Advanced Traffic Violation Control and Penalty System using RFID and Image processing technology

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Abstract*— Roads play a vital role in connecting people globally by facilitating transportation of goods, enabling travel and promoting economic development. They contribute to overall societal progress. Roads can contribute to bottleneckfactors like insufficient capacity, poor design and inadequate traffic management. High volumes of the vehicles and inefficient intersections can also play a role in creating traffic on roads. Additionally, factors like accidents, construction can further aggravate congestion. It is challenging for the officials to check for a traffic infringement every time, it leads to unhappy circumstances for both drivers and ramblers as it becomes risky. To overcome these, technology plays a vital role therefore in this work RFID and Image processing based methods are focused. In this system the benefits of both the technologies has been utilized at the same time to avoid the drawbacks like falsification of the vehicle number plate, concealment of the Fast access tag. In this work, simple mail transfer protocol is employed to convey a mail notification over the internet about the fine that is enforced on the motorist. By this propensity of escaping consequences will be reduced.

Index Terms- RFID tag, RFID reader, esp8266MOD, Image processing.

I. INTRODUCTION

In the modern landscape of urbanization and accelerating vehicular traffic, the need for efficacious traffic management and enforcement systems has become predominant. Traffic violations contribute remarkably to road accidents, congestion, and overall road safety concerns. To constrain individuals to adhere traffic regulations, and it is essential to give a brisk reply to infringement done by them.

Government of INDIA (GOI) has a dream to make every organization and transaction digitized. Government has initiated so many steps to digitize the organizations and forced the citizens to use digitized mode in their day to day life. As per the W.H.O. Road accidents are not a small matter now a days, it is listed in their top health agendas now a days. As per the statistics road accidents are the leading cause of death in 15–29 years age group. In this digitized country there should be some solution which can enforced automatic penalty on the traffic rule violator so that they will stop themselves to do the road safety offences. Government should also go ahead to curb such road offenders by penalize them forcibly from their AADHAR linked accounts automatically. In this paper a solution is proposed which can integrate easily with the existing methods of penalty in INDIA to penalize the violators automatically. To orate these challenges, this paper introduces an ingenious framework. By amalgamating the state of the mediatechnologies and methodologies, this system focus to revolutionize the traditional approach to traffic management.

In recent many works have been proposed a transparent penalty frameworkfor exposing all kinds of infringements utilizing the path of travel ofa personal vehicles by tracing them. Analogously,for speed limit breach detection can be done using Mobile vehicularnetworking.In contrast, approaches such as digital image processing and traffic management making use of RFID innovationsare gaining more adoration because of their unique benefits. These RFID reader uses radio waves to recognize the vehicle which contains a Base-16 number known as a unique identification (UID) number, which is stored in RFID tags and it is scanned by a reader. Depending on the application type such as toll system, security setup, archives, etc. RFID readers can be chosen between three classifications i.e. Low Frequency has short

transmission ranges, typically anywhere from a few inches to less than six feet, High Frequencythe standard scale is anywhere from a few inches to several feet, and Ultra High Frequency can generally be read from 25 plus feet away. This invention works in two approaches i.e. active and passive. An Active RFID tag has its own power source which makes it more appropriate for request like aradio broadcastfor longer-distance. Still, it is a expensive technology. Although, the Passive RFID tag receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna, it is more affordable, systematic and more appropriate for quick moving vehicles.Hence in this work passive RFID is used. Admitting this technology has many benefits, it undergoes disadvantages like concealment, unauthorized alteration of Fast access tags which can be convinced over when it is utilized along with image processing technique. In an Image processing technique, a snapshot of a scanned image is taken and by manipulating it information of the vehicle can be validated. It is observed that image processing technique are convenient though it is unproductive when it is utilized exclusively. As a result this work focus on RFID technology and image processing along with ESP 8266 Wi-Fi module.

