International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 05 | May - 2021 ISSN: 2582-3930

A Smart Toll Challan System using Radio Frequency Identification

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Abstract - Toll Collection System is always an important entity for any of the country, a number of toll collection system like automated coin machine, RFID are already available in the market. While various countries are using different types of toll collection system according to their budget and convenience. Few of the designed and adopted system have their own drawbacks like time consumption, fuel consumption, vehicle emissions. In this paper, we have proposed and designed a reliable toll collection system. The main objective is to stop the vehicles from over-speeding, overloading and also from driving the expired vehicles. Our proposed solution is the best feasible solution to handle the stated problems. Average speed and Registration Certificate of the vehicle can be checked by the proposed system by scanning the RFID tag at toll plaza and a weighing sensor will be installed at toll plaza to calculate the weight of vehicles. The system will detect if the vehicle will break the rules and also helps in maintaining the discipline on roads.

Key Words: RFID tag, RFID reader, Load Cell, Green HX711, Registration Certificate of vehicle

1. INTRODUCTION

The world with a large population has a country like India, which is the 2nd largest country in terms of population with over 1.35 billion people [1]. In which 27 million people have their own car and 5.46 million from them are enabled with FASTag. It is very important to have an effective toll collection system because maintaining the data and performing all the tasks manually very difficult. Also, Manual collection creates error and consumes a lot of time and human effort. Along with this, there are so many problems such as increase in rate of road-accidents and in the rate of pollution in the environment. So, to overcome these problems it is important to have an authentic toll collection system. To have an authentic toll collection system many previous types of research focus on different automated toll collection techniques to save time and human efforts.

Many researches focused on different automated systems. The idea of that research was to use a different method/technique but they all lack in some way and were not able to control all the problems. Some of the methods are shown in Fig 1.

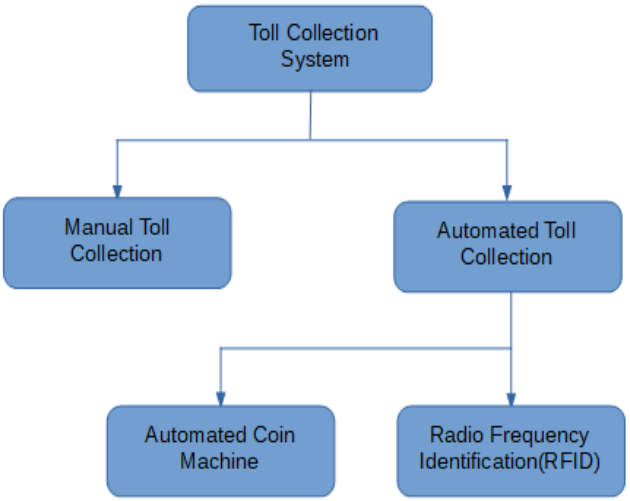

Fig - 1: Types of Toll Collection System

1.1 Manual Collection

It is a Conventional method of toll collection. In which a person is sitting at the toll booth and whenever vehicle enters, the user pays the toll charges by cash/card. The person sitting at toll booth collects the toll charges and allows the user to pass the toll plaza.

1.2 Automated Collection

This system is the combination of Hardware and Software which is designed in a way to work automatically and to decrease the human effort and increase authenticity in the toll collection system. Many of these systems use Radio

Frequency Identification and other technologies that have been discussed in subsections.

1.2.1 Automated Coin Machine

This system uses a coin sensing machine in which the user drops the coin/token i.e., generated by the operating company. To identify the dropping of the coin, the coin sensing machine uses the Infrared (IR) transmitter and Infrared (IR) receiver [2]. A continuous signal is generated between the IR transmitter and the IR receiver. Whenever a coin is dropped the signal is interrupted and this interruption results in the detection of the coin [3]. Just after the detection of coin, the operations are performed by the system.

1.2.2 Radio Frequency Identification(RFID)

RFID stands for Radio Frequency Identification and it is a technique that is used to store or retrieve data from the RFID tags. An RFID system mainly comprises of (i) RFID tags, (ii) RFID readers, (iii) middleware, (iv) database. RFID tags contain the uniquely identified IDs of each user. RFID tags are scanned by RFID readers and the data from the tag is read by the RFID reader. RFID reader with help of middleware transmits the data or ID to the server and the Middleware comprises of all those components which transmit the data from the RFID reader to the server [4]-[5]. The server compares the received data from the database and if the data is matched, the operations are performed by the system.

