AUTOMATIC TOLL SYSTEM

Main Project Report

Submitted by

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CERTIFICATE

Certified that this is a bonafide record of the Main Project work done by **Ajay Sangamithran P (B2ENCS1118)** *titled* "AUTOMATIC TOLL SYSTEM" *towards the partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering of the Department of Computer Science and Engineering under Kannur University during the year 2015-2016.*

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Abstract

Traffic congestions at toll booths are a phenomenon noticed at all toll booths situated between major cities around the world. Traffic conjunction nearby toll stations cause wastage of time due to large queues and a large amount of air and sound pollution. One of the earlier methods that had been proposed to minimise these traffic congestions that are occuring nearby toll stations primarily due to stopping vehicles inorder to collect toll fee manually is to implement an RFID based automatic toll plaza but one of the major problems of this system is that it requires an RFID tag to installed on every vehicle that uses this facility and the RFID associated with each vehicle be stored in a central database .

The main objective of this Automatic toll system is to implement a user friendly stop free system where you donot have to stop at the toll plaza inorder to manually pay the toll fee which inorder saves time and reduces traffic conjunction which wastes a lot of journey time and fuel.

In the proposed system, a camera will capture the image of number plate of the fast moving vehicle which doesnot need to stop at the toll booth for paying the toll fee. Using image processing techniques, the registration number of the vehicle is extracted. This registration is passed on to the central server. At the server, the server matches the obtained number against the central database, through the RTO and obtains the vehicle type and the registred owners details. The corresponding toll fee is levied against the above mentioned registration number based on the type of vehicle associated with the license plate saved in the RTO database. The owner now has the option to pay the total amount due at the various road tax offices or via online within a predefined time span. Failure to clear dues within the time span will result in fines.

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Chapter 1

Introduction

Any structure, building or system needs maintenance and rehabilitation, which are of course costly. Highways and roads are also not an exception. From the very past, the construction, extension, maintenance and operating costs of highways, roads, bridges and tunnels were collected directly or indirectly. In the old indirect method, the expenses are compensated either by the tax payment for fuel or by budget allocation of the national income. The shortcoming of this method is that a number of taxpayers, who do not use any of the roads and carriageways, have to pay extra money. However, in the other system, called direct method, the tolls are taken directly from the drivers passing that road or street. The figure 1.1 shows a toll booth which collects toll manually.

Figure 1.1: A toll booth

Automatic toll system is used as a technology for fast and efficient collection of toll at the toll plazas. This is possible as the vehicles passing through the toll plaza do not stop to pay toll and the payment automatically takes place from the account of the driver. These days delay at tollbooths is quite common in almost all the major Highways. This leads to increases in Congestion, inconvenience, energy and fuel consumption. The present work discusses here how to eliminate the delay at tollbooths. The figure 1.2 shows the traffic congestion caused by a manual toll booth and how it makes the life of people hard while travelling.

Figure 1.2: Traffic caused by a toll booth

The main purpose of this project is to collect the correct toll value, according to vehicles class, automatically on arrival of the vehicle at toll booth. It is needed to build a real time application, which recognizes reliable, safe and environment friendly. At present, customers have to wait at the toll booth, for long time, to pay the collector. Automated toll system would successfully remove unnecessary traffic delays. Automated toll collection is fast becoming a globally accepted for toll collection.

Some of the benefits which the driver has on using automated toll system are:

- No or shorter queues at toll plazas by increasing toll booth service turnaround rates.
- Faster and more efficient service.
- Facility to make online payments
- Other benefits for the motorists include fuel savings and reduced mobile emissions by reducing or eliminating deceleration, waiting time, and acceleration.

And likewise the toll operator has his benefits too , which include:

- Lowered toll collection costs.
- Better audit control by centralizing user accounts.
- Expand capacity without building more infrastructures

The most common method used to implement automated toll system is by using RFID(Radio Frequency Identification).The Capacitive Sensor used here to sense the vehicle size.IR sensor is used to detect the vehicle and the Gate models are used here to open and close while the vehicle is entering or exit in the Toll Tax unit. The RFID reader is used to read the tag of the vehicles. The Vehicle information is stored in the microcontroller based on the TAG number.Based on that number the Tax amount for that vehicle will automatically transfer to the toll gate system. And that cost information will be sent through GSM modem to a mobile phone of the owner. The status of the vehicle will be displayed in the LCD.When further vehicle is going towards the Load cell plate it has to pass through the IR transmitter - receiver gate.The RFID data is stored on tags which respond to the reader by transforming the energy of radio frequency queries from the reader (or transceiver), and sending back the information they enclose. A computer hosting a specific RFID application pilots the reader and processes the data it sends.

But RFID has many disadvantages which reduces the efficiency of the automated toll system and some of them are:

- RFID systems are expensive
- RFID technology is harder to understand
- Can be less reliable
- Tags are application specific. No one tag fits all
- More than one tag can respond at the same time
- extra hardware components has to be installed in the vehicle to support RFID technology

So to overcome these issues we proposed a system which makes use use of image processing instead of RFID . The process starts when a sensor detects the presence of a vehicle and signals the system camera to record an image of the passing vehicle.The image is passed on to a computer where software running, on the computer extracts the license plate number from the image. LPN (License plate number) can then be verified in a central database.

If number is valid for this system then LPN recorded in a database with other information such as vehicle number, time, balance, personal details. License plate numbers can also be further processed and used to control other systems such as raising a gate.These toll systems are generally composed of four main components: Sensor used for vehicle identification, LPR Camera for capturing images, Computer with TOLL, Image processing software and Gate controlled system.

Figure 1.3: A toll booth

Input of the system is the image of a vehicle captured by a camera. The captured image is processed to extract the text from the number plate which is given as its output.The next part separates the characters individually. And finally recognition part recognizes the characters giving the result as the plate number. For better performance of image to text conversion high resolution camera is required. High resolution Camera captures the license plates flawlessly in any weather condition and at high speed

Thus a system used as an Automated Toll collection booth, based on image processing saves the time at toll booth, minimizes the fuel consumption during the idle condition of the vehicle. In turn we can save the environment from emission of extra carbon monoxide . Hence we can save our country. Also it serves in providing the tracking system for theft vehicle which is secured and highly reliable can be obtained. It can be used to remove all drawbacks with the current system such as time and human effort and it also doesn't require any tag only required best quality camera and fixed font number plate on each vehicle.

Automatic toll system is a user friendly toll system which saves time and reduce traffic conjunction. A camera will capture the image of number plate of the fast moving vehicle. Using image processing techniques the registration number of the vehicle is extracted. This registration is passed on two the central server. At the server the server matches the obtained number against the central database and obtains the vehicle type and the registered owners details.

Automatic toll system is designed mainly to avoid traffic congestion due to toll booths. At present, customers have to wait at the toll booth, for long time, to pay the collector. Automated toll system would successfully remove unnecessary traffic delays; keep an eye on any car that might not be correctly registered or number plates exchanged for theft purpose. Automated toll collection is fast becoming a globally accepted for toll collection.

For collecting toll fee an online system is used. In this system the user can check whether his or her vehicle has any due payment. The user can pay their toll payment using the given online system. This online system is linked with RTO database. So the user only has to enter the vehicle registration number. On entering the vehicle registration number,the system displays details of the vehicle, the user also gets information about the amount due.

In order to charge toll fee for a vehicle, a camera module will take a photo of the fast moving vehicle. The image will include the vehicle registration no. An image preparation for text extraction of the vehicle registration no: is performed using functions predefined in OpenCV library. Text extraction is performed using Tesseract engine. The registration number extracted is compared with the list of vehicles in the RTO database and the central server used in the project updates the database accessed in the online system with an increment in the payment to be done for vehicle corresponding to the extracted registration number.

