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SMART TOLL SYSTEM USING IOT

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ABSTRACT

In India the expansion of roads has become inevitable with the growth of vehicles. Transportation plays a key role in the economy of our country. Toll collection is an important factor that supports the transportation network. The major disadvantage of manual toll collection system is time consumption. It also causes fuel wastage and environmental pollution. Automated toll system is an efficient method which can be implemented in highly congested metropolitan cities. The proposed system will reduce the wastage of time in tolls, wastage of fuel, and reduce pollution. In this system the user's vehicle can pass through the toll booth without stopping. An active RFID tag is used which includes the user's vehicle number and the unique chassis number. The RFID reader reads the tag and then matched with the database. RFID range coverage can be increased. Cloud is used in handling database and server loads.

KEYWORDS: RFID, Internet of Things (IOT), NodeMcu.

1. INTRODUCTION

Advancement of an industry is concentrated with the growth of transport. Transportation helps to increase the trade of goods. It creates utility of place and time, increase the mobility of labor and capital. Public transport system and toll collection system are two critical factors of national transport networks. Both these modes correlate each other. Public transport can improve the operational statistics of the toll facilities and demand the broader public by mitigating the traffic congestion.

Development of any nation greatly relies upon its economy and infrastructure. The infrastructure of a country is related to the transport system. Transportation is a critical element and its advancement is dependent with the toll management.

Toll collection system is the method in which the commuter pays a certain amount of money to the transportation authority's when they go from one city to another. This amount is used for the development of the other factors that contribute to the proper functioning of the transport sector like highways, bridges and expressways. This upgrades the transportation industry of the nation.

There are several modes by which the toll collection can be practiced. Manual toll collection is the conventional method. More man power is required here. The toll barrier is lifted by man power. The details regarding the vehicle and the commuter are not recorded and thereby retrieval is harder. There are chances for collusion between the toll booth operator and the users. In manual or non-automated toll collection system the driver has to stop his vehicle and pay the required amount to the toll collector. Time consumption was a major drawback of this system.

Electronic toll collection system relies on the fact of cashless transaction. This is the most efficient mode of toll collection system. The problem of time consumption caused by the manual toll collection system is solved here. Here the commuter need not stop the vehicle to pay the toll. Emissions can be reduced to a large extend. This in turn minimizes the air pollution. The congestion around the toll plaza have been reduced thereby there is a decrement in the number of accident reports. The commuters can pay the toll mount from their bank account

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which motivates cashless transaction. A clear data regarding the details of the vehicle and the number of vehicles passing the toll booth can be obtained by the electronic toll collection system and thereby enhancing the data collection.

2. LITERATURE SURVEY

There are many methods available for toll collection. The existing system includes Toll collection using barcode, QR code, ORT system, Telepass system, EZ Tags and ERP systems.

A. Toll collection using barcode

In Barcode system the vehicle will be equipped with a barcode tag. This tag will be detected by a barcode reader attached at the toll booth. Once the detection is completed and the user is matched, then the corresponding toll amount will be deducted from the user's bank account [1].

B. Toll collection using qr code

A QR code is mounted at the front of the user's vehicle. A camera is used to capture the picture of the code. The image obtained will be further send to a code decoding process. If the information given is authentic and matches with the database, then the toll amount will be reduced from his account. Following the deduction, the barriers will be opened or else the barriers will be kept closed [2].

C. ORT system

The major advantage of Open road tolling (ORT) system is that it, it does not require the use of any toll booths. Vehicle identification or automatic number plate recognition is used here. The drivers need not wait a long time at the toll booth for paying the amount [3].

D. Telepass system

This system consists of an On-Board Unit (OBU) which is attached on top of the windscreen of vehicle. OBU is battery powered and they communicate with the toll booths using short range communication. When the user enters the toll lane the OBU is detected and it emits a beep sound followed by lifting of the toll barrier. When the user leaves the toll lane a second beep is produced along with that the photograph of the number plate is captured. The owner is then given a bill for the toll amount [4].