2. RELATED WORK

Toll collection is at such a high scale is a very big problem. In past few years, so many methods/techniques have been introduced to solve this problem. This system illustrates such toll collection system.

Initially, the manual toll collection system was used. This is the most widely used system for toll collection. On every toll plaza there are several toll booths, and every booth has a toll collector who collects the toll amount from each individual vehicle passing through the toll road and dispense the change. After the completion of this process, the vehicle is allowed to pass.

But this system is time consuming and requires much human efforts. So, to overcome such problems, an automated toll collections system was introduced. This system removes the method of collecting the toll manually. Automated toll collection system uses two different methods such as automated coin machine and Radio Frequency Identification (RFID).

In this system, a coin sensing machine is placed at the entrance of toll booth. There will be a coin opening to insert the coin and the coin sensors are placed at the opening. Whenever a vehicle enters, a message is displayed at the screen placed beside the machine. The driver drops the coin inside the machine, the signal between the Infrared (IR) transmitter and Infrared (IR) receiver is interrupted and this interruption results in the detection of coin [6]. As the coin is detected, the toll gate is opened and the vehicle is allowed to pass. But the problem with the system is that it is time consuming and the total number of reading per hour will be less as compared to the Radio Frequency Identification (RFID).

RFID (Radio Frequency Identification) was the new method introduced, which gives the solution to this problem as this method is fast as compared to the Automated coin machine. The RFID system includes 4 components RFID tags, RFID readers, middleware and database. In this system, a unique RFID tag is installed behind the rear-view mirror of the vehicle. Whenever, the vehicle enters the toll plaza and comes in the range of RFID reader, the reader scans the tag and collects the information from the tag [7]. The reader transmits the data to the database through the middleware and the data is compared with the data stored in the database [8]. If the data is matched, the balance from the owner's account is deducted and the user is allowed to pass the toll plaza.

In *today's* pandemic situation, for travelling people prefer their personal vehicle instead of public transport. Due to this, number of the vehicles on the road are *increasing* rapidly. Increase in the number of vehicles on the road, number of problems also arise like road accidents, air pollution, wastage of fuel. As the rate of road-accidents and the rate of pollution in our environment is increasing very rapidly. So, the proposed system will be controlling these problems with the help of Radio Frequency Identification (RFID).

3. PROPOSED SYSTEM

The proposed system helps in maintaining the discipline on the roads and maintaining safety measures. Number of vehicles on road has doubled since last 2 decades and hence the pollution is increasing day by day. A speed limit is set on every highway, but still people make fun of road safety rules and found offending the traffic laws, consequently getting vulnerable to large number of road accident.

This is obviously impossible for traffic police to personally stand on road and check the speed of each vehicle. Thereby to mitigate this issue government has proposed the installation of camera on highways to catch the law offenders. People do not obey the traffic rules and cross the allowed speed which results in increasing the number of accidents on the road.

Now considering all the problems, the proposed system is introduced to overcome all the problems. The system will mainly comprise of 3 features: (3.1) Calculating the average speed of vehicle, (3.2) Checking the Registration Certificate (RC) of vehicle, (3.3) Calculating the weight of vehicles

3.1 Calculating the average speed of vehicle

This feature will control the people from over-speeding. With the help of this feature, the rate of road-accidents will be controlled. The system will mainly compare the average speed of vehicle to the speed limit of that road and detects whether the vehicle has crossed the speed limit or not. In order to calculate the average speed, the system requires the

passing time of both the toll booths and the distance between them. So, the system will store the current time in the RFID tag whenever the vehicle will pass the first toll booth. When the vehicle will reach the second toll booth, the passing time of first toll booth will be fetched from RFID tag and subtracted from the current time to calculate the time difference. By this, the system will detect the average speed and compares it with the speed allowed.

3.1.1 Algorithm

Step 1:
If toll booth 1 for current date, the RFID tag is scanned and current date-time is stored in the RFID tag.

Step 2:
If toll booth 2 for current date, the date-time stored in the RFID tag will be fetched and subtracted from the current date-time, to calculate the time difference.

i.e. Time Difference = Current Time – Fetched Time
After this, current date-time is stored in the RFID tag.