These days delay at tollbooths is quite common in almost all the major Highways. This leads to increases in Congestion, inconvenience, energy and fuel consumption. The present work discusses here how to eliminate the delay at tollbooths. Automatic toll System assists in the management of toll operations by providing valuable data such as traffic volume, vehicle classification, and fare expected & collected. Multiple payment methods are supported using Cash, Smart Cards and Bar coded tickets . The adoption of this system is expected to bring a number of significant advantages

The other major alternatives to automation include using a barcode based tag on every car and installing a bar code scanner at the toll station. The barcode laser systems which uses tags(barcode) that are mounted on the number plate of vehicles, through which information embedded on the barcode are read by barcode readers. The drawback of this system is it requires direct line of sight and barcode scanner needs to be close to it. The laser systems were used in Electronic Toll Collection systems which utilized bar-coded stickers affixed to each vehicle. These barcodes were read by Laser scanner as vehicles passed the toll booths. However the scanner had poor reading reliability and it was sensitive to weather and dirt and has to be located as close as possible to toll booth. The problem with this model is that it requires a one time installation of bar code on all vehicles and also needs human resource to handle vehicles without tags.

Some new systems also use a continuous video stream based automation. In this method a continuous video stream is taken as the input, when a vehicle passes the corresponding frames of the video are identified for registration number extraction. The advantages of this system is that in the event of an accident the live footage can be used as evidence. The challenges of implementing the system outweigh the advantages as the such as system needs s high bandwidth connection to the server to stream the video and also imparts huge demands on the memory for storage.

A method which beats the shortcoming of the above mentioned method is an NFC tag based method. In this method an NFC tag is attached to the vehicles. Unlike the video stream based method the automation system using NFC does not require large bandwidths and memory for storage. It does not require complex machinery for implementation like in the case of the bar code based automation. The only shortcoming of this system is that it needs a one time installation on all vehicles and it needs human resource to process vehicle's without the tag.

Another technique used is of Smart Card Based Toll Gate Automated System which enables the user to access the system, toll booth in less time and a maximum of human effort is needed. Data produced from wireless sensor network deployments lacked the measurement quality and data set richness associated with previous cable-based test programs, thereby limiting the perceived role of wireless sensors in advanced structural health monitoring.

Calm active infrared is a relatively new technology. It is similar to RFID system, the only difference is that it has an active infrared unit installed on vehicle which contains all the information. In comparison to RFID, it has a faster data reading rate, reliability, accuracy, efficiency and it works well in all environment conditions. It also comes over the problem of interference. Lack of interoperability, vendor support and high cost are the roadblocks in usage of this technology. Apart from these, it is still under research and many other aspects need to be studied yet.

Electronic toll collection (ETC) is a technology enabling the electronic collection of toll payments. It has been studied by researchers and applied in various highways, bridges, and tunnels requiring such a process. This system is capable of determining if the car is registered or not, and then informing the authorities of toll payment violations, debits, and participating accounts. The most obvious advantage of this technology is the opportunity to eliminate congestion in tollbooths, especially during festive seasons when traffic tends to be heavier than normal. It is also a method by which to curb complaints from motorists regarding the inconveniences involved in manually making payments at the tollbooths. Other than this obvious advantage, applying ETC could also benefit the toll operators.

The benefits for the motorists include:

- Fewer or shorter queues at toll plazas by increasing toll booth service turnaround rates
- Faster and more efficient service (no exchanging toll fees by hand)
- The ability to make payments by keeping a balance on the card itself or by loading a registered credit card; and
- The use of postpaid toll statements (no need to request for receipts).

Other general advantages for the motorists include fuel savings and reduced mobile emissions by reducing or eliminating deceleration, waiting time, and acceleration.

Meanwhile, for the toll operators, the benefits include:

- Lowered toll collection costs
- Better audit control by centralized user accounts and
- Expanded capacity without building more infrastructures.

Thus, the ETC system is a win-win situation for both the motorists and toll operators, which is why it is now being extensively used throughout the world.

The implementation of automated toll system will significantly contribute to improve travel conditions by addressing delay caused by both recurring and nonrecurring traffic congestions. Also one of the main contribution of this user friendly automatic toll system is that it reduces the human resources at the toll booth. But we cannot completely avoid human resources because for the process like maintenance needs human resources.

The major contribution of the automated toll system is reducing the waiting time at the toll. Unlike naive toll systems this automated toll system does not provide any toll gate to stop the vehicle to collect the toll. In this system an automated high quality camera is provided at each toll booth. These cameras are placed in such a way that they would take the picture of the license plate of the vehicle passing through the toll booth. The photo is then image processed and the registration number is extracted from the image of the number plate. Then a tax fee is levitated against the vehicle with the extracted registration number.

Another main contribution of the proposed system is to provide a facility for online payment in turn solve the problem of tender change, which in turn reduce a considerable amount of waiting time.

Motivation

The entire motivation behind developing an automation system for toll collection is from a number of reasons. The existing system using human resource is been in use since a long time and is not able to catch up with the requirements of today's society. There is an urgent need to adopt new methods of toll collection.

The traffic on roads is increasing at a large rate. This traffic leads to high wait times at intersections and toll gates. The wait at toll gates further increases due to various reasons such as the commuters arguing with the employees at the toll gate, further time is lost due to inability to tender exact change and sometimes commuters even ask for directions at toll gates.

Waiting at the toll station queue is a very frustrating experience. Even the vehicle's that ply for emergency services such as ambulance and fire engines get stuck at the toll station traffic. Some commuters refuse to leave without an argument with the employees, wasting everyone else's time. Employees are mostly harsh and are rude with the commuters. This behavior worsens if the commuter does not have exact change to tender. Some commuters try to cut queues at the toll station which leads to minor accidents and also may lead to fights at the toll stations.

Automation of the toll station also benefits the owner's of the total station as it reduces the reliance on human resource. The employer need not employ multiple employees round the clock in different shifts. They all can be replaced by the automated system reducing labor costs and trouble from various workers unions. The only human resource that might be required are for the updation and maintenance of the system.

Automation of the toll gates will reduce all these unnecessary delays. Commuters can pay the amount due online as per their convenience.

The available prototypes for automation all require a one time installation of tags on each and every vehicle. They also need human resource to process the vehicles without these tags. The tags installed can be for barcode based recognition, NFC based recognition or Infrared based recognition. All the alternative prototypes requires complex machinery for implementation. The proposed system requires no such one time installation and only needs a good quality camera for implementation.

Unlike naive toll systems this automated toll system does not provide any toll gate to stop the vehicle to collect the toll. In this system an automated high quality camera is provided at each toll booth. These cameras are placed in such a way that they would take the picture of the license plate of the vehicle passing through the toll booth. The photo is then image processed and the registration number is extracted from the image of the number plate. Then a tax fee is levitated against the vehicle with the extracted registration number.

There are other type of automated toll systems one commonly seen is based on RFID, the major draw backs of this system are requires one time installation in all vehicles, requires human resource to an extent, database needs to be updated for all vehicles, and also the coast for this design is high. But the proposed automatic toll system would over come these disadvantages to an extent.

Another motivation of this system is to provide an online facility for paying the toll taxes. This online Payment can reduce the waiting time at the toll and can also solve the problem of tender change.

Chapter 2

Literature Review

This chapter deals with the prior research works that were done in this domain and has helped in evolution of this topic and the background information about the various technologies used in the project.

2.1 Literature review

Toll roads have existed for at least the last 2,700 years, as tolls had to be paid by travelers using the SusaBabylon highway under the regime of Ashurbanipal, who reigned in the 7th century BC. Many modern European roads were originally constructed as toll roads in order to recoup the costs of construction, maintenance and as a source of tax money that is paid primarily by someone other than the local residents. In 14th-century England, some of the most heavily used roads were repaired with money raised from tolls by pavage grants. In the 20th century, road tolls were introduced in Euro pe to finance the construction of motorway networks and specific transport infrastructure such as bridges and tunnels. Italy was the first European country to charge motorway tolls, on a 50 km motorway section near Milan in 1924.