E. Toll collection by EZ tags

In this system the users sign up through EZ website through telephone. Following the registration, the driver will be equipped with a small, white radio frequency transponder which will be affixed behind the rear-view mirror. The vehicles when enter the toll lane, the sensors fixed at the toll booth will read the EZ Tag and the corresponding amount will be deducted [5].

F. ERP toll collection system

Electronic road pricing is a gantry system. This uses a system of sensors on two gantries. License plate number of the vehicle is captured by a camera attached to the gantries. The vehicles are equipped with an In-vehicle (IU) unit. A cash card is inserted which will used only for the payment of road charges. Once the vehicle passes under the ERP gantry, the toll amount will be deducted from the cash card and the corresponding amount will be displayed on an LCD screen [6].

The limitations of the existing systems are:

- Less storage capacity.
- The system is not fully automated.
- Payments are not fully ensured.
- High expense on ERP system.

The proposed system can overcome the limitations of the existing systems.

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3. PROPOSED SYSTEM

The proposed system will give an ease for passengers to pass the toll without waiting for hours as in today's scenario. The proposed system uses the RFID to make our life easy and automated thus saving the efforts of carrying money and records manually.

The proposed system includes a unique RFID tag which is affixed into user's vehicle's front glass. All the transactions are done by using RFID. The detailed working is explained below.

A. Block diagram

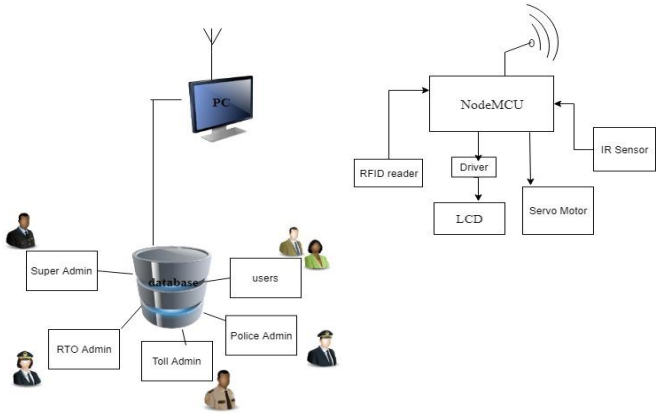

Fig.1 Block Diagram

This figure gives the general design interpretation of the system and how the components are linked and the different modules in it. Modules in the system can access the data from the database. Our system contains different hardware module as follow:

- NodeMCU
- RFID reader and Tags
- IR Obstacle Sensor
- Servo motor

Different Software Modules as follow:

