks fosters an improved environment, allowing individuals greater freedom to travel, facilitating significant trade in goods and services, boosting employment opportunities, and promoting social mobility. Moreover, the economic health of a country is closely associated with efficient transportation methods. A rising number of vehicles on the road can lead to various issues such as traffic congestion, accidents, and environmental degradation. Different sectors of the economy employ various transportation modes for distinct purposes. Therefore, the escalating demand for immediate transportation significantly impacts the global landscape and environmental sustainability. These factors contribute to the economic competitiveness by minimizing transportation expenses at production sites and ensuring the timely delivery of products to consumers. The smart toll gate

system represents a technological advancement capable of verifying the authorization status of vehicles and subsequently alerting the relevant authorities. The control unit of the violation notice, debits, and associated accounts. The primary benefit of this smart toll gate system is its capability to reduce congestion at toll booths, especially during peak travel seasons when traffic tends to increase beyond usual levels.

1.1 LITERATURE SURVEY

The conducted survey focuses on [1] the susceptibility to highway tolls and the maintenance of data needed to assess threats to road infrastructure, which relies solely on simulations utilizing a well-established traffic model.

[2] It provides the quickest route to a destination and recalibrates the path in case of traffic, delivering precise route information to users while minimizing both travel time and expenses. [3] This process incorporates electronic payment for tolls via prepaid cards and also includes card recharging stations. Feedback from passengers is collected and analyzed with the help of gathered statistics using the Mann Whitney test for improvements. [4] A study is conducted concerning toll payments made using RFID technology and potential enhancements. This study also retains information about both the vehicle and its user. [5] The sharing economy simplifies the process by connecting vehicles to a registry online. Vehicles document their travel by regularly sending data to the controller, focusing on collecting real-time traffic updates to ensure smooth driving conditions.

It tracks passenger travel by comparing a vehicle's location with that of the toll plaza using GPS and charges the vehicle owner accordingly. [7] RFID sensors installed at the toll capture information from passing vehicles, facilitating seamless digital transactions based on unique patterns. [8] This eliminates the need for manual labor, thereby enabling much faster automotive travel than traditional toll systems, with RFID data stored in the cloud to ease payment processes. [9] The toll system is designed to enhance efficiency through contactless fare collection and advanced management. In this setup, a variable resistance testing

section is utilized to assess a vehicle’s capacity, allowing recovery of charges on a per-vehicle basis. [10] It automatically registers vehicles coming on or off highways or trams, reducing wait times for toll payments significantly. Comprehensive monthly statements are dispatched to the recipient at month’s end, providing user specific details about the vehicle, including reference number, vehicle number, and billing address for the driver. [11] It suggests mobile payment options for tolls. The application aims to reduce the time spent in queues for payments and to alleviate congestion. This system is designed to identify the position of the vehicle and the toll using sensing devices, allowing for automatic assessment and payment through a mobile application. To evaluate the procedure at toll plazas, it includes a range of actions such as prohibiting certain vehicles, increasing toll rates, and managing unique payment methods for users. It implements security protocols to reduce toll-related crimes. Using a GSM module, it can block specific types of vehicles. A simple code message is sent to the system, and the barrier remains closed for the vehicle even if payment has been completed. A proposed solution for electronic payment at expressway tolls utilizes RFID tags, while also using image processing and cloud technology to keep track of vehicle records. This system includes a method to compute the travel distance of a vehicle so that the toll is charged based on this distance, thereby avoiding extra charges. [6]

1.2 EXISTING SYSTEM

In the current method, there is an automatic unit for collecting payments, but it lacks the efficiency of the proposed system, and there is no automatic barrier that opens at that time. There is no technology in toll collection designed to detect vehicle fraud or recognize vehicles. However, the existing system includes technology that provides the shortest route to minimize journey time. It operates using a prepaid card system for toll payments. Additionally, the system incorporates a sharing economy feature that simplifies the process by connecting vehicles to a registry over the internet. It also utilizes RFID sensors installed at the toll booths. A mobile application for toll transactions is also part of the system. These toll collection methods are rather time-consuming. There are opportunities for vehicles to evade toll payments, which results in long queues for following vehicles. Taking into account the average wait time per vehicle, every year, around 72,000 vehicles are idling for 5 hours, contributing to pollution and fuel wastage. When considering 50 toll plazas, this leads to a significant loss of fuel and money, resulting in heavy traffic. In addition to government vehicles, there are also vehicles with number plates in Tamil. There is currently no specific method for recognizing vehicle number plates in Tamil. Despite the automatic toll collection system, it relies solely on template matching, which is outdated technology. This system employs image processing techniques to maintain vehicle records but does

not effectively identify stolen Do not use the word “essentially” to mean “approximately” or “effectively”.