Manual Toll Collection is not appropriate method for toll collection as it very time consuming. This method causes relatively long amount of waiting time at toll booth. Vehicles have to stop until their turn comes. It requires toll collector for working. Collector classifies vehicles, generates receipts with printer and then gives that receipt to vehicle owner. In all this process takes significant amount of time as there is a lot of human intervention included.

The Electronic Toll Collection system is currently being used throughout the world. Other countries that have applied the ETC system are Canada, Poland, the Philippines, Japan and Singapore, among many others.

The ETC system used in Canada is known as the Canada 407 Express toll route (ETR). It is one of the most sophisticated toll roads in the world.

The Canada 407 ETR is a closed-access toll road, which means that there are gantries placed at the entrance and exit points of each toll. In this system, cameras are equipped with Optical Character Recogntion (OCR).

The OCR cameras are used to photograph license plate numbers of vehicles that do not have transponders. The toll bill will then be sent directly to the registered address of the vehicle owners. Other than that, two laser beam scanners are placed above the roadway to detect the types of vehicles passing through the gantries. Nevertheless, this toll road bears a very high infrastructure cost, and the users are the ones who help recover the cost through increments in their toll bills.

The ETC system used in the Philippines has been implemented at the South Luzon Expressway (SLEX) since August 2000. The ETC is referred to as the E-PASS system, which uses Transcore technology. Here, electronic transponders are placed in front of a vehicles rear view mirror. Each time a vehicle enters the toll booth, the tag is read by the receiver, automatically identifying the account and debiting the toll fee amount from the corresponding account. Once the amount has been debited, the control gate will lift and the vehicle is allowed to pass through.

The Electronic Toll Collection system used in Poland is called national automatic toll collection system (NATCS). It consists of national automatic toll collection center, control gates and onboard units (OBI). NATCS uses a combination of global system for mobile communication (GSM) with satellite - ba sed Global Positioning System (GPS). Using GPS technology, the OBUs calculate the toll fees, and then transmit the information to the NATCS computer center . In order to identify the plate numbers of trucks, the system has control gates equipped with digita l short range communication (DSRC) detection equipment and high resolution cameras . Due to the technical specifications, this system incurs a high cost for motorists.

Related works on the topic of reducing traffic congestion in tolls are mainly based on detection of a vehicle using either of the following technologies, RFID technology,barcode laser systems, infrared technology, image processing after capture of the image of the passing vehicle or usage of NFC reader to detect passage of vehicle.The usage of identification of vehicle using image recognition offers a better advantage over the other various forms of identification techniques available.

RFID technology based automatic toll systems require an RFID transponder installed on all vehicles inorder for proper operation. Vehicles which donot have the RFID tag installed will have to go through the old fashioned manual toll collection lanes since they cannot be processed in the automatic lanes. The micro simulation model for the automated toll plaza system using RFID technology. The 8051 microcontroller is used for the control system. The signal is sent to the PC via RS-232 cable from PIC. In this system, the microcontroller is the main part of the system because of the signal is sent to PC and the output results showed on the LCD display. And then, the microcontroller sent the signal to the motor driver for opening the traffic gate. The author also described the GSM modem to update the information about the database of user account.

The barcode laser systems which uses tags(barcode) that are mounted on the number plate of vehicles, through which information embedded on the barcode are read by barcode readers. The drawback of this system is it requires direct line of sight and barcode scanner needs to be close to it. The laser systems were used in Electronic Toll Collection systems which utilized barcoded stickers affixed to each vehicle. These barcodes were read by Laser scanner as vehicles passed the toll booths. However the scanner had poor reading reliability and it was sensitive to weather and dirt and has to be located as close as possible to toll booth.

Another technique used is of Smart Card Based Toll Gate Automated System which enables the user to access the system, toll booth in less time and a maximum of human effort is needed. Data produced from wireless sensor network deployments lacked the measurement quality and data set richness associated with previous cable-based test programs, thereby limiting the perceived role of wireless sensors in advanced structural health monitoring.

VPS technique consists of worldwide satellite navigation system incorporation with a communication mechanism. It works with the help of a global positioning system (GPS)unit installed on vehicle attached to an on board unit (OBU), which stores the coordinates of the vehicle and send the transaction information to the toll authorities via GSM (global system mobile communication). This system is highly reliable, accurate and efficient. The efficiency of this system is not affected by environmental conditions. It provides a payment option only for the distance travelled and is highly flexible in generating the corresponding payment details. It can also be used by the police petrol for highway surveillance and theft prevention of automobile. The associated shortcomings for this system are its excessively high installation, running and maintenance cost, careful handling, requirement of extra power and other accessories.

Calm active infrared is a relatively new technology. It is similar to RFID system, the only difference is that it has an active infrared unit installed on vehicle which contains all the information. In comparison to RFID , it has a faster data reading rate, reliability, accuracy, efficiency and it works well in all environment conditions. It also comes over the problem of interference. Lack of interoperability, vendor support and high cost are the roadblocks in usage of this technology. Apart from these , it is still under research and many other aspects need to be studied yet.

Yet another technique implemented is of Laser Technology. By this technique the process time has been reduced to an higher extent. To construct an historic vibration database, periodic real-time transmission of vibration measurements would be required, but only at a very low duty-cycle. Limiting the use of the radio transceiver, which accounts for the largest power consumption of the device, reduces the average current consumption to a level that is sustainable with a combination of AA batteries and a piezoelectric generator.

Another important related work is the Automatic License Plate Recognition System which is video based.The algorithm proposed is designed to recognize license plate of vehicle automatically based on video. Since it is video based it needs frame differencing or motion detection especially when the vehicles are at high speed.

In [1] Mutturaj Hubballi has discussed how to implement a Automatic Number Plate Recognition (ANPR) algorithm using image processing in toll booth. Camera is used for capturing the image of the vehicle number plate. The captured image would be converted into text using ANPR algorithm. Toll booth passes the vehicle plate number to the central server which holds the information about registered users. Server then uses this vehicle number to verify whether the user is registered account holder or not. If the user is registered account holder then server transmits the information about vehicle type, account balance to the toll booth. Based on the vehicle type, toll is deducted from the customers account and then the toll gate is opened. Central server is updated with users account balance using internet protocols by the toll booth the vehicle passes through. The user is updated about his account status via SMS.

ANPR can be used to store the images captured by the cameras as well as the text from the license plate. Systems commonly use infrared lighting to allow the camera to take the picture at any time of the day. ANPR technology tends to be region-specific, owing to plate variation from place to place. ANPR uses optical character recognition (OCR) on images taken by cameras.Captured image is converted to grey scale and smoothened to remove noise using median filter. Adaptive histogramming is performed to enhance contrast of the image. Discrete wavelet transform is performed using Haar filter to enhance the vertical edges. The intensity values are summed row by row and the row with the maximum value is identified.

Cropped plate region is subjected to noise filtering and is further processed using structural element for morphological operations to enhance contrast of the image. Edges are brightened using convolution function. Then the characters & digits of the plate are segmented and each is saved as a different image. The pre-processed image is given as input to segmentation function. The objects in the image are identified by labeling and plotting bounding boxes around them. Each object identified is taken and only those objects with number of rows and columns within the predefined number range are considered and the corresponding characters are extracted which gives the number plate.

OCR is done using template matching. Images from A to Z and numbers from 1 to 9 are taken into different variables and are pre-processed. All these variables are stored in the form of a cell in which each sub matrix represents a letter. The same process is done for printed upper case, printed lower case, and printed numbers, hand written upper case, hand written lower case and hand written numbers. All the model inputs are saved under the same variable name. The central database is the heart of the whole database system. This central database will be managed by a central administrator. The customer has to be registered for this account to use this system. Database includes all registered vehicles with details about owner, vehicle number and account balance. When the registered customer passes through a specified toll booth then automatically the toll fee will be deducted from customer's account. Central database is updated with this information at a same time, the customer will receive the information through SMS to his mobile using GSM modem.

