

Smart Highway Toll Collection System

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Abstract: Smart highway toll collection system is used to minimize the time by collecting the toll amount electronically. In RFID based toll collection systems we face many problems. In order to overcome that this proposed system is developed with an automated license plate recognition system. In this system, a webcam is interfaced with a raspberry pi that captures the image of a vehicle that passes through the tollgate. The captured image will be processed by image processing techniques and it will be sent to the R.T.O database server to identify the users and the type of their vehicle. This retrieved information will be sent to the system through GSM module and the respected amount will be deducted from users account and it will be notified to the mobile number which has been registered before. If the respected amount is deducted correctly the barrier will open and the vehicle is allowed to leave the tollbooth. If not the barrier will remain closed.

Index Terms: RFID, R.T.O, GSM, Tollgate, Raspberry pi.

I. INTRODUCTION

Now a days due to the drastic increase in automobiles there occurs large congestion in tollbooth. In previous years the manual toll collection method is widely in practice all over India. In this system, it requires more human labor and it also requires an attendant to sit there all overtime. The collector has to determine the amount to be paid by the user depending upon the type of the vehicle and its characteristics

In order to overcome the difficulties faced in the manual toll collection system, Electronic Toll Collection (ETC) came into existence.

The main aim of this system is to allow vehicles to pass through the toll gate with minimum delay. The Radio-frequency identification (RFID) is one among the ETC system. It uses electromagnetic fields to identify and to track the tags which are attached to the objects automatically. This system uses Radio Frequency Identification Technology (RFID) for making toll amounts directly from the respected account. In this system, the tag is mounted on the front screen of the vehicle that passes through the toll booth which produces minimum delay. The tag consists of two components, reader and tag.

The RFID tag consists of an integrated chip attached to an antenna, which contained the information stored electronically. The RFID reader is a component which is used to collect the information from an RFID tag. The data from the tag to the reader are transmitted by the radio waves. RFID Toll Collection System is shown in Fig. 1.



Fig. 1 RFID Based Toll Collection System.

Three types of toll roads exist: open (with mainline barrier toll plazas), closed (with entry or exit tolls) and open road (presence of electronic toll collection gantries). Nowadays the toll roads use the aggregation of all the three above. In order to overcome the difficulties faced in the manual toll collection system automatic toll collection system came into existence. In this proposed system, the toll amount will be deducted electronically instead of manually. The congestion of vehicles in the toll gate can be reduced by this system. In this automatic toll collection system, the license plate will be captured by the webcam and it is processed by image processing technique, the collected information will be sent to the RTO database server to identify the user and the type of their vehicle. This information will be again sent to the system through the GSM module and the respected amount will be deducted from the user's account. Once the amount has been deducted successfully, the barrier will open otherwise it remains closed. Manual Toll Collection System is shown in Fig. 2.

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Fig. 2 Manual Toll Collection System

II. EXPERIMENTAL SETUP

The proposed system's main processor is the raspberry pi board. The vehicle's license plate is captured by the webcam and processed using an image processing technique which is then programmed with the raspberry pi board. The 16 * 2 LCD is used for displaying the validation message. To make the validation process easy a buzzer is also interfaced with the raspberry pi board. Infrared (IR) sensor is used to sense aspects of the surroundings by emitting rays. GSM module is used to retrieve the database of the respective vehicle from RTO server and also it is used to send the notification message to the users about the amount that has been deducted from the account. The stepper motor is used to indicate the status of the barrier whether it is opened or not according to the specific cases.

III. PROPOSED METHOD

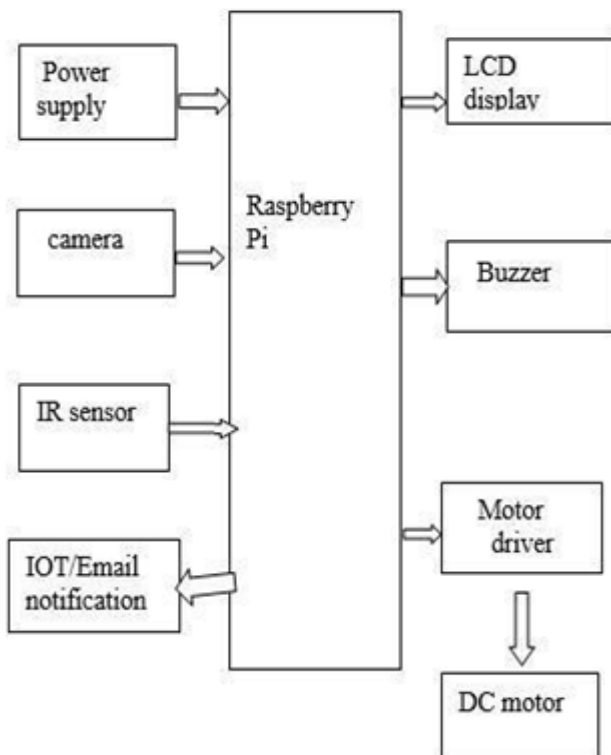


Fig. 3 Proposed Block Diagram

IV. HARDWARE DESCRIPTION

RASPBERRY PI:

