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Vehicle detection and automation of toll plaza using wireless systems

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ABSTRACT

When lot of vehicles converge at a single point this is called as traffic congestion, traffic congestion is a common problem as the number of vehicles are increasing day by day, congestion on highways are mainly due to toll payment, toll payment are done manually by exchanging money for a ticket, when huge number of vehicles stop for manual toll payment, this causes traffic congestions at toll plazas, which can be automated and hence solving the traffic congestions. The automation of toll plaza can be done in different methods such as ANPR (Automated Number Plate Recognition) using Image processing, RFID (Radio Frequency Identification) and LiFi, but in this paper, the use of wireless technology is explored for toll automation because of its versatility to weather and high speed, high efficient characteristics, further fine can imposed by analysing the information sent by the vehicle.

Keywords: *ETC, Road fine, Wireless Sensor Networks.*

I.INTRODUCTION

In a single day there are lakhs of vehicles passing through a single toll road, in which manual toll operation is a difficult task to perform and it is time consuming, by using electronic toll collection (ETC), we can collect toll charges without even needing to stop the vehicle at toll booths. This can be done using various methods such as Image processing [1], RFID [2], LiFi [3] and wireless systems. In this paper wireless systems are explored for ETC, the toll booth and vehicle are equipped with wireless units, once the vehicle enters the toll region it transmits various information, which is used for digital payment.

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II.METHODOLOGY

There are two units in this system, a unit called as toll unit as shown in Fig. 2.2 which is located at a toll booth it consists of a wireless module for communication connected to a microcontroller, this module is connected to the internet in order make entries on to the database. The second unit is vehicle unit which is placed in vehicle as shown in Fig. 2.1 this unit has a microcontroller which collects the sensor data constantly and transmits the collected data along with the vehicle details using a wireless module (ESP Module). Sensor data acquired are from Speedometer and Load cells.

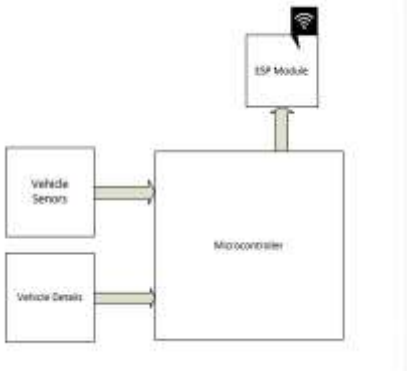

Figure 2.1: Vehicle

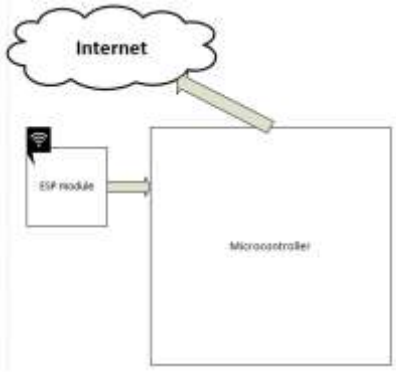

Figure 2.2: Toll Unit

There are four phases

2.1 Vehicle detection

In Vehicle detection phase the toll unit scans for the vehicle unit, when the vehicle unit is detected, the connection between vehicle unit and toll unit is established and the data from the vehicle is transferred to the toll unit, since wireless devices provide long range and high speed the connection can be established easily, depending on the wireless system used the toll unit can connect to large number of vehicle modules at a given instant of time.

1.2 Transmission of data from vehicle

Once the toll unit detects the vehicle unit by scanning, the wireless systems are paired, and the data packets from the vehicle unit is transferred to the toll unit, the data packets consists of the information as given below in the Table 1.

Information	**Used for**
Vehicle Type(HCV,LCV)	Toll payments as the price varies
Vehicle License plate number	Toll payments to compare with the database
Vehicle Load weight	Fine generation
Vehicle Speed	Fine generation

Table 1: Data Packet Contents

1.3 Comparing the obtained data with the toll database for Electronic Payment

Once the data from the vehicle module is obtained, the field called vehicle license plate number is extracted and this information is used to compare with the registered database which contains the registered vehicles details as shown in the Table 2.

Vehicles License Plate Numbers	**Payment Account Details (Account Number)**	**Available Balance in Rupees**
KA 01 C 1234	ABCD-1234-XXXX	1000.00
KA 40 T 8965	KILO-4568-XXXX	1235.00
AP 12 M 7895	ALPH-7895-XXXX	987.00
TN 04 J 6549	LINE-6549-XXXX	2531.00

Table 2: Database Contents

Once the registered account is found the respective toll amount is deducted from the available balance. However there exists a special case when the user does not have any available balance, in this case the toll amount is recorded as traffic violation.

1.4 Extracting the traffic violation information and reporting it to RTO

In this phase the information collected from the vehicle sensor i,e Load sensor and Speedometer are compared to the respective toll roads threshold value and the respective fine amounts are recorded, the same is notified and updated on traffic police database. An example of a vehicle traffic violation is shown in the Table 3.

Vehicle License Plate Number	**Violation Type**	**Details of the violation**
KA 01 C 1234	Over Speeding	Speed Value = 120kmph
KA 01 C 1234	Over Loading	Weight = 18,000 Kg
KA 01 C 1234	Toll crossed when balance is low	Balance = -120 Rupees

Table 3: Traffic violations contents

There are currently two violations over speeding and over loading, over speeding can be applied for both car and trucks, overloading is only required for the truck, by sending these recorded data to the traffic police authorities, they can take suitable action required.