In [2]The arithmetic capability of digital signal processors (DSPs), the multiple peripheral interfaces and the high frequency execution of the ARM processors make them an attractive choice for real time embedded systems. Rapid development of Field Programmable Gate Arrays (FPGAs) offers alternative way to provide a low cost acceleration for computationally intensive tasks such as digital signal processing. Most of these applications use ARM, DSPs and FPGAs due to the processing power offered, in order to provide portability and real-time capability, and create custom embedded architectures for different application requirements. The design is to implement an efficient and novel architectures for automatic number plate recognition (ANPR) system using ARM-DSP System-on-Chip platform, which operates in high definition (HD) and in real time. In addition, a separate ANPR algorithm is developed and optimised, by taking advantage of technical features of FPGAs which accelerate digital image processing algorithms. The investigation of the algorithm and its optimisation focused on real time image and video processing for license plate (LP) or number plate localisation (NPL), LP character segmentation (NPS) and optical character recognition (OCR) in particular, which are the three key stages of the ANPR process .

ANPR often forms part of an intelligent transportation systems. Its applications include identifying vehicles by their number plates for policing, control access and toll collection.

This complete system, is an embedded standalone, intelligent and capable of capturing and processing license plates on board the device, and represents an advance on the traditional commercial ANPR system which uses a standard definition camera to capture the vehicles, with a separate nearby computer to process the images. The major advantages of the embedded system presented here include a reduction in cost and increased portability, as the system no longer requires separate processing hardware and expensive multiple data transferring media.The second part of the investigation focused on developing and accelerating a full ANPR algorithm on FPGA. A range of image processing algorithms and architectures for each ANPR stage have been developed and optimised to exploit features and innovations available within new FPGAs

The ARM-DSP based ANPR system described is designed for commercial applications where the need for low power, low prices and real time systems is vital. A single FPGA can also be added as a plug-in to the ARM-DSP based hardware SoC, depending on the extra resources needed for the application. The overall results have shown that it is possible to use cheaper off-the-shelf ARM-DSPs and FPGAs multicore processors for standalone ANPR systems through device and algorithm optimisation to achieve real-time performance at higher recognition rate using efficient algorithms.

In [4] an automated toll booth which makes use of image prcessing is described.the image of the vehicle number plate and its class is important. In this system a high resolution camera is used for capturing the image of the vehicle number plate. The captured image would be converted into the text using ANPR and the toll would be cut from the customers account and then open the gate. At the same time, while passing the vehicle through the toll plaza, a tracking system will be activated for the theft vehicles. If the vehicle is stolen and an entry is being made in the central database by the police, a silent alarm would buzz which would indicate the operator at the toll booth that the vehicle is a stolen vehicle.

For the identification, the information of the vehicles, registered against the number plate, stored on the central database, through the RTO will be used for verification. So for this purpose the captured number will be sent to the server received at the toll.

2.2 Background Informations

This section discusses about some of the important terms and technologies used in this project. Knowledge about these helps to understand this project in-depth.

2.2.1 Raspberry Pi

The Raspberry Pi is a series of credit cardsized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools and developing countries. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. Its capable of doing everything we expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.The Raspberry Pi has the ability to interact with the outside world and has been used in a wide array of digital maker project, from music machines to weather stations and tweeting birdhouses with infra-red cameras.

Tools are available for Python as the main programming language,with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, C++, Java,Perl, Ruby and Squeak Smalltalk. The Raspberry pi is now extensively used in the field of embedded systems.

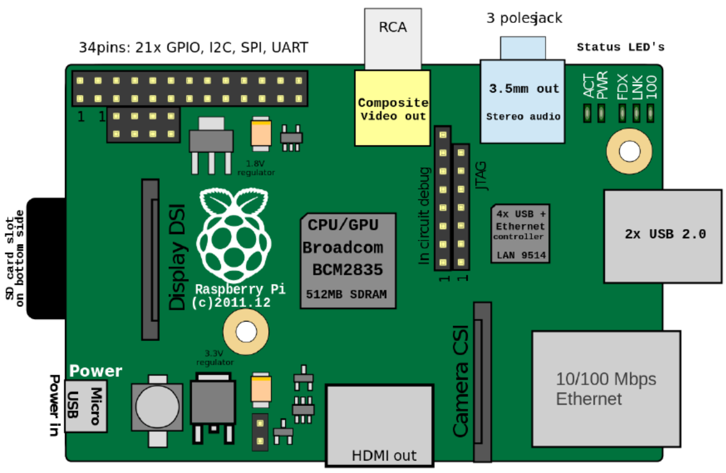

Figure 2.1: Raspberry Pi

The Raspberry Pi Foundation is a registered educational charity based in the UK. The foundations goal is to advance the education of adults and children, particularly in the field of computers, computer science and related subjects. The foundations charitable work are immense in number and have touched lives.

The allure of the Raspberry Pi comes from a combination of the computers small size and affordable price. Enthusiasts envision using the small form-factor PC as a cheap home theater PC (HTPC), or secondary low-power desktop. Institutions, like schools and businesses, could benefit from deploying a fleet of computers for a fraction of the cost of traditional desktop towers. The small size makes for an easy-to-hide computer that sips power and can be mounted behind the display with an appropriate case. It could also be used in niche applications, like digital signage. While it will not blow away any recent hardware in performance, it does make for a cheap secondary computer which could be useful for troubleshooting and researching solutions if your manual rig fails to boot as well.

The Raspberry Pi is not the only small device of its kind, two prominent examples in the enthusiast community are the Arduino and BeagleBoard. Although the systems are of similar form-factors, the Raspberry Pi is a greatly different beast. On the hardware front, the Raspberry Pi is based around an ARM SoC that is very much closed source. Conversely, the Arduino and BeagleBoard systems are based on fully open source hardware. The BeagleBoards do use ARM processors (TI OMAP 3530 SoC), but different GPUs. The Arduino boards are even further dissimilar due to using 8-bit and 16-bit Atmel micro-controller chips. The biggest difference between something like the Arduino and the Raspberry Pi is in the intended usage.

The Arduino is meant to be used as a development board with microcontrollers that will be programmed and then integrated into larger machines or electronics and allowed to run on their own. On the other hand, the Raspberry Pi is meant to be used as a final product and operate as a traditional desktop computer (in fact, the distributors refused to ship the Raspberry Pi until it received CE/FCC EM interference certification). Admittedly, the BeagleBoards do dip into the Raspberry Pis usage territory with projects like BeagleBoard Ubuntu and XBMC support, but the devices do have a higher barrier to entry due to its price. Smaller differences include the use of a non-modular design in the Raspberry Pi (no removing/replacing chips, as well as clock speed, power usage, and price differences). Also, the Arduino and BeagleBoard both have extensive device lineups that include expensive higher end models whereas the Raspberry Pi computer is designed around the idea of producing a computer that is capable enough as cheaply as possible.

Raspberry Pi 2 - Model B Technical Specification:

- Broadcom BCM2836 ARMv7 Quad Core Processor powered Single Board.
- Computer running at 900MHz.
- 1GB RAM.
- 4 x USB ports.
- Lens:4 pole Stereo output and Composite video port.
- Full size HDMI.
- CSI camera port for connecting the Raspberry Pi camera.
- DSI display port for connecting the Raspberry Pi touch screen display.m
- Micro SD port for loading your operating system and storing data.
- Micro USB power source.

2.2.1.1 GPIO Pins

One powerful feature of the Raspberry Pi is the row of GPIO (general purpose input/output) pins along the top edge of the board. One can program the pins to interact in amazing ways with the real world. Inputs don't have to come from a physical switch, it could be input from a sensor or a signal from another computer or device. For example: The output can do anything, from turning on an LED to sending a signal or data to another device . If the Raspberry Pi is on a network, we can control devices that are attached to it from anywhere and those devices can send data back. Connectivity and control of physical devices over the internet is a powerful and exciting thing, and the Raspberry Pi is ideal for this.