1.2 PROPOSED SYSTEM

In the proposed system, image processing is utilized to keep track of each vehicle. Stolen vehicles can be easily detected using pressure sensors combined with image processing. A cloud-based vehicle database is maintained through an IoT module. Payments are processed automatically, and breaches of vehicle number plates are also detected with pressure sensors. The primary focus is on the front-end elements, namely the RFID tags, RFID scanner, and pressure sensor. The RFID tags carry a unique ID that is used to identify authorized users, and these users are recognized by the receiver. Upon successful authorization, control is transferred to the motor via the Arduino IDE. This IDE incorporates embedded C programming, which manages the selection and timing of components to be used. This system employs Optical Character Recognition as opposed to template matching, enhancing overall efficiency. The numbers and characters found on the number plates are identified using a method called edge segmentation. Additionally, it is capable of recognizing vehicle number plates written in Tamil, utilizing trained datasets for this purpose. By employing image processing techniques, the system can verify the driver against the details of the RFID user account. If there is a discrepancy, the vehicle is flagged for further verification. This application serves as an automatic alternative to traditional manual systems. It also includes a display panel that shows the user's information and indicates if the user is unauthorized. In cases of unauthorized access, control is transferred to a buzzer that sounds an alarm, enhancing security measures. This approach helps to minimize waiting time, conserve fuel, and alleviate traffic congestion.

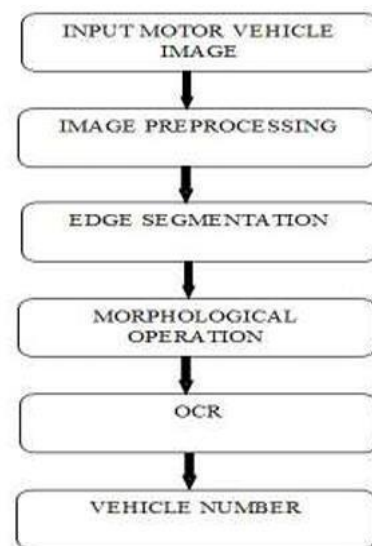


Fig. 1 Block Diagram for Image Processing

2. METHODOLOGY

In this setup, which serves as the system's central control, we utilize the ARDUINO UNO (ATmega328P) microcontroller as it houses all the program instructions for the entire system. The image processing component is employed to recognize the vehicle number by reading the number plate through OCR, while the pressure sensor is utilized to determine the weight of each vehicle and classify them accordingly.

The collection of fees is determined by the type of vehicle. An RFID card monitors the funds in the vehicle owner's account and the corresponding vehicle database. In cases of stolen vehicles, the barricade will not open as it is controlled by a SERVO motor. Stolen and other violating vehicles are identified by comparing their registration numbers with those listed in police notifications. Additionally, stolen vehicles are detected through a pressure sensor that checks the vehicle's weight for classification purposes. If a vehicle lacks the appropriate license plate according to its category, law enforcement will be notified. The toll payment details and process are shown on an LCD screen.

2.1 MODULE DISCRIPTION

a) Vehicle categorizing using pressure sensor

When the vehicle is passed to the toll gate the pressure sensor in the gate detects the weight of the vehicle. By detecting the weight, the vehicle is categorized.

b) Vehicle number recognition

The vehicle number is recognized using optical character recognition. The OCR algorithm segments the number and texts using edge segmentation. It compares the segmented numbers and text with the database and when both matches it retrieves the data. It also recognizes the characters in Tamil by using trained datasets.

c) Arduino interfacing with RFID reader

When the RFID card is scanned in RFID scanner, the antenna of the tag receives signals from an RFID reader or scanner and it returns the signal, usually with a few additional data. It compares the RFID card number with user details in the database and then the payment is done. If the number doesn't match with the database, then the illegal vehicle can be identified. And if the user does not have sufficient balance, an alert will be notified.

d) Theft detection and vehicle processing

When the vehicle is passed through the toll, the theft vehicle is detected using pressure sensor and number recognition by comparing the number with the vehicle that is categorised. Based on the vehicle category, the payment is done. If the

comparison is mismatched, the theft vehicle is detected and the barricade does not open.