- Super Admin
- RTO Admin
- Toll Admin
- Police Admin
- User

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B. Flow diagram

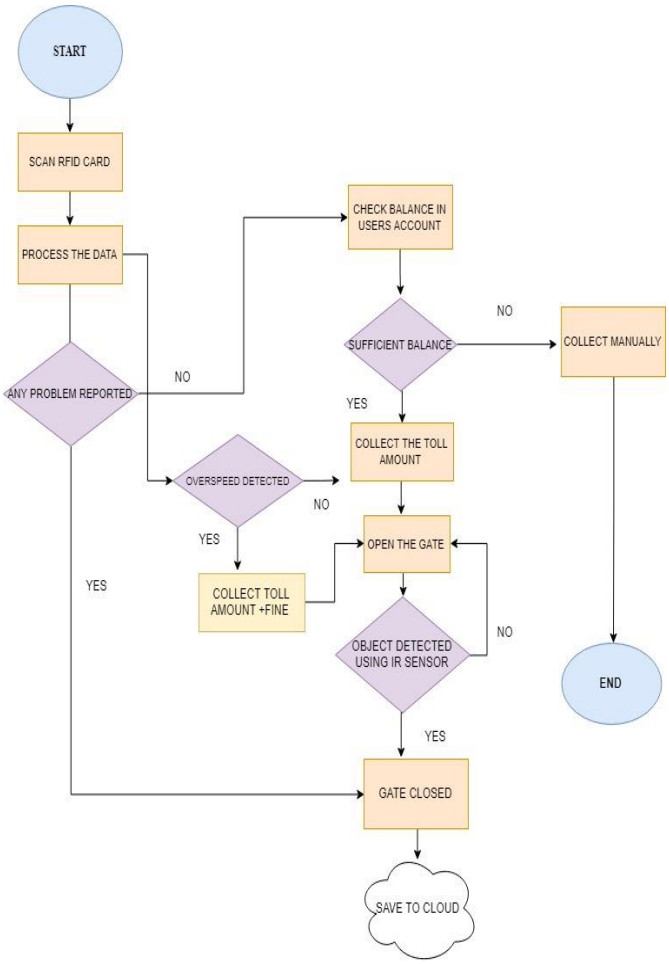

Fig 2. Flow Diagram

The diagram describes the flow of process in the proposed system. When a vehicle arrives at the toll booth, the RFID reader located at toll booth will scan the RFID tag affixed onto user's vehicle. Next, it will check the database for the same. If a match found, it will check whether any problem such as theft is detected. If yes, the gate remains closed and if not, it will go to check the available balance in user's E wallet. Now the appropriate toll amount is deducted if adequate balance is present in E wallet or else the amount is collected manually. After successful transaction, the gate will be opened. After when the car goes outside the barrier the IR sensor will sense the presence of vehicle and the barrier is closed. The data will be saved in cloud for future use.

While checking whether any theft is detected, it will also check whether overspeed is detected or not. If overspeed is detected, the fine amount along with the toll amount is collected. If overspeed is not detected then the appropriate toll amount will be deducted from E wallet.

C . Working

The owner of the car must create an account with the unique chassis number of the car. After the procedure at RTO office, RTO admin will issue a unique RFID card through which transactions can occur. This RFID card is supposed to be attached to the front glass of the car. Next, the super admin will set up a toll booth for a highway and allocate a user name and password for the toll admin and the toll for all kind of vehicle.

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At toll booth, the toll admin will log in. He has the admission to the transaction history but cannot edit the details. When a vehicle arrives at the toll booth, the RFID tag is red by RFID reader and it automatically detects the vehicle and the amount is deducted from the E wallet. If there is no sufficient balance in his account then the money is collected manually. After the successful transaction, the barrier is lifted using the motor. When IR sensor detects the presence of the car, the barrier is closed. The emergency vehicles like ambulance and government vehicles are registered as VIP vehicle and given a separate line so it can go without disruption. If any user registers his vehicle as stolen, then when the vehicle arrives at toll booth it is detected and the barrier remains closed. The super admin only has the access to the history so the corruption or alterations can be avoided. The data is stored in cloud and is used for calculation yearly tax.

4. HARDWARE AND SOFTWARE REQUIREMENTS

A. NODEMCU

NodeMCU is an open source IOT platform refers to LUA based firmware which runs on ESP8266 Wi-Fi chip. Open source platform means its hardware is open for edit, build or modify. ESP8266 is a low-cost Wi-Fi chip. The features of NodeMCU are its Wi-Fi capability, analog pin, digital pin and serial communication protocols. We can connect it with serial devices like i2c enabled LCD display by using this serial protocol.