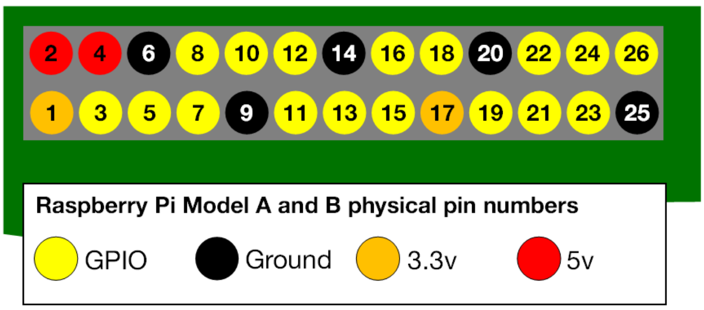

Figure 2.2: GPIO Pins

GPIO numbering involves the GPIO pins as the computer sees them. The numbers don't make any sense to humans, they jump about all over the place, so there is no easy way to remember them. You will need a printed reference or a reference board that fits over the pins.

Physical numbering is the other way to refer to these pins, by simply counting across and down from pin 1 at the top left (nearest to the SD card). This is 'physical numbering' and it looks like the GPIO pin diagram given above.

2.2.1.2 Camera Pi Module

The Raspberry Pi camera module can be used to take high-definition video, as well as stills photographs. Its easy to use for beginners, but has plenty to offer advanced users if they are looking to expand their knowledge. There are lots of people using it for time-lapse, slow-motion and other video cleverness.Libraries are bundled with the camera to create effects.

The Raspberry Pi camera board contains a 5 Mega Pixel sensor, and connects via a ribbon cable to the CSI connector on the Raspberry Pi. The camera consists of a small (25mm by 20mm by 9mm) circuit board. The software for the camera supports full resolution still images up to 2592x1944 and video resolutions of 1080p30,720p60 and 640x480p60/90. It can be accessed through the MMAL and V4L APIs,and there are numerous third-party libraries built for it ,including the Picamera Python library.

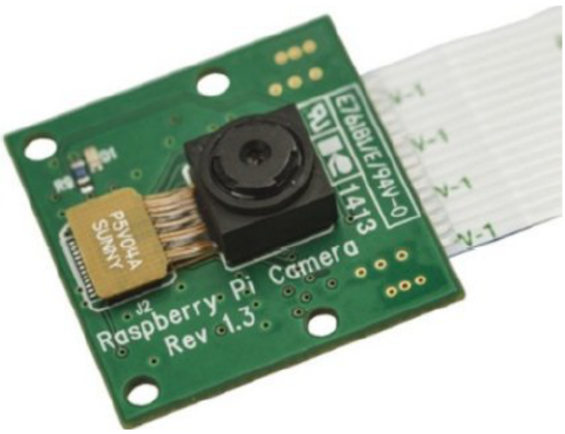

Figure 2.3: Camera Pi Module

The camera module is very popular in home security applications,and in wildlife camera traps.The video and still image quality is better than a USB webcam of similar price. Features:

- 5MP sensor
- Pixel Count: 2592 x 1944
- Pixel Size: 1.4 x 1.4 um
- Video: 1080p at 30 fps with codec H.264 (AVC)
- Lens: f=3.6 mm, f/2.9
- Angle of View: 54 x 41 degrees
- Field of View: 2.0 x 1.33 m at 2 m
- Full-frame SLR lens equivalent: 35 mm
- Fixed Focus: 1 m to infinity
- Up to 90 fps Video at VGA
- Board size: 25 x 24 mm (not including flex cable)

2.3 OpenCV

OPENCV stands for Open Source Computer Vision.It is a popular computer vision library containing programming language functions, started by Intel in 1999. OpenCV is written in C++ and its primary interface is in, C++,but it still retains a less comprehensive though extensive older C interface. There are bindings in Python,Java and MATLAB/OCTAVE. OpenCV's application areas include:2D and 3D feature toolkits, Gesture recognition, Humancomputer interaction(HCI), Mobile robotics.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 7 million. The library is used extensively in companies, research groups and by governmental bodies.

Along with well-established companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota that employ the library, there are many startups such as Applied Minds, VideoSurf, and Zeitera, that make extensive use of OpenCV. OpenCVs deployed uses span the range from stitching streetview images together, detecting intrusions in surveillance video in Israel, monitoring mine equipment in China, helping robots navigate and pick up objects at Willow Garage, detection of swimming pool drowning accidents in Europe, running interactive art in Spain and New York, checking runways for debris in Turkey, inspecting labels on products in factories around the world on to rapid face detection in Japan.

It has C++, C, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications and takes advantage of MMX and SSE instructions when available. A full-featured CUDA and OpenCL interfaces are being actively developed right now. There are over 500 algorithms and about 10 times as many functions that compose or support those algorithms. OpenCV is written natively in C++ and has a templated interface that works seamlessly with STL containers.

The first alpha version of OpenCV was released to the public at the IEEE Conference on Computer Vision and Pattern Recognition in 2000, and five betas were released between 2001 and 2005. The first 1.0 version was released in 2006. In mid-2008, OpenCV obtained corporate support from Willow Garage, and is now again under active development. A version 1.1 ”pre-release” was released in October 2008. The second major release of the OpenCV was on October 2009. OpenCV 2 includes major changes to the C++ interface, aiming at easier, more type-safe patterns, new functions, and better implementations for existing ones in terms of performance (especially on multi-core systems). Official releases now occur every six months and development is now done by an independent Russian team supported by commercial corporations.

Adopted all around the world, OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 9 million. Usage ranges from interactive art, to mines inspection, stitching maps on the web or through advanced robotics.

OpenCV is basically a library of functions written in C. The user is closer to directly providing the machine language code to the computer to get executed. So ultimately the user gets more image processing done for his or her computers processing cycles, and not more interpreting. As a result of this, programs written in OpenCV run much faster than similar programs written in Matlab. For example, we might write a small program to detect peoples smiles in a sequence of video frames. In Matlab, we would typically get 3-4 frames analysed per second. In OpenCV, we would get at least 30fps, resulting in real-time detection. This makes OpenCV much better at demoing prototype programs using a standard PC and webcam.

OpenCV has a modular structure, which means that the package includes several shared or static libraries. The following modules are available:

- Core functionality - a compact module defining basic data structures, including the dense multi-dimensional array Mat and basic functions used by all other modules.
- Image processing - an image processing module that includes linear and non-linear image filtering, geometrical image transformations (resize, affine and perspective warping, generic table-based remapping), color space conversion, histograms, and so on.
- Video - a video analysis module that includes motion estimation, background subtraction, and object tracking algorithms.
- calib3d - basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence algorithms, and elements of 3D reconstruction.
- features2d - salient feature detectors, descriptors, and descriptor matchers.
- objdetect - detection of objects and instances of the predefined classes (for example, faces, eyes, mugs, people, cars, and so on).
- highgui - an easy-to-use interface to simple UI capabilities. videoio - an easy-to-use interface to video capturing and video codecs.
- gpu - GPU-accelerated algorithms from different OpenCV modules.
- some other helper modules, such as FLANN and Google test wrappers, Python bindings, and others.

2.4 Tesseract

Tessaract Engine is described in [3]. Tesseract is an optical character recognition engine for various operating systems. It is free software, released under the Apache License, Version 2.0, and development has been sponsored by Google since 2006. Tesseract is considered one of the most accurate open source OCR engines currently available

The Tesseract engine was originally developed as proprietary software at Hewlett Packard labs in Bristol, England and Greeley, Colorado between 1985 and 1994, with some more changes made in 1996 to port to Windows, and some migration from C to C++ in 1998. A lot of the code was written in C, and then some more was written in C++. Since then all the code has been converted to at least compile with a C++ compiler. It was then released as open source in 2005 by Hewlett Packard and the University of Nevada, Las Vegas (UNLV). Tesseract development has been sponsored by Google since 2006.