Step 3:
If (Time Difference >= Average Time):
Vehicle is driven according to the speed limit of the road.
Else:
Vehicle is driven at high speed as compared to the speed limit of the road.
Here, Average Time is the time taken to travel from toll booth 1 to toll booth 2.

By this algorithm, the vehicles will be detected which has crossed the speed limit. Hence, the system can stop the vehicles from over-speeding and can control the rate of road-accidents.

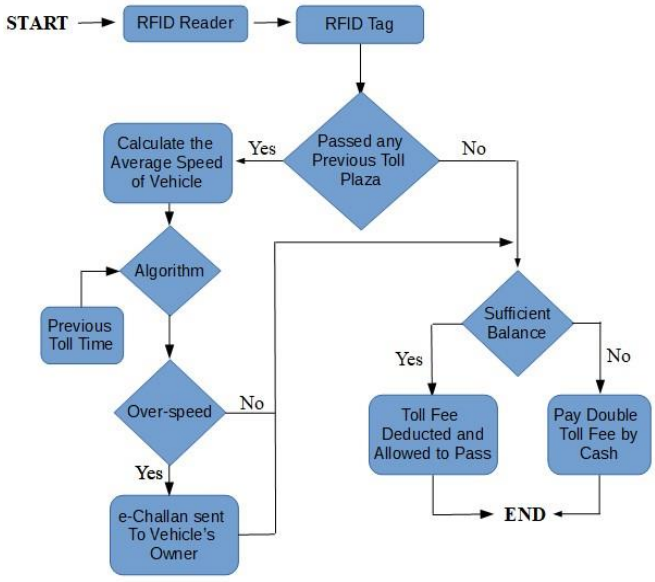

Fig - 2: Average Speed Flow Chart

3.2 Checking the Registration Certificate of vehicle

This feature will mainly control the rate of pollution in the environment. At the time of toll collection, the system will compare the expiry date of the vehicle to the current date. To compare the dates, the system will get the current date using datetime module of python and compares it with the expiry date of the vehicle. The expiry date will be fetched from the database linked to the RFID tag of that vehicle. If the vehicle expiry date is past the current date than the vehicle is expired.

3.2.1 Algorithm

Step 1:
At the time, the RFID tag is scanned. The expiry date of the vehicle is fetched from the database.

Step 2:
The vehicle expiry is compared to the current date.

Step 3:
If (Vehicle Expiry >= Current Date):
Registration Certificate of the vehicle is Valid.
Else:
Registration Certificate of the vehicle is Invalid.
By this, the validity of the vehicle of Registration Certificate of vehicle can be checked.

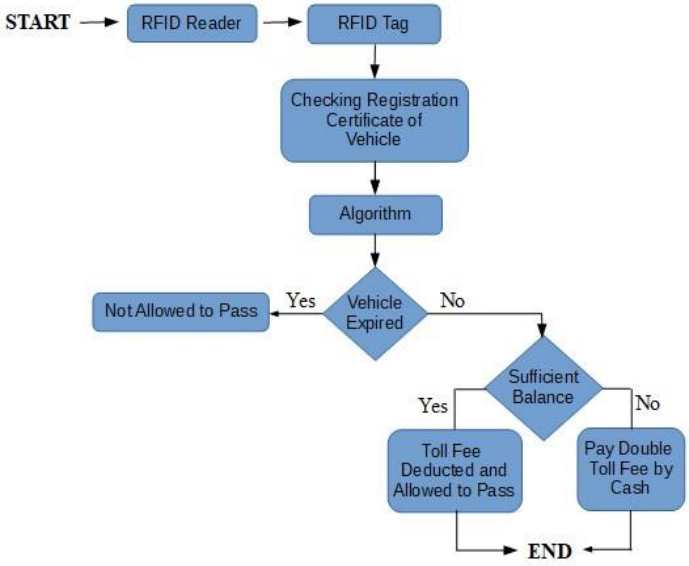

Fig - 3: Registration Certificate check Flow Chart

3.3 Calculating the weight of vehicles

This feature will control the people from overloading. With the help of this feature, the rate of road-accidents can be controlled. The system will mainly compare the current weight of vehicle to the weight allowed and checks whether the vehicle is overloaded or not. To calculate the weight, the system will use the load cell [9] along with green hx711 [10]. The load cell will calculate the weight of vehicle and transfers it to the hx711 in the form of analog signal. HX711 converts

the analog signal to digital signal and then the system will compare the current weight of vehicle to the weight allowed. If the current weight of the vehicle is more than the weight allowed, the vehicle is overloaded.

