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Advanced Traffic Violation Control and Penalty System using IoT and Image Processing Techniques

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***Abstract*— Roads are the major connective mode in any country and often characterized by traffic congestion due to lack of traffic management. It may be due to the large population, lack of technology and violation did by the people, among them, traffic rule violation is a major issue. It is very difficult for the Authorities to check there is a traffic rule violation or not, which leads to miserable situations where it becomes dangerous not even for the drivers but pedestrians as well. From recent research, it is found that due to this in India the number of accidents per 1000 vehicles it is 35. To overcome these violations, technology can play a major part hence in this work IoT and Image Processing based methods is focused. This manuscript highlights the monitoring of traffic signal violation and its penalty system. In this work, Radio Frequency Identification (RFID) along with Image Processing techniques is used. In recent year's work both the technology has been used separately and has its advantages and disadvantages. Hence in this work, the advantages of both technologies are utilized while using both the techniques simultaneously to avoid the disadvantages such as tempering of the License plate, hiding of Fastrack tag, etc. In this system, GSM technology is used to send an alert about the penalty imposed on the owner of the vehicle. By doing this the tendency of getting away without being penalized will reduce and subsequently the traffic violation will be mitigated without industrious use of human resources.**

Keywords— RFID tag, RFID detector, Image Processing, GSM, Database.

I. INTRODUCTION

Developing a Country with a high population such as India, has a vast population which uses the high number of vehicles for the transit from one place to another, and therefore lots of vehicles are required and which causes lots of traffic on the road. Heavy traffic congestion leads to an increase in the number of violations and hence it is difficult to manage and control traffic. To compelling people to follow traffic rules, it is necessary to give a quick response to violations done by them. Thus many technologies are improved in response to their action. These quick actions may be useful for controlling traffic rules. Hence in recent years for controlling traffic rules many works have been purposed such as Dae-Woon Lim et al. [1] suggested method for detecting all kinds of violations using the traveling trajectory of individual vehicles by tracking them. Similarly, Kumar Sridharamurthy et al. [2] proposed a method for speed violation detection using Vehicular Ad Hoc networking. However, techniques such as image and video processing [3,8-10] and traffic controlling using RFID transmitters[4-7] are gaining more popularity due to their distinct advantages. These RFID detection system uses radiofrequency waves to identify the vehicle which has a hexadecimal number known as a unique identification number. This number is stored in RFID tags and scan by a detector such as RC 5322. Based on the type of application such as security system, toll system, libraries, etc., RFID detectors can be selected between three categories i.e. Low Frequency (30 kHz to 300 kHz.), High Frequency (3 to 30 MHz) and Ultra High Frequency (300MHz to 3 GHz). This technology works in two modes i.e. active and passive. Active technology uses own battery which makes it more suitable for applications like the broadcast signal for long-distance however, it is costly technology. In contrast, this passive RFID is less costly, efficient and more suitable for fast-moving vehicles [5] hence in this work passive technology is used. Although this technology has many advantages, it suffers from limitations such as hiding, tempering of Fastrack tags which can be overcome when it is used along with image processing technology. In image processing techniques, a real digital image is captured and by processing it the information about the vehicle can be cross-verified. It is found image processing techniques are useful [9] although it is less effective when it is used individually. Hence this work highlights RFID and image processing techniques along with wireless technology ESP 8266 Wi-Fi.

Excluding the introduction and conclusion, this paper contains three sections wherein the first section i.e. Method, Experimentation and Simulation, results.