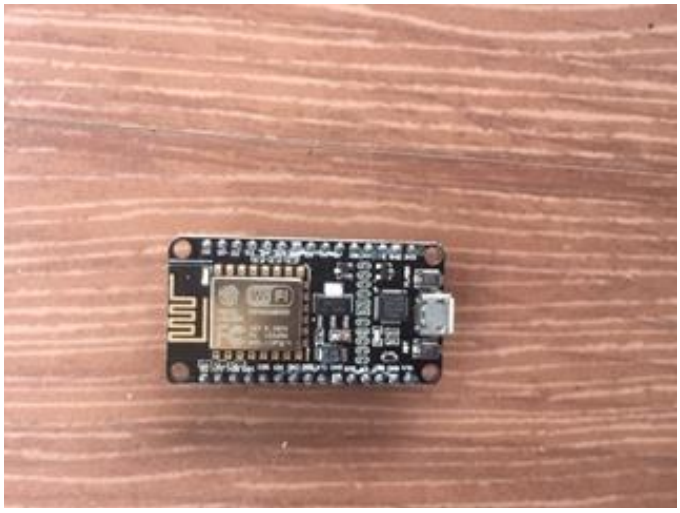

Fig 3. NodeMCU

B. RFID reader and tags

RFID means radio frequency identification. It uses electromagnetic fields to identify the tag attached to objects. Information is electronically stored in this tag. Reader sends a signal to the tag and read its response. Tags have a factory assigned number which is used as a key into the database. Each tag has individual serial numbers so the RFID can differentiate among different tags that will be within the range of the RFID reader. There are 2 types of tags: active and passive tags. The reader emits the radio waves and it reaches the chip antenna then the energy is converted into electricity that can power up the microchip in the tag. Then the tag can send back information that stored in the tag by reflecting EM waves.

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Fig 4. RFID Reader and tag

C. LCD

In 16x2 LCD it can display 16 characters per line and there are 2 lines. It contains 2 registers called command and data. The command register stores the command instructions and data register stores the data to be displayed on the LCD. ASCII values are displayed on the LCD.

Fig 5. LCD

D. Servo motor

A servo motor can rotate in 90 degree or in 180-degree rotation. The servo motor is controlled when an electric pulse of PWM is send through a control wire. The position of the shaft is determined by the PWM sent to the motor. Based on the duration of the pulse it will turn to the desired position. The servo motor used here is for the opening and closing of the barrier when a vehicle is arrived at the toll booth.

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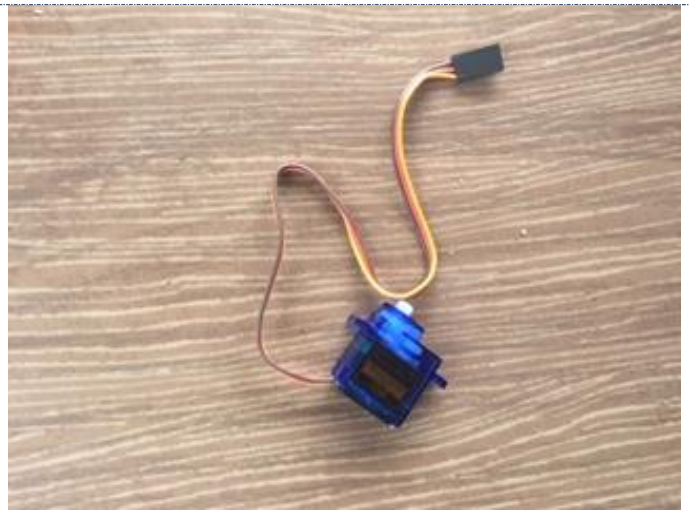

Fig 6. Servo motor

E. Super admin

It is controlled by the government authority. When our system is implemented it will check the collection done at the different tolls. It is mainly used to track the record details of the different toll.

F. RTO admin

It is used to register new vehicle and assign new RFID tag to newly registered vehicle. This is done at the RTO office. The user information like vehicle type, number, chassis number, address and mobile number of the owner are taken here then the username and password are given to the owner.

G. Toll admin

This admin is present at the toll booth .it is used to check the collection details.

H. Police admin

If a vehicle is stolen then the owner can register that vehicle as stolen at the police admin. It is controlled by the police authority.