3.3.1 Algorithm

Step 1:
At the time, the vehicle reaches the toll plaza. The current weight of the vehicle is calculated.

Step 2:
The current weight of the vehicle is compared to the weight allowed.

Step 3:
If (Current Weight < Weight Allowed):
The vehicle is not overloaded.
Else:
The vehicle is overloaded.
By this algorithm, the weight of the vehicle can be checked. Hence, the system can stop the vehicles from overloading which results in controlling the rate of road-accidents.

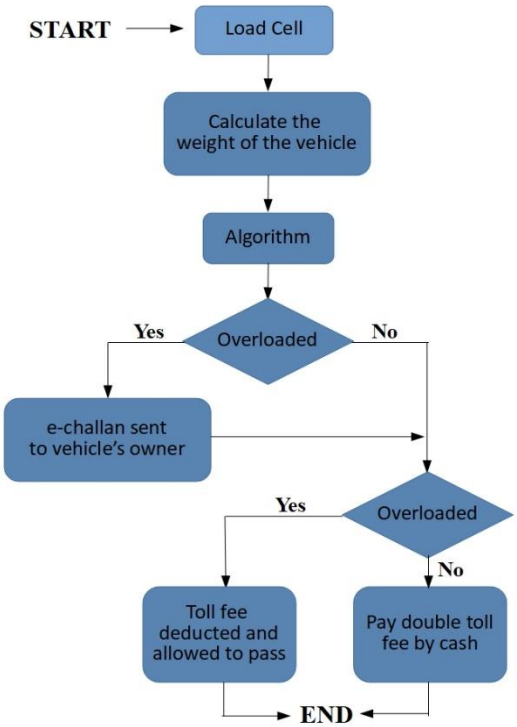

Fig - 4: Calculating the vehicle weight Flow Chart

4 RESULTS AND RESULT ANALYSIS

In this section, the proposed system was tested on different toll booths. Average speed of a vehicle is calculated considering that the toll tax for toll booth 1 and toll booth 2 is Rs. 80 and the over-speeding fine is Rs. 500. The speed limit between and the distance between both the tolls is 60km/h and 60 km respectively, so the average time must be at least 60 minutes to travel from one toll to another.