Raspberry Pi which is of the same size as the credit card is also called as a mini computer that does many tasks like word processing, spreadsheets etc. It is portable and cost-effective. It is widely used in mobile phones. It has been evolved from various versions that differ in capacity of memory and peripherals device support. Raspberry Pi 3 is the first version which supports arm 64 architecture since it contains 1.2 GHz ARM Cortex-A53 CPU. In our proposed system the raspberry pi board process the entire architecture.

Buzzer

The buzzer has piezo crystals, in the middle of two conductors. When a voltage is applied to the crystals, they pull one conductor and push the another, hence produces a sound wave in the range of 2 to 4 kHz. There are two types of buzzers which are active and passive buzzers. While electrifying an active buzzer the sound will be produced because it has a default oscillating source, but passive buzzers do not produce sound because it doesn't have any source. Because of more oscillating sources, the active buzzer is more expensive than passive buzzers. It can be used in alarm devices, timers, and to confirm the user's input such as mouse click etc. In this proposed system the buzzer is used to intimate the owner of the vehicle to passes.

Specifications of Buzzer:

- Operating voltage: 4 to 7
- Sound output: minimum 85db
- Current consumption: maximum 25M

Dc Motor

DC motor is used to convert electrical power into mechanical power. By using the variable supply voltage or by changing the current, the speed of the DC motor is controlled. Larger DC motors are used in electric vehicles, electronic devices, and steel rolling mills. Dc motors can be powered by existing direct current lightning power system which is widely used. Small Dc motors are used in tools, toys and, other small applications. Larger Dc motors are used in elevators and propulsion of electronic vehicles. The replacement of DC motors with AC motors can also be possible. DC motor is used to pave the way for the vehicle's owner according to the payment details. DC motors are classified into following the types

- Shunt Motor
- Series Motor
- Compound Motor

Motor Driver

1298n h-bridge DC motor is used in this proposed system. This can easily control the speed and direction of two dc motors or one bipolar stepper motor. The motors having a voltage of between 5 to 35V dc can use the L298N H-bridge module.



Fig. 4 Motor Driver

Webcam

A webcam is an input device that can be connected to a computer or any other processor which can be used to capture images or any object's motion videos. The webcam doesn't have any built-in storage as that of digital camera and digital camcorder, as an alternative, it has been always connected to a computer and uses its hard drive for the purpose of storage. In our proposed system the webcam is programmed with raspberryPi to capture the license plate of a vehicle that passes through the tollgate.

LCD Display

The power consumption is very much lower when comparing to the LED and LCD screen because it is working on the principle of blocking light better than dissipating. The definition of LCD is derived from the word "Liquid crystal". Liquid crystals use backlight or reflectors to produce the images by not emitting the light directly. It is the grouping of two states of matter – the solid and the liquid. The common devices like computer monitors, DVD, laptops, digital watches are made up of LCD. In this proposed system the LCD has been used for displaying the validation message in the toll booth.

IR Sensor

An IR sensor is an electronic device that sends infrared rays to sense the objects around it. It consists of an IR transmitter and IR receivers. IR transmitter sends the IR energy and detects the presence of any obstacles by their reflected energy transmitted by the receiver. In our proposed system it is used for detecting the presence of a vehicle.

V. RESULTS

The results are shown in the following Figures:



Fig. 5 validated image



Fig. 6 vehicle number is detected



Fig. 7 HSC Colour image of license plate



Fig. 8 Segmentation image

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Python 2.7.9 Shell
File Edit Shell Debug Options Windows Help
Python 2.7.9 (default, Sep 26 2018, 05:58:52)
[GCC 4.9.2] on linux2
Type "copyright", "credits" or "license()" for more information.
>>>
----- RESTART -----
>>>
PROCESS COMPLETED
VEHICLE DETAILS
NUMBER = MH 12 DE 1433
VEHICLE TYPE = HONDA CITY
TOLLGATE AMOUNT = 50
AVAILABLE AMOUNT = 150
>>>
```

VI. CONCLUSION

License plate recognition is the most prescribed system than RFID because it works on the basis of a faster algorithm. The Webcam is used to capture the license plate image and the text version of these images will be obtained from image processing algorithms. The redeemed details will be sent to the RTO database server to get the information about the vehicle details. According to the type of vehicle's identity, the respective amount will be debited from the owner's account. The barrier is open and the vehicle is allowed to leave only after the payment process.



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