II. METHOD

In this work, an automated system is proposed as shown in Fig.1.This advanced traffic control approach consists of RFID which is pre-install in vehicles with unique ID consist of owners and vehicle detail in an organized database of all registered vehicles which is developed using MySQL. Moreover, image processing technology is also used to detect the vehicle and figure out its license plate which is simulated and tested on Python using a real digital image. The purposed system involves the functioning as if there is a red signal and any vehicle tries to cross the signal it will come under the RF zone of the reader at that moment RFID reader reads the tag along with the image processing data and directs it on the server using ESP8266 module. This module has integrated Wi-Fi works on TCP/IP which provide connection and take the signal from sensors. Further license plate data matched and verified with the database using both the technologies and if the identity is authenticated it sends an alert message to the owner using GSM technology else another penalty would be imposed according to the law of tempering. In this system, direct messages will be sent to the owner which creates a very quick and efficient where people will have an obligation to follow the traffic rules.

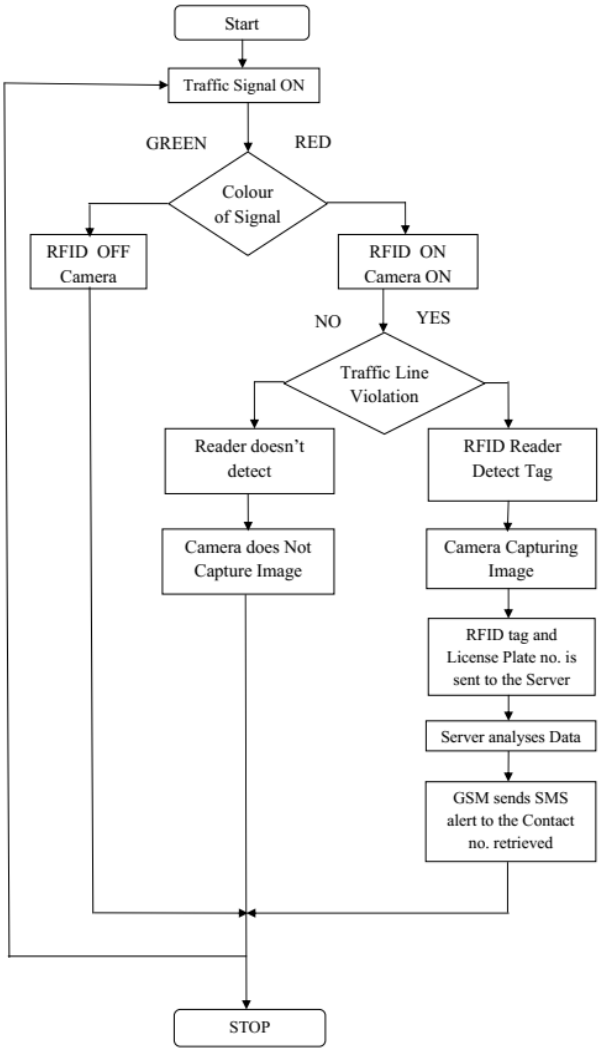

Fig.1 Flow Chart

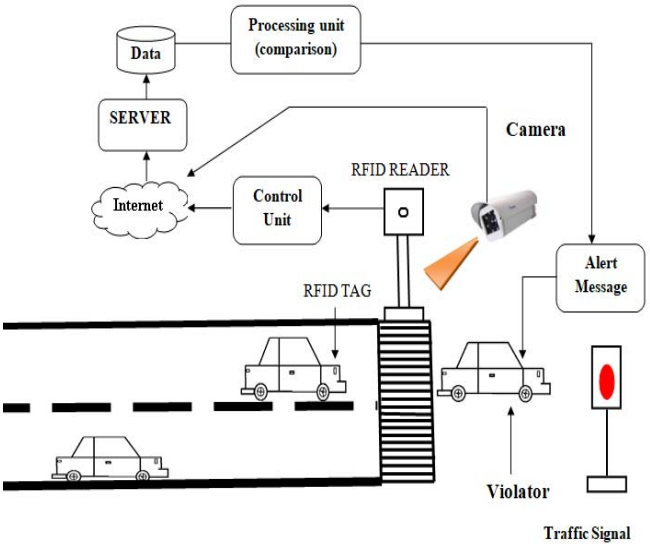

Fig.2. Traffic Violation Control System

III. EXPERIMENT AND SIMULATION

To validate our proposed system experimental analysis is performed. Here in the experimental setup, RFID-RC522 tag detector is used and mounted at the stop line on the road and an image of the car that violates the traffic rule is fetched by the PYTHON code for processing purpose. This RFID-RC522 tag detector will be used to detect the passive RFID which will be installed on the vehicles. The RFID tag detector generates an electromagnetic field through its antenna which is of 13.56 MHz frequency that triggers the passive RFID tag. After getting triggered the RFID tag transfers the data stored in it in the form of hexadecimal values to the detector. The RFID-RC522 has a 4-pin Serial Peripheral Interface (SPI) which is used for communication with a microcontroller. The microcontroller used is Node MCU the reason being it has 802.11b/g/n HT40 Wi-Fi transceiver to connect to the Wi-Fi. The voltage range of its operation is 3 Volts to 3.6 Volts and have used D1, D2, D5, D6, D7 pins of Node MCU to work as Serial Peripheral Interface. The GND and 3V3 pins are used for supplying to the RFID-RC522 other pins are connected as follows:

- D1 of Node MCU is connected to the RST of RFID-RC522.
- D2 of Node MCU is connected to the SDA of RFID-RC522.
- D5 of Node MCU is connected to SCK of RFID-RC522.
- D6 of Node MCU is connected to MISO of RFID-RC522.
- D7 of Node MCU is connected to the MOSI of RFID-RC522.

The programming of Node MCU is performed on Arduino IDE using SPI, MFRC522, ESP8266WiFi, ESP8266HTTP Client and Software Serial libraries. The Node MCU is connected to the MySQL database using Wi-Fi. The MySQL database and a web page named Penalty Portal are made by using PHP, CSS, and HTML. The MySQL database has the following information stored in it:

- The RFID tag number in decimal format.
- The name of the owner of the vehicle.
- The vehicle license plate number.
- The address on which the vehicle is registered.
- The contact number of the owner of the vehicle.
- The penalty amount to be charged on red signal violation as prescribed as per the law.

Further, for the Image Processing part, PYTHON3.7 is used which is efficient and reliable for license plate recognition. The used PYTHON code works on the K-Nearest Neighbour Algorithm for image processing as shown in Fig.3. The PYTHON code for image processing of a license number plate of a vehicle works Fig.4 as follows,

- The image of the vehicle is fetched from the location prescribed.
- The image is then converted into GREYSCALE.
- The THRESHOLDING is performed after the grey scaling of the image.
- Possible characters are searched on thus obtained image after thresh holding of image.

- Vectors of those possible characters are formed and then vectors of matching characters are formed using a red rectangle.
- Vectors of possible plates are searched where the plate with the largest matching characters is considered as the desired plate.
- From thus obtained license number plate the characters are recognized and stored in a string.
- Then, by using the RFID tag number, the vehicle number is fetched from the database by Node MCU and using the Serial library in PYTHON it is imported in the second string. After the matching of both the strings if they came out to be same then the Node MCU triggers the SIM800L GSM Module using the following pins:
- The RX pin of SIM800L is connected to D3 of Node MCU.
- The TX pin of SIM800L is connected to D4 of Node MCU.
- Using the AT commands used to configure a SIM800L GSM module a Penalty Alert Message is sent to the registered contact number as fetched from the database. This message contains information about the vehicle's as well as the owner with the penalty amount charged as per the law guidelines.

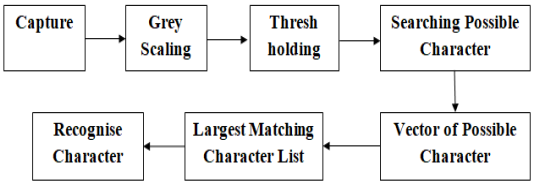

Fig.3 Block Diagram Of Image Processing Algorithm

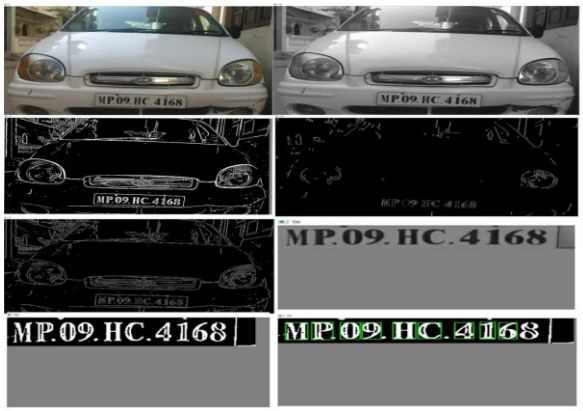

Fig.4 Processing of Vehicle Image

IV. RESULTS

The proposed system explained above was tested and simulated on different vehicles and different distances by using different RFID detectors. The whole system takes maximum 10 to 120 milliseconds to analyze the license plate and RFID tag synchronously and 1 to 3 seconds for sending message which alert to the person's registered mobile number with the details like license plate number, owner name, date and time of rule violation, the penalty amount charged also with the section details as per the law guidelines as shown in Fig.5. As shown in Table1 If un-matching of vehicle number plates is observed during processing then message alert for number plate tempering is sent to the owner in addition to the traffic rule violation. Simultaneously, Information of the person concerned is updated on the database named Penalty Portal successfully as shown in Fig.6.

TABLE.1 ACTION TAKEN BY THE SYSTEM

RFID TAG NO. DETECTED(in decimal)	LICENSE PLATE NUMBER AS PER DATABASE	LICENSE PLATE NUMBER OBTAINED BY IMAGE PROCESSING	MATCHED/ UNMATCHED	ACTION
169	MP09HC4168	MP09HC4168	MATCHED	SMS SENT
162	MP09UF4579	MP09UF4579	MATCHED	SMS SENT
175	MP09TT0806	MP43TC2201	UN-MATCHED	TEMPERING SMS SENT
145	MP09VH5706	MP09VH5706	MATCHED	SMS SENT

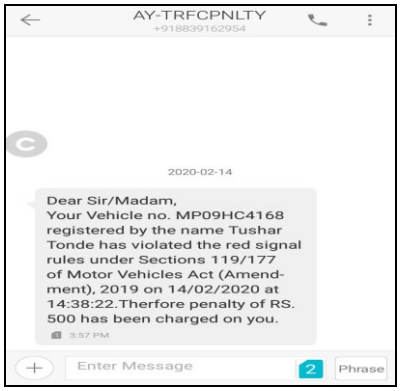

Fig.5 Penalty Message when both data matched

Penalty Portal

RFID	Owner Name	Vehicle Number	Address	Contact Number	Penalty
169	Shreya Asoba	MP 09 SK 5010	122 Krishna vihar	8839162954	500
162	Tushar Tonde	MP 09 HC 4168	27 Dravid nagar	8770561376	500
145	Sandeep Sharma	MP 13 KU 4586	63 Vijay nagar	9827542954	500
45	Shreya Supekar	MP 09 JT 7855	82 Vaishali nagar	8109568755	500
155	Rajesh Verma	MP 04 GH 7548	05 Aajad nagar	9770684557	500
204	Sanidhya Soni	MP 09 HG 5010	45 Gumasta nagar	8839457156	500
144	Yashasvi Sharma	MP 09 SH 7844	45 Shiv sagar colony	8770497852	500
162	Ishita Pandey	MP 09 JF 7846	48 B Sudama nagar	8106578425	500

Fig.6 Details Of Violators On Webpage

V. CONCLUSION

In this work, both RFID and image processing techniques are utilized for traffic control. After experimentation and simulation, it is concluded that the purposed method can be implemented in the existing system and provide reliable results. The purposed method shows clear scope to reduce the probability of error in traffic violation control. However, this work can be improved further by using more advanced image processing techniques and adding new features.

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