5. RESULT

Figure below shows the hardware connections

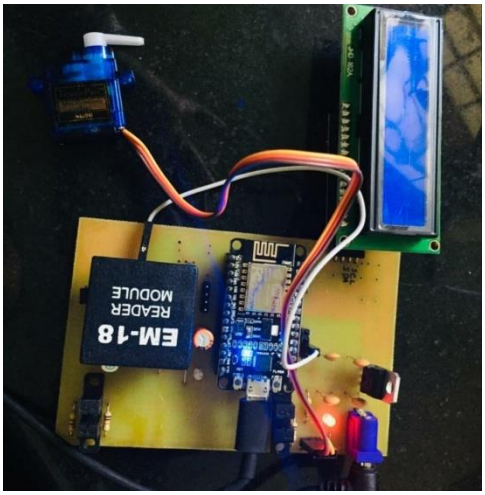

Fig.7 Hardware

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when we run the program the LCD will display the following .The figure below shows the case of a normal vehicle.

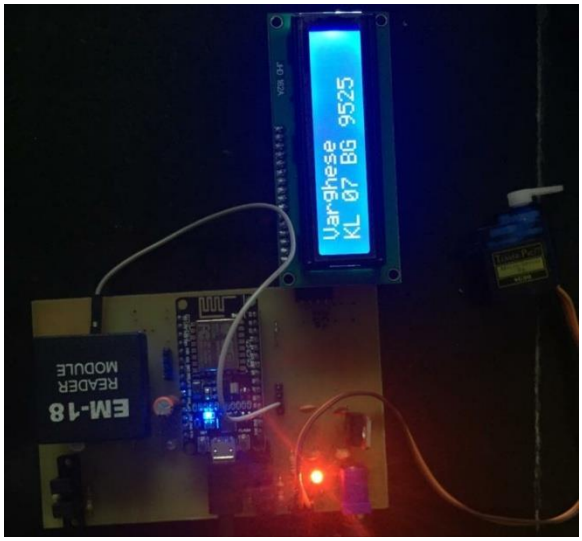

Fig 8. Normal case

If the vehicle is stolen the following message will be displayed

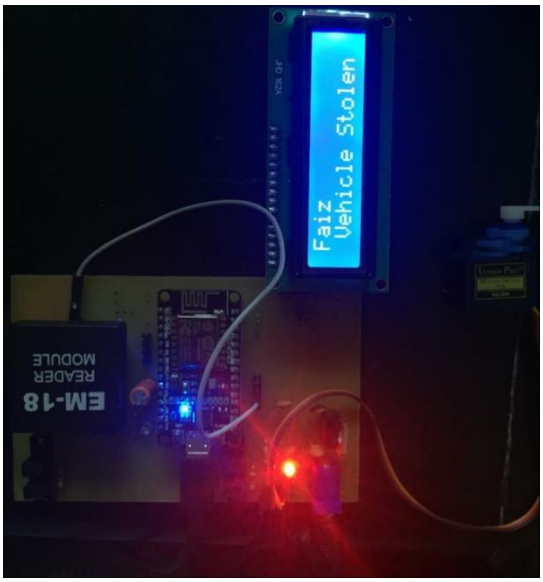

Fig 9. Stolen vehicle

6. CONCLUSION

The objective of this paper is to automate toll collection system which in turn can reduce the time wastage, fuel wastage, environmental pollution and also reduce hardship caused by the manual toll collection system .The vehicles need not stop in the toll booth and stand in long queues and the transactions are made cashless using E-wallet .The system is reliable and the data is stored in the cloud, so we can access them in future.

The government authority can get an approximate amount of road taxation and corruption can be reduced. We successfully implemented theft detection system in the toll booth. We also implemented fine collection for over speed vehicles and those which violates traffic rules. Our system is:

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- Automated
- Promote Cashless transaction
- Clean environment and conserve fuel
- More reliable data collection
- Theft detection
- Fine payment for traffic violations

7. FUTURE SCOPE

As a future extension we can keep the RFID reader modules at the traffic signals so that when traffic violations or over speed is detected corresponding fine will be deducted from the user's account immediately.

A detector can be kept at the toll booth which detects weapons and bombs. The barrier will be closed and such vehicles will be stopped in the toll booth.

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