Flow Diagram:

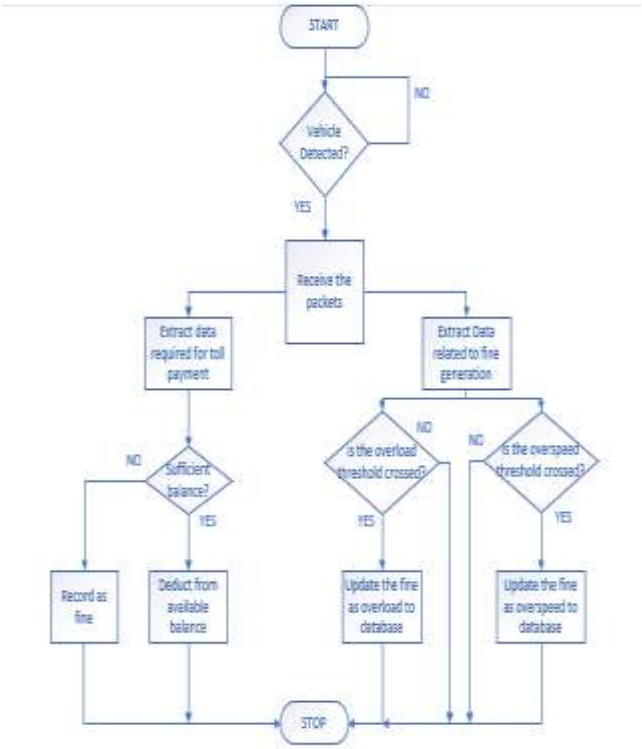

Figure 2.3: Toll unit flow

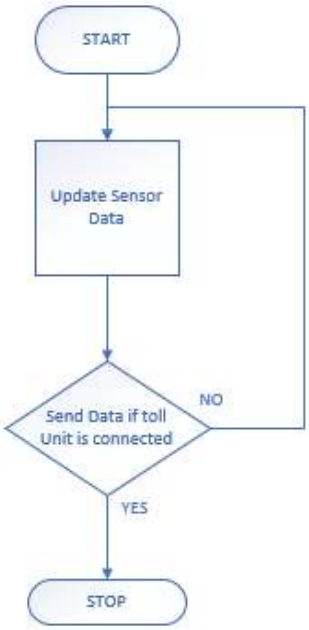

Figure 2.4: Vehicle unit flow diagram

III.RESULTS

Wireless communication can offer better efficiency when compared to other techniques of ETC. However, the speed and accuracy of the techniques depends upon the individual components and algorithms used.

CONSTRAINTS	MANUAL PAYMENTS	RFID	IMAGE PROCESSING	WIRELESS SYSTEMS
AVERAGE TIME TAKEN FOR PAYMENT	30 seconds	7 seconds	8 seconds	5 seconds
REQUIRED SPEED OF THE VEHICLE FOR DATA TRANFER	have to stop	<20kmph	<30kmph	<50kmph
DISTANCE	1metre	2 metres	10-15metres	250metres

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Table 4: Comparison of techniques

Further, we can provide android application for users, a sample screenshots are as shown in fig 3.1 and 3.2.

Fig 3.1: Screenshot of Police Database

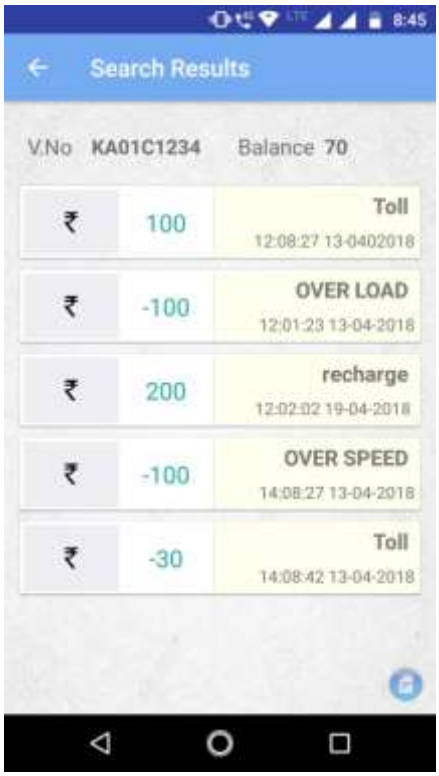

Fig 3.1: Screenshot of user Database

IV.CONCLUSION

There are other methods for Electronic toll collection (ETC), wireless communication has less disadvantages.

- For ANPR using Image processing technique, it requires the image to be enhanced properly, since image is a source for extraction the camera should be capable of capturing high resolution image and further the image should be processed accordingly, the reflection of number plates can also disrupt the ANPR.
- RFID technology is widely used for ETC, however this system does not work well in harsh weather conditions and the detection of speed and load cannot be analysed in this technology, same RFID can be card can be misused by making payments for different vehicles using a single RFID card.
- Wireless systems on the other hand is fast, efficient and can work even in harsh weather conditions, and further vehicle related huge data can be exchanged/collected, but however wireless systems are costly when compared to others.

V.FUTURE ENHANCEMENTS

The proposed system can also be used for commercial purposes such as automatic security gate by detecting and allowing only registered vehicles. Since the system uses wireless systems this can also help vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, thus it is potential technology which can further be used for other advancement in vehicle communications (Vanets).

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