After a joint project between HP Labs Bristol, and HPs scanner division in Colorado, Tesseract had a significant lead in accuracy over the commercial engines, but did not become a product. The next stage of its development was back in HP Labs Bristol as an investigation of OCR for compression. Work concentrated more on improving rejection efficiency than on base-level accuracy. At the end of this project, at the end of 1994, development ceased entirely. The engine was sent to UNLV for the 1995 Annual Test of OCR Accuracy, where it proved its worth against the commercial engines of the time. In late 2005, HP released Tesseract for open source.

Tesseract was in the top three OCR engines in terms of character accuracy in 1995. It is available for Linux, Windows and Mac OS X, however, due to limited resources only Windows and Ubuntu are rigorously tested by developers.

Tesseract up to and including version 2 could only accept TIFF images of simple one column text as inputs. These early versions did not include layout analysis and so inputting multi-columned text, images, or equations produced a garbled output. Since version 3.00 Tesseract has supported output text formatting, hOCR positional information and page layout analysis. Support for a number of new image formats was added using the Leptonica library. Tesseract can detect whether text is monospaced or proportional . The initial versions of Tesseract could only recognize English language text. Tesseract v2 added six additional Western languages . Version 3 extended language support significantly to include ideographic (Chinese & Japanese) and right-to-left languages as well many more scripts. V3.04, released in July 2015, added an additional 39 language/script combinations, bringing the total count of support languages to over 100. If Tesseract is used to process right-to-left text such Arabic or Hebrew the results are ordered as though it is left-to-right text.

Tesseract is suitable for use as a backend, and can be used for more complicated OCR tasks including layout analysis by using a frontend such as OCRopus.Tesseract's output will be very poor quality if the input images are not preprocessed to suit it: Images (especially screenshots) must be scaled up such that the text x-height is at least 20 pixels, any rotation or skew must be corrected or no text will be recognized, low-frequency changes in brightness must be high-pass filtered, or Tesseract's binarization stage will destroy much of the page, and dark borders must be manually removed, or they will be misinterpreted as characters.Tesseract does not come with a GUI and is instead run from the command-line interface.

Tesseract is an OCR engine rather than a fully featured program similar to commercial OCR software such as Nuances Omnipage. It was originally intended to serve as a component part of other programs or systems. Although Tesseract works from the command line, to be usable by the average user the engine must be integrated into other programs or interfaces, such as FreeOCR.net, WeOCR or OCRpous. Without integration into programs such as these, Tesseract has no page layout analysis, no output formatting and no graphical user interface (GUI).

Brief overview of how Tesseract works:

- Outlines are analysed and stored.
- Outlines are gathered together as Blobs.
- Blobs are organized into text lines.
- Text lines are broken into words.
- First pass of recognition process attempts to recognize each word in turn.
- Satisfactory words passed to adaptive trainer.
- Lessons learned by adaptive trainer employed in a second pass, which attempts recognize the words that were not recognized satisfactorily in the first pass.
- Fuzzy spaces resolved and text checked for small caps.
- Digital texts are outputted.

During these processes, Tesseract uses:

- algorithms for detecting text lines from a skewed page.
- algorithms for detecting proportional and non proportional words (a proportional word is a word where all the letters are the same width).
- algorithms for chopping joined characters and for associating broken characters.
- linguistic analysis to identify the most likely word formed by a cluster of characters.
- two character classifiers: a static classifier, and an adaptive classifier which employs training data, and which is better at distinguishing between upper and lower case letters.

Tesseract development is currently being led by Google, under the direction of Ray Smith, Tesseracts original developer and one of the foremost experts on OCR technology. Although the participation of Google is of obvious benefit to the project, detailed information concerning the exact nature of the work being undertaken by Googles software engineers between updates is not made publicly available. It is therefore difficult for independent developers to coordinate their work with that being done by Google, and presently developers cannot be certain that their work will be compatible with, and not duplicate, work already carried out by Google.

Chapter 3

Automatic Toll System

This chapter gives idea about the design, architecture and working process of the automatic toll system. Automatic toll system is a user friendly toll system which saves time and reduces traffic conjunction. A camera will capture the image of number plate of the fast moving vehicle. Using image processing techniques the registration number of the vehicle is extracted.

This registration is passed on to the central server. At the server, it matches the obtained number against the central database and obtains the vehicle type and the registered owner's details. A corresponding charge is added against the owner's name depending upon the type of vehicle as identified from the central database based on the registration number extracted from the captured image.

3.1 Design

Automatic toll system is designed mainly to avoid traffic congestion due to toll booths. At present, customers have to wait at the toll booth, for long times, to pay the collector. This wait time can go up because of various factors such as arguments between the commuters and the teller or from the lack of exact change to tender. Automated toll system would successfully remove unnecessary traffic delays; keep an eye on any car that might not be correctly registered or number plates exchanged for theft purpose. Automated toll collection is fast becoming a globally accepted for toll collection.

As compared to the existing alternative the proposed system does not involve any one time installation of tags such as NFC, barcode or laser tags on each and every vehicle, which is a tedious task.

For collecting toll fee an online system is used. In this system the user can check whether his or her vehicle has any due payment. The user can pay their toll payment using the given online system. This online system is linked with

RTO database. So the user only has to enter the vehicle registration number. On entering the vehicle registration number,the system displays details of the vehicle, the user also gets information about the amount due.

In order to charge toll fee for a vehicle, a camera module will take a photo of the fast moving vehicle. The image will include the vehicle registration number. An image preparation for text extraction of the vehicle registration number is performed using functions predefined in Opencv library. The operations performed on the image include conversion to Grey scale, contour mapping, Gaussian filtering and inverting black and white, all to exclude unwanted background details and remove unwanted noise. Text extraction is performed using Tesseract engine. The registration number extracted is compared with the list of vehicles in the RTO database and the central server used in the project updates the database accessed in the online system with an increment in the payment to be done for vehicle corresponding to the extracted registration number.

The proposed system is designed using only open source software and by using minimum components. The algorithms have been fine tined to maximize efficiency so as to maintain a high price to performance ratio.

3.2 Architecture

The architecture of the automatic toll system consists of a Raspberry Pi 2 model B, camera module(pi camera), and a trigger module. The main component of the automatic toll system is the Raspberry Pi board, it works like a central processor of the system. It is responsible for extracting the registration number from the image of the vehicle obtained from the camera. It gets the input in the form of an image coming from the camera module. The image is taken upon a trigger produced by the trigger module. The trigger module can consist of pressure sensitive plates installed on the road or it can be infrared detectors installed to sense an arriving vehicle.

Based on the trigger the speed and distance of the vehicle from the designated point can be calculated. The time required by the vehicle to reach the designated point can be calculated. The designated point can be defined as the point on the road from which the camera can take the best picture of the vehicle along with its registration plate.

The image processing unit prepares the image for text extraction. It eliminates all unwanted noise and unwanted details from the image. The output of the image processing unit is a black and white image with the text of the registration plate highlighted and all the other noise removed. This image is then passed on to the text extraction module. The text extraction module extracts the text from the image based. It consists of the Tessaract engine. The engine is tuned to look for only a particular set of characters and a particular

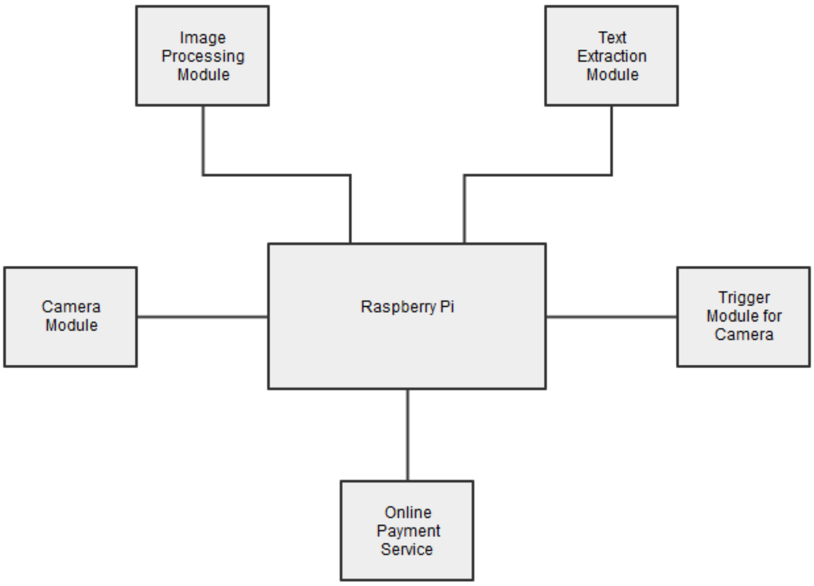

Figure 3.1: System Architecture

type of string defined by a regular expression because the characters and type of a registration plate number are defined and this is limited search field will help increase efficiency.

The Fig 3.1 shows the basic outline of the system architecture. The extracted vehicle registration number is then passed on to the online payment service. This service matches the obtained string against the database to identify the vehicle type and the owner. The system then adds the amount due against the owner's name depending upon the vehicle type. The owner can then make the payment through the online service as per his/her convenience.

3.3 Explanation of work

To describe the working of the system. The Automatic toll system consists of two parts,

- Vehicle registration number recognition.

  In Automatic toll system a camera module will take the image of the number plate. From this image the registration number of the vehicle is extracted.Using this registration number of the vehicle toll fee is added into the database corresponding vehicle registration number. The user can pay their toll fee using the online system. The requirements in this step are that the camera should be set at an angle from where it can capture an image of the vehicle that contains the registration plate. The

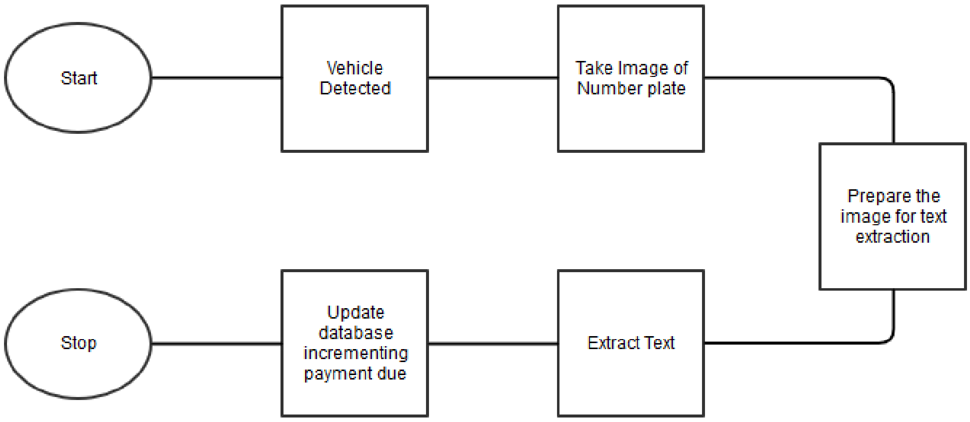

Figure 3.2: Flowchart : Text Extraction

camera should also have a high shutter speed to be able to catch still images of moving vehicles.

The Fig 3.2 shows a basic flow of control within the system for extraction of the registration number from the photo taken. Text extraction from the raw image is time consuming and the results have low efficiency. Hence the image is passed through various steps of image processing to improve character recognition efficiency. First the image is converted to a resolution of 640 x 480 without retaining aspect ratio. Then the picture is trimmed by 40 pixels on the left and 50 pixels on the top.

Figure 3.3: Sample Input Image

The Fig 3.3 shows the sample input image captured by the camera which shows the registration plate of the vehicle. The remaining steps make use of the OpenCV library for image processing. First the image is converted to Grey scale effectively reducing the number of colors present and reducing the complexity of the algorithm that follows.

Figure 3.4: Image in grey scale

The Fig 3.4 shows how the image will look like once is has been trimmed and converted to grey scale. The image is then subjected to contour mapping to identify the most important contour plain in the image. The identified contour is then retained and the all the remaining areas are blurred. This is done to reduce the importance of the background and also help with noise reduction. The output of this phase will be an image in which the element that is clear will be the vehicle registration plate and all other elements will be blurred.

Figure 3.5: Contour filtered image

The Fig 3.5 shows how the image will look like after contour mapping is carried out and the background has been blurred leaving a the registration plate as the clear and dominating element of the picture. The blurring ensure that all the regions except the mapped contour region are treated as unwanted and will be excluded from the image in the next phase. This image is then passed through a Gaussian filter that will filter out the image based on threshold values. The threshold value set for this system is 65. All the pixels which after going through the Gaussian filter has a Gaussian value greater than 65 are set to black and all other pixels are set to white. The process thus converts a Grey scale image to black and white. This will further reduce the difference between the various pixels used to represent the image further reducing the complexity of the algorithm that follows. In the final image the only elements visibly detectable will be the characters of the vehicle registration number.

Figure 3.6: Black and white image

The Fig 3.6 shows how the image will look like after it has been passed through the Gaussian filter. The image will be mostly dark and the characters will be in white. The image thus obtained will have all the prominent details of the image shown in white and the all the associated spaces near it shown in black. This image now needs to inverted in terms of black and white to highlight the regions necessary.

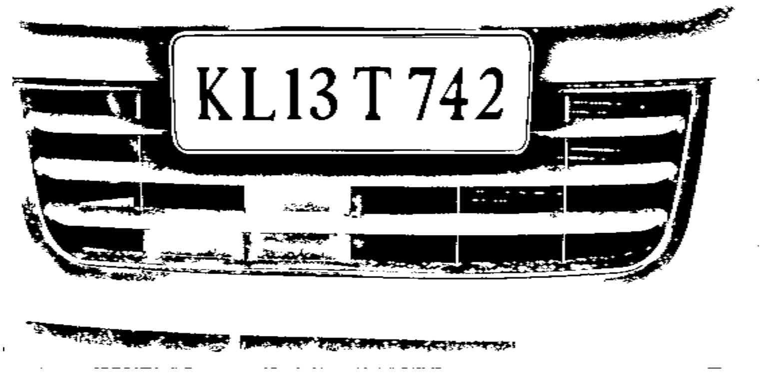

Figure 3.7: Final output image

Fig 3.7 shows how the final image will look like after inversion. All the background details and noise has been filtered out. The only prominent details that survive are the numbers of the registration plate.

After this the image is ready for text extraction. The text extraction is done using an open source engine called Tesseract Engine. The image is converted into a .tiff format before text extraction. This is done using image magic. The .tiff format is preferred by the Tesseract engine. The engine works upon the image and identifies the characters present in the image. The engine is capable of identifying many languages and characters. Hence, to improve efficiency we limit the language to English and the character set to a set of 36 characters. The 36 characters being the numbers 0-9 and the alphabets A-Z in capitals. This reduces the domain of optical character recognition functions that the engine may have to perform and will increase the efficiency as the engine now has to look only for a smaller set of characters.

The text extraction from the image happens in a series of steps. The first step is line finding. This step analyses the image and finds out he regions where text is present. The next step is baseline fitting. This step involves analyzing if the line is straight, if not it attaches a baseline along with the identified text area with respect to which the text will appear straight. Once the text lines have been found, the baselines are fitted more precisely using a quadratic spline. This was another first for an OCR system, and enabled Tesseract to handle pages with curved baselines, which are a common artifact in scanning, and not just at book bindings.

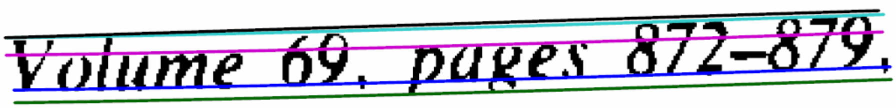

Figure 3.8: Baseline Fitting

The Fig 3.8 shows how the base line of the text region was identified and how the base lines were fitted. The third step is fixed pitch detection and chopping. Once the text area has been identified Tesseract will chop the area into separate units such that one unit contains only one character of text.Tesseract tests the text lines to determine whether they are fixed pitch. Where it finds fixed pitch text, Tesseract chops the words into characters using the pitch, and disables the chopper and associator on these words for the word recognition step.

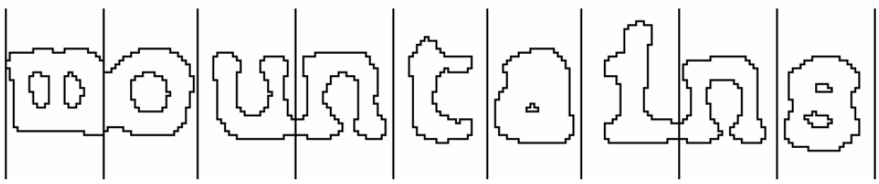

Figure 3.9: Chopping into characters

The Fig 3.9 shows how the identified text ares is chopped in parts such that only once character is present in each part. The lest step is word finding. The identified and chopped up characters now have to grouped into words depending upon the spaces between the characters.

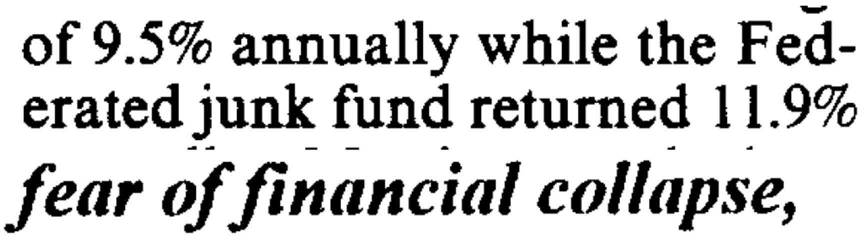

Figure 3.10: Grouping into words

The Fig 3.10 shows how the text area characters chopped up are grouped into words depending upon the difference in space between the characters. The gap between the tens and units of 11.9 % is a similar size to the general space, and is certainly larger than the kerned space between erated and junk. There is no horizontal gap at all between the bounding boxes of of and financial. Tesseract solves most of these problems by measuring gaps in a limited vertical range between the baseline and mean line. Spaces that are close to the threshold at this stage are made fuzzy, so that a final decision can be made after word recognition.

The text extracted from the image may not always contain just the vehicle registration number. It may at times contain extra characters extracted by the engine from noise and background information that had survived the image processing. Hence it is important to process and output text and subject it to pattern matching. A regular expression is defined which defines the regular pattern of a vehicle registration number. The regular expression is defined in equation 3.1

$$[A-Z][A-Z][0-9]\{1-2\}[A-Z]\{1-2\}[0-9]\{1-4\} \tag{3.1}$$

The regular expression defines that the string must begin with two capital letters, followed by upto 2 digits, followed by upto 2 alphabets which is followed by upto 4 digits. The regular expression helps eliminate all the unwanted characters that may appear in the extracted text and brings out just the required vehicle registration number. The final string output obtained from this phase is passed on to the Online system for calculating the dues.

- Online system for paying dues.

  The final vehicle registration number obtained from the first part is used as the input for the second part of the system. The obtained string is passed on to the database where is it matched against all records until a match is found. The owner and vehicle type parameters from the matching record are identified. The due is calculated as per the vehicle type and added in the records against the owner's name.

The owner can then pay this bill as per his convenience online by visiting the payment website.

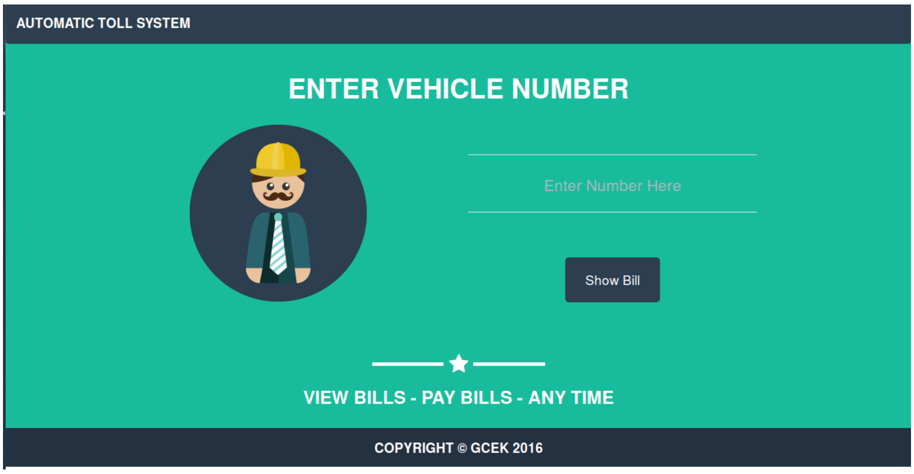

Figure 3.11: Website Home Page

The home page of the website as shown in Fig 3.11. All the user has to do is type in his vehicle registration number in the field provided and then the system will redirect the user to the user's page. The new amount due for the user is calculated by using the formula

$$TolalAmountDue = TolalAmountDue + CurrentDue \tag{3.2}$$

Where the current due is obtained from the database as per the type of the vehicle and the total amount due can also be obtained from the database as the total amounting pending against the user.

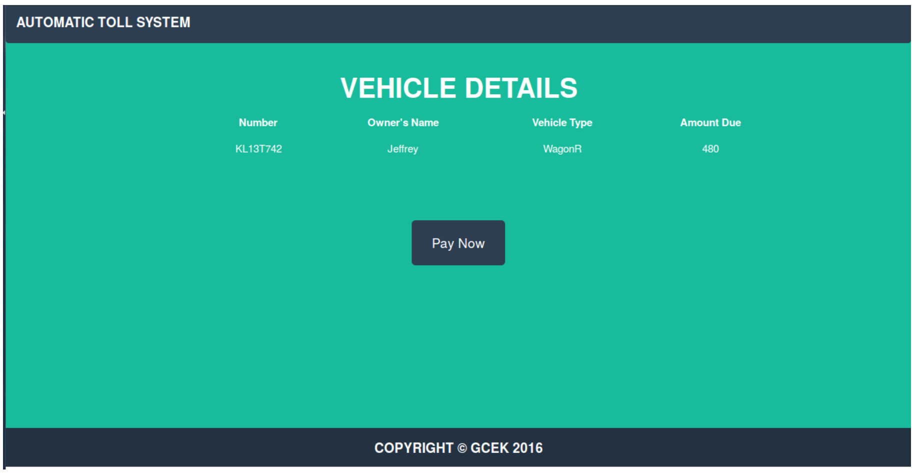

Figure 3.12: Page showing user details

The page showing user details is shown in Fig 3.12. This page will contain the user's name, the vehicle type and the amount due for the corresponding vehicle registration number. The user can view and pay the bill as per convenience by clicking on the " Pay Now " button and completing the bank transaction. Once the transaction is complete and the authorization is obtained the amount due for the user will be calculated accordingly.

Chapter 4

Experimental Setup and Results

This chapter discusses the experimental setup of the proposed system and the validation phase.

4.1 Experimental Setup

For experimental purpose the following setup need to be done. Camera used for taking photos of the number plates of the vehicles passing through the toll station is the Pi camera, which is connected to the Raspbrry Pi. The camera is set up from an angle that allows it to take a shot of the vehicle's front that contains the registration plate. A simple trigger is used to trigger the camera upon the arrival of the vehicle. The trigger used can be pressure plates on the road, which work by identify the approaching vehicle by the pressure it applies on the road, or even by infrared detectors. The

Raspberry Pi is used as the central processing hub. All the data is relayed to it. It controls all the flow of information and the functioning of the system. It accepts the image as input and performs the necessary functions such as conversion to Grey scale, contour mapping, Gