An Intelligent Highway Toll Collection System by License Plate Recognition

[1]G.Sathya, [2]M.Pavithra, [3]S.Swetha, [4]R.Rohini
[1]*Assistant Professor*
Department of ECE
SNS College of Engineering
Coimbatore

Abstract

A highway toll collection system is implemented in almost every highway. This is an important component of the modern Intelligent Transportation System. The regular way of toll collection is by paying manually. This intelligent toll collection system is a technology in which the image of the license plate is captured and processed. When the vehicle crosses the toll booth, it is sensed by the pressure sensor placed on the hump. When it is detected, the camera will capture the image of the license plate. The vehicle owners account details is linked to the RTO database. Thus by processing the image captured the vehicle owner's account is detected and the toll will be collected automatically. Whenever a vehicle approaches the toll booth, the camera will start to capture the images and stores them. The camera should be able to capture good quality images irrespective of the external factors. It should be able to know the number plates from different countries as well. Thus database should contain the information of every vehicle owners.

Keywords

Intelligent Highway toll collection, RTO Database, openCV, Image processing, ITS)

I. INTRODUCTION

The intelligent highway toll collection system is an intelligent way of traffic controlling system. It can be used for various traffic control applications such as automatic toll collection, traffic management, parking fee collection, and surveillance. This technology includes image processing which has four processes such as license plate extraction, character segmentation and character recognition. Here the image of the vehicle's number plate is captured and processed to obtain the detail of the vehicle owner. A good quality image is to be obtained for better recognition as various environmental factors may pose as a problem while processing. This has four steps for the automation of toll collection such as pressure sensing to know if a vehicle is approaching, capturing the image of the license plate, segmentation and recognition of the image and collecting the toll from the account.

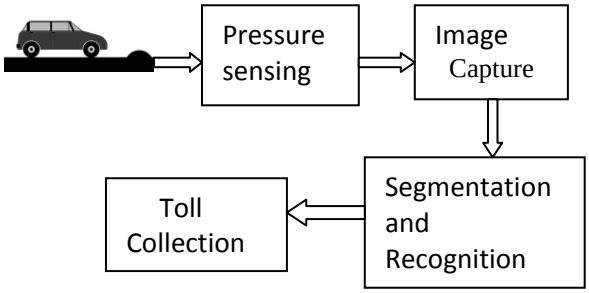


Fig 1. steps in toll collection

II. LIMITAIONS IN THE EXISTING PROCESS

In the existing system video monitoring is only possible in the particular area through camera. Here we can't extract the information. Only Optical character recognition is possible. But this method is not 100% accurate. It will not capture the picture of the number plate at every situation. So we go for this technique which is highly accurate. Another existing process is the use of the RFID in the vehicles. But to implement the RFID in every car is not possible and it is a costly one. The following are some of the main limitations in the existing process.

A. Environmental factors

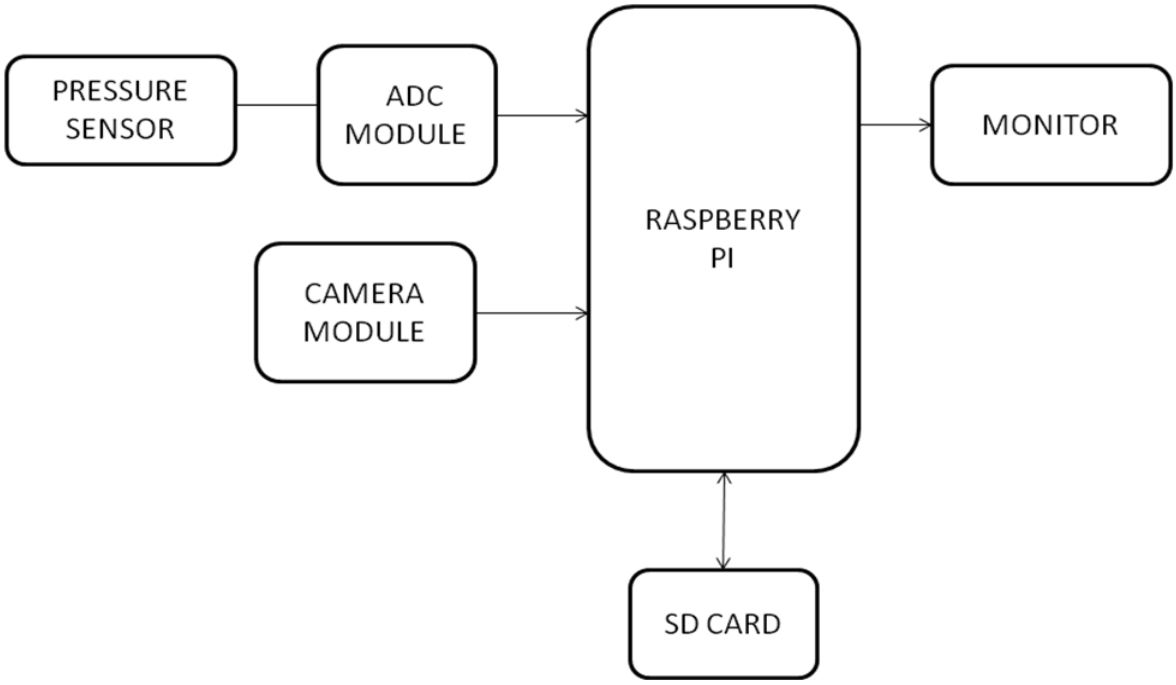
Various factors are affecting the quality and depth of the image obtained. Environmental factors like rain, snow may affect the image quality. Vehicle lighting is also a threat in obtaining the good quality image.

B. Different number plates

Our country has number of states and each state has different models of number plates. Thus the toll collecting system should be able to recognize the number plates from different places. Also the number plates vary in sizes. The plates from other nations vary in font as well as color.

III. SYSEM ARCHITECTURE

In this block diagram the entire system is controlled by Arm11 processor and this processor is implemented on Raspberry Pi Board. Then this board is connected with monitor, camera, SD card and IP connected through LAN. Raspberry pi is the key element in processing module which keeps on monitoring the vehicles by interfacing camera with it. The extracted information can be used for further verification. The block diagram is shown below



The block working is explained as follows. Every toll booth has a speed breaker in the entrance. A pressure sensor is placed on it. When a vehicle moves over the speed breaker an electrical signal is generated. This notifies that the vehicle is entering the toll booth. As soon as the vehicle passes the camera starts to take the picture of the number plate. Immediately the picture taken is processed and the vehicle number is recognized. After the number recognition, the owners account is traced and the toll is collected from the account.

These are the hardware used in the block

- raspberry pi
- camera
- pressure sensor
- ADC module
- SD card

The software used is

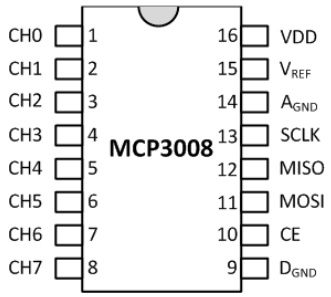
- OpenCV
- Raspbian jessie

A. Presssure sensor

The pressure sensor is used to know if the vehicle is approaching the toll booth. The pressure sensor responds to the force applied on it. The force applied will deflect the pressure transducer and the electrical output is generated. The output of the pressure sensor will be in the analog form. But the raspberry pi has to take digital output. So an ADC is used for the digital conversion of the output. The pressure sensor is placed at the speed breaker in the toll booth. When a vehicle approaches, the pressure exerted by the vehicle on it will produce an electrical signal. This is used to operate the system only when the vehicle enters the toll booth and is not activated when Someone steps on it. The toll is not collected for the two wheelers. Thus the threshold value of the pressure is kept in such a way that the toll is collected from other vehicles