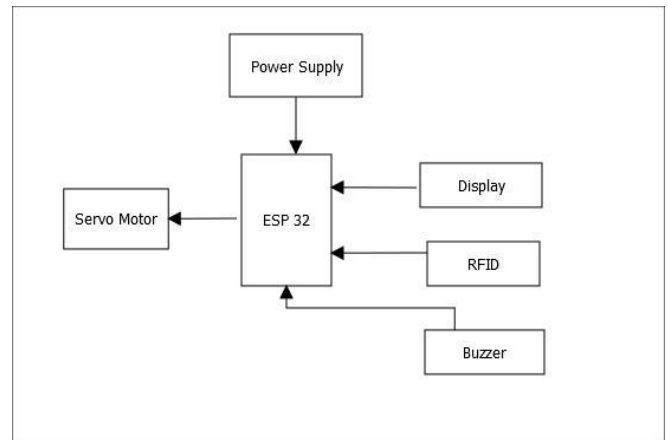


Figure 1: System architecture

3. Result

The tags currently registered in the Arduino IDE can be authorized and granted access through the system, while vehicles that are not registered will be denied entry, triggering an alarm and notifying the authorities about the unauthorized user. It also checks for license plates in Tamil, as many vehicles in Tamil Nadu have number plates featuring Tamil characters. The implementation of electronic tolls enhances user convenience and reduces traffic congestion. With this system, safety at toll booths is improved, and it enables the identification of stolen vehicles. Users are required to maintain a prepaid account specifically for this purpose.

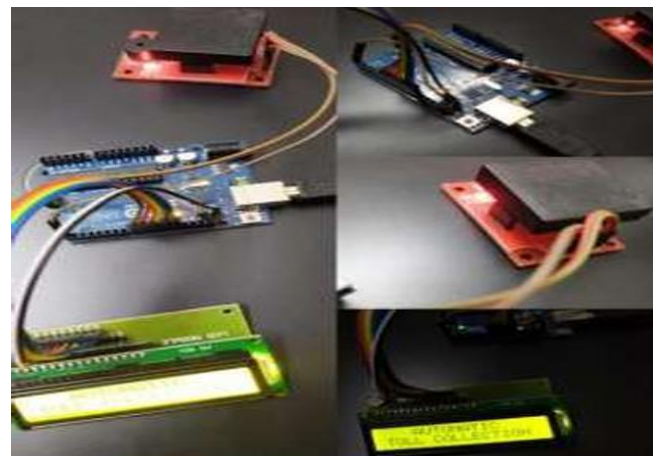


Figure 2: Arduino System

4. CONCLUSIONS

The system aids in minimizing the wait time at toll plazas by utilizing technologies such as RFID and optical character recognition. Additionally, it can easily identify stolen

vehicles and those involved in hit-and-run incidents by cross-referencing vehicle numbers with data stored in the cloud database. As the wait time decreases, it also contributes to better management of heavy traffic. Moreover, it is capable of recognizing vehicle numbers displayed in Tamil. Therefore, the Smart Toll Gate system can be regarded as superior to the traditional manual toll gate system. Although this system has been successfully put into operation, there are still opportunities for improvement. Planned enhancements include the ability to send transaction details via SMS to users' mobile phones. Furthermore, instead of employing edge segmentation for OCR, the Google Cloud Vision API can be integrated, which can recognize both users' faces and characters and numbers. This API from Google offers high-level security and includes free built-in functions. In Tamil Nadu, many vehicles feature number plates in Tamil characters. The introduction of digital tolls improves user convenience and alleviates traffic congestion. With this system in place, security at toll booths will increase, making it easier to identify stolen vehicles. Users are required to maintain a prepaid account specifically for this service.

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