II. METHODOLOGY

In this proposed work, a computerized system, as depicted in Figure 1, is developed. This system incorporates RFID tags pre-configured in the vehicles, each containing a unique identification number (UID) in the hexadecimal format, which holds the vehicle holder'sinformation in a categorized database in MySQL. This set-up is concerned with the operation of the traffic signals. If a vehicle attempts to cross a red signal, the RFID detector captures the tag information adjacent to image processing and transmits it to the server utilizing ESP8266 mod. This module facilitates wireless communication to transfer data to central server. Additionally, Image processing technology is utilized to determine license plate and verify the vehicle details. This systemis assessed in python using real image processing techniques. If the license plate data matches the database, a notification is sent to the owner regarding the fine to be paid based on the law.

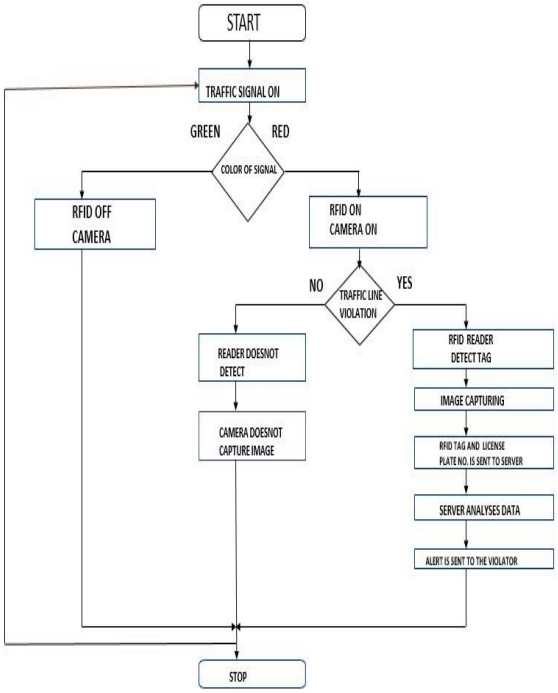

Figure 1: Flow chart

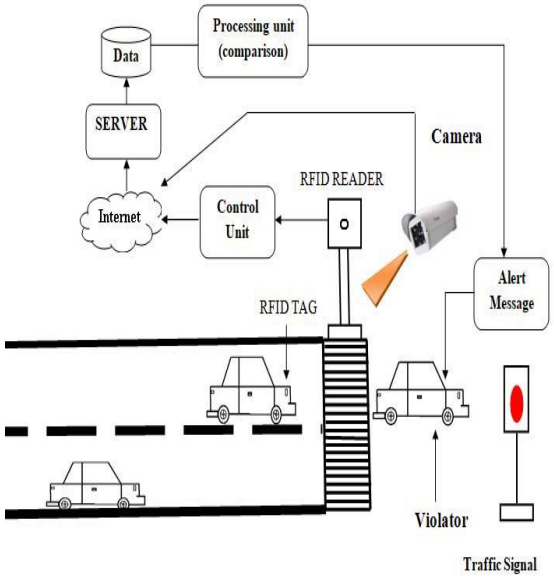

Figure 2: Block diagram

III. EXPERIMENTAL SETUP

To corroborate our presented work test was carried out. Here RFID-RC522 tag reader is being utilized and embedded at the road's end line. A car's picture was captured by a python script for processing.This

RFIDtag detector recognizes the passive RFID tag placed on vehicles. It uses radio waves to transmit signal triggers the tags. Once activated, a tag responds with a wave of 13.56 MHz frequency, transmitting the stored data in the hexadecimal values to the RFID detector. The RFID-RC522 communicates with a microcontroller via a 4-pin Serial Peripheral Interface (SPI).

We used ESP8266mod because it features an 802.11b/g/n HT40 Wi-Fi transceiver, allowing it to connect to Wi-Fi. It operates within a voltage range of 3V to 3.6V and utilizes the D3, D4, D5, D6, D7 pins for SPI communication. The GND and 3V3 pins power the RFID-RC522 detector, with other connections as follows:

- D3 of ESP8266 moduleis connected to the RST of RFID-RC5322.
- D4 of ESP8266 moduleis connected to the SDA of RFID-RC5322.
- D5 of ESP8266 moduleis connected to the SCK of RFID-RC5322.
- D6 of ESP8266 moduleis connected to the MISO of RFID-RC5322.
- D7 of ESP8266 moduleis connected to the MOSI of RFID-RC5322.