B. ADC Module

The MPC3008 is the 16 pin analog to digital converter used here. It is a low cost 8-channel 10- bit analog-to-digital converter which reads the analog input from the pressure sensor. This ADC has 8 channels. Any of these channels is used to get the input. The raspberry pi is a digital-only computer. Thus we need to give digital inputs. But the output from the pressure sensor is in the analog format and it needs to be converted. The raspberry pi does not have an internal analog-to-digital converter. Hence we use an external analog-to-digital converter. This acts as a bridge between the analog and the digital values. The pressure obtained may be in any number of bits. So we use a 10 bit ADC.



PIN DIAGRAM

The MPC3008 is connected to the raspberry pi using a SPI connection which is the Serial peripheral interface. It can be connected either through software SPI or hardware SPI. The VDD of MPC3008 to the raspberry pi is 3.3V in both the SPI connections. The hardware SPI is faster but less flexible. So we can use the software SPI. When the analog input is given to the ADC it will be connected to either of the channels. Then the electrical input is converted to digital format of 0s and 1s which will be given to the raspberry pi for further operations.

C. *Camera module*

The camera is an important part of the system. The toll can be collected from the respective owners only by taking the picture of the license plate. The image of the number plate is captured and processed. The processing includes the three steps as image extraction, character segmentation and character recognition. The image is captured with certain dimensions to cover the number plate alone for greater quality. The camera should be operable at every environmental condition. A good quality camera operable at every situation is used here. The images captured will be saved and then linked to the database to extract the owner's detail and to collect the toll.

D. *Raspberry pi*

The Raspberry Pi is a credit card sized single computer or SoC which uses ARM1176JZF-S core. SoC, or System on a Chip, is a method of placing all necessary electronics for running a computer on a single chip. Raspberry Pi needs an Operating system to start up. In the aim of cost reduction, the Raspberry Pi omits any on-board non-volatile memory used to store the boot loaders, Linux Kernels and file systems as seen in more traditional embedded systems. The raspberry pi 3 has a wifi, Bluetooth and a quad core 64-bit ARM cortex. A SD/MMC card slot is provided for storing. After boot load, as per the application program Raspberry Pi will get execute. All the modules are connected to the Raspberry pi. The Raspbian Jessie is the language for the raspberry pi which uses python.

The raspberry pi is the main component of the system. It is a mini-CPU which performs the entire task. The pressure is converted to the digital format by the ADC and given to the raspberry pi. The raspberry pi will do the other operations. It will compare the obtained pressure with the threshold value. When the pressure exerts the threshold value it will turn on the camera. The camera will capture the image and is saved. Then further processes like character segmentation and recognition is done.

E. *Software requirement*

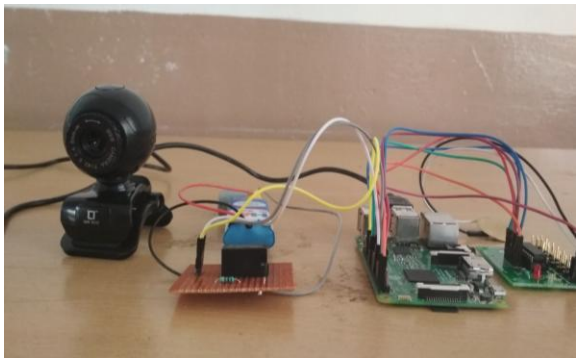
The operating system of the raspberry pi is the raspbian jessie which is preloaded with python. The python language is used for the programming for the ARM1176JZF. Python is a simple programming language and raspbian jessie is the primary operating system of raspberry pi 3.

OpenCV is the Open Source Computer Vision written on C++. It supports many languages like python, java, C++ Etc; OpenCV python is faster and easy to code. The program is coded in the OpenCV software. The raspbian Jessie is the operating system based on the Linux. The OpenCV python version will be installed in the raspbian Jessie. With the help of this the python programs are implemented. The program for each and every operation is written and then implemented.

IV. BLOCK EXPLANATION

The intelligent highway toll collection system is a way of collecting the toll automatically which reduces the time and labor. The hardware recognizes the vehicle while the software helps to collect the toll from them. The pressure sensor senses the pressure exerted by vehicle and sends the signal to the ADC. The ADC will convert the analog signal to digital format and will give it to the raspberry pi. The raspberry pi will compare the pressure obtained with the threshold value and will obtain the result. If the pressure is greater than the threshold value then the camera is turned on and if it is less than the threshold value the picture is no taken. After capturing the image the number plate is processed to extract the information about the owner and the toll is automatically collected.

A relay and a motor is used in between the raspberry pi and the camera module. A relay is a switch that opens and closes automatically and controls a circuit. A relay consists of common, normally open and normally closed pins. At first it is in common and normally closed. When the pressure is more than the threshold value then the raspberry pi will identify it and turns the switch towards common and normally open. This in turns makes the motor to run and capture the image of the number plate. The motor needs a supply. So a 9V battery is used to provide the voltage supply.

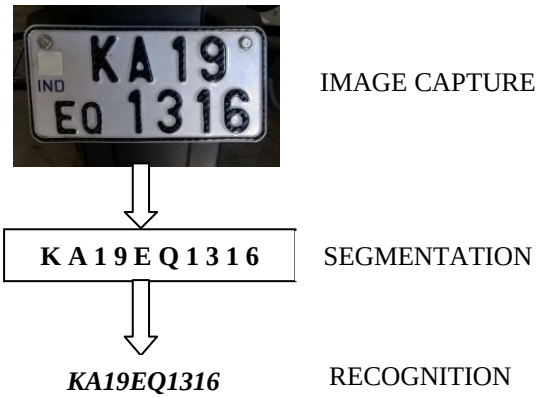


The raspberry pi is connected to the monitor of a system through a HDMI cable. The pressure is continuously monitored for every second. When it exceeds the threshold value the image is captured and saved in the folder in the raspberry pi.

V. ALGORITHM

The steps involved in the intelligent toll collection are explained in the form of an algorithm as follows.

Step 1: The pressure is sensed and compared continuously.
Step 2: when the pressure exceeds the threshold value the image of the license plate is captured.
Step 3: the image is processed and the characters is segmented.
Step 4: The segmented characters of the number plate are then recognized.
Step 5: Then the toll is collected from the vehicle owner's account



VI. APPLICATONS

This system is used for the automation of the toll collection. It can also be used in different applications such as traffic surveillance and parking fee collection. Many people obey the traffic rules but some do not. In such cases number of the vehicle which violated the traffic rules can be obtained and the fine amount can be automatically traced from their account. Parking fee collection is also time consuming work. So if this system is implemented in such areas, the parking fee can also be collected. This system can also store the information of the vehicles which has arrived to the certain places.

VII. FUTURE DEVELOPMENTS

- This system can be updated regularly to know the new owners details. It can also be upgraded to monitor several vehicles at a time.
- This system can include a setup which can collect the toll for both up and down timing of the travel.
- Video based monitoring and collection system can be implemented as it will continuously monitor the booth without taking pictures and the number plate can be extracted from the video.
- If there is no money n the vehicle owner's account then a notice is set to them immediately to pay the toll amount.
- The character recognition process can be made much faster and easier.
- A notification message can be sent to the registered mobile number along with the receipt of the payment

VIII. CONCLUSION

This paper "An intelligent highway toll collection system by license plate recognition" presents about an overview of automation in the toll collection by image processing and recognition. By adapting this technology various applications like traffic surveillance, parking fee collection etc can be implemented. Here we propose a method for automatic toll collection without human intervention. The image quality can be increased and 100% accuracy can be attained by further processes.

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