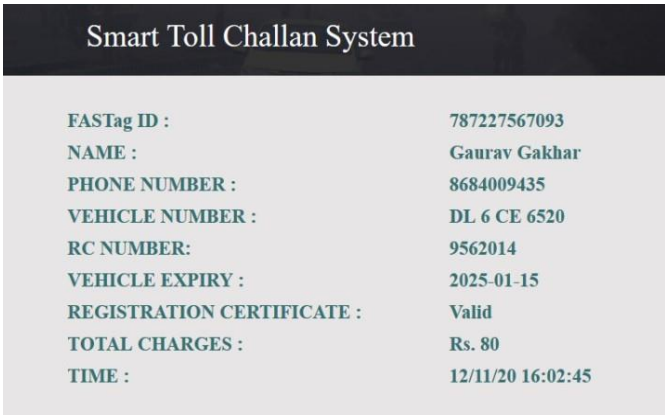

Fig - 5: Tag Details at Toll Booth 1

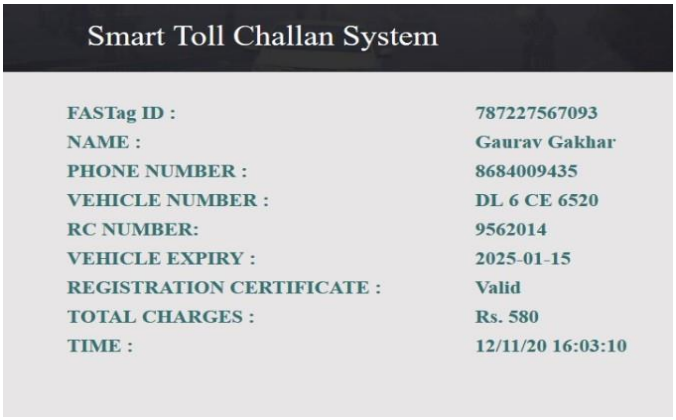

Fig - 6: Tag Details at Toll Booth 2

So, when the vehicle reached the toll booth 1, the toll tax deducted was Rs. 80(as shown in Fig 5). When the vehicle reaches the toll booth 2, the time taken by the vehicle was less than 60 minutes. By this the system concludes that the vehicle has crossed the speed limit, so the fine of Rs. 500 will be added to the toll amount and the total amount will be Rs. 580. Now, talking about the next feature i.e., Checking the Registration Certificate of vehicle. In this, the system has compared the expiry date of the vehicle to the current date. If the current date is past the expiry date, that means the Registration Certificate of vehicle is valid. Hence the system is showing "Valid" in the above Fig 6. If the expiry date is past the current date than the Registration Certificate of vehicle is "Invalid" or the vehicle is expired. This is shown in Fig. 7.

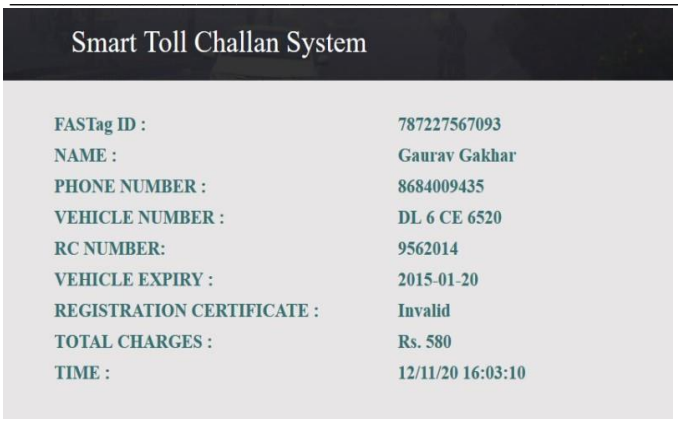

Fig - 7: Validity of Registration Certificate

After the testing of first 2 features, the testing of the third feature was done i.e., Calculating the weight of vehicle. In this system, the system has compared the current weight of the vehicle to the weight allowed for that vehicle. If the current weight of the vehicle is more than the weight allowed, the overloading fine will be charged from the person i.e., Rs. 1000. As you see in Fig. 8, the toll fee amount was just Rs. 60 and the weight allowed was 3 kg but the vehicle weight is more than the weight allowed. Hence, the amount of Rs. 1000 is added into the total amount and the toll fee deducted is Rs. 1060.

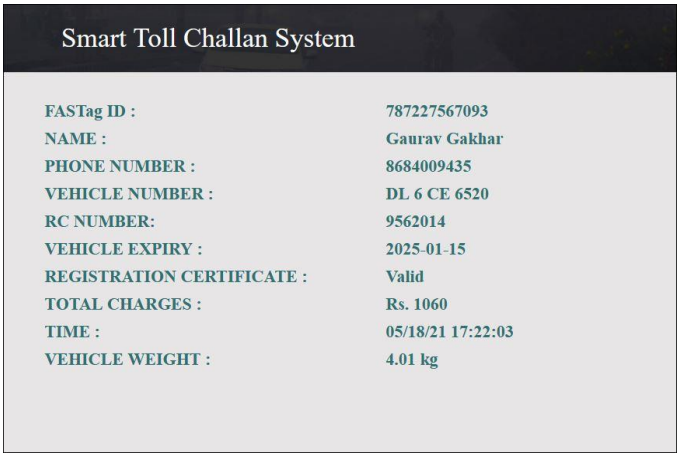

Fig - 8: Weight of the Vehicle

Considering this scenario, the proposed system was implemented and that comes out in a positive way and worked efficiently in real-time scenario. The time complexity of the algorithm is also efficient, so the system will work much faster as compared to the current toll collection systems. Hence, the system can be implemented at the different toll booths and can be used to stop people from over-speeding, overloading and can also control the rate of pollution in the environment by not allowing the expired vehicles to travel on roads.

5 CONCLUSION

A good and reliable toll collection system is very needful for a country like India with such a large number of vehicles. The system is very useful for traffic police and required authorizes. This is very helpful to run the rules and regulations smoothly by calculating the average speed of vehicles while crossing the toll plaza. The system also provides the solution for the pollution control by checking the RC. It also calculates the weight of the vehicles, to stop them from overloading. Authors merged the most commonly used RFID with some features and found a realist way of controlling the rate of road-accidents and pollution in the environment.

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