The ESP8266 module was programmed using Arduino IDE, employing SPI and MFRC522 to read/write data from RFID tags easily, along with ESP8266WiFi, ESP8266HTTP Client, and Software Serial libraries. The ESP8266 module connects to a MySQL database via Wi-Fi. MySQL database is managed through a Heidi SQL interface, storing the following data:

- The vehicle registration plate number.
- The contact detailsof the vehicle holder.

For Image Processing, Python version 3.11 is utilized, which is effective and valid for vehicle registration plate recognition. The Python code utilizes the K-Nearest Neighbour Algorithm for image processing purpose as shown in Fig.3.

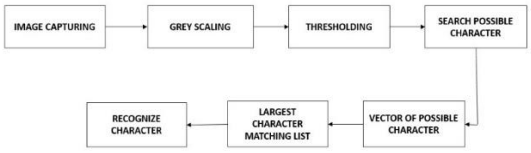

Figure 3: License plate extraction

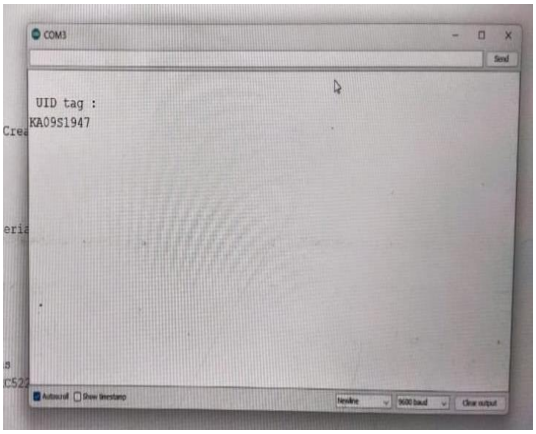

Figure 4: RFID tag detection

IV. RESULT

The system was tested on various vehicles using RFID readers. It successfully synchronized the analysis of the license plate and RFID tag within 15 to 110 milliseconds. Email notifications were sent within 3 to 6 seconds, and the owner's details were updated on the database efficiently. Figure 5 and Table 1 illustrate the email notification and database update process, respectively.

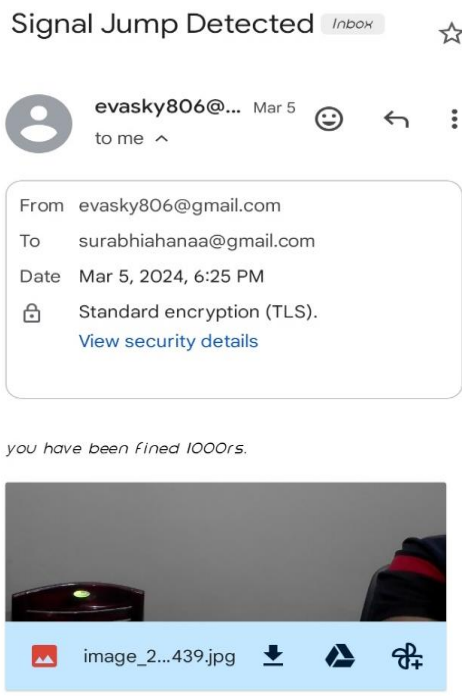

Figure 5: Penalty message mailed to the violator.

Table 1: Details of the owner in the database

Vehicle number	Email
KA09EV0998	gururanjitha665@gmail.com
KA04MW7442	surabhiahanaa@gmail.com
KA01MA0134	vidyargowda15@gmail.com
KA09S1947	vidyamnec@gmailcom

CONCLUSION

This paper effectively automates the detection and penalization process, significantly reducing the time and effort required for traffic law enforcement. The integration of RFID technology, image processing, and database management provides a reliable and efficient solution for modern traffic management.

FUTURE SCOPE

Utilizing technologies like AI-based surveillance cameras, license plate recognition, and anomaly detection algorithms to identify stolen vehicles. Integrating real-time data sharing with law enforcement agencies can enhance the system's efficiency in tracking and recovering stolen vehicles. Additionally, exploring block chain technology for secure and transparent data storage could be beneficial for maintaining the integrity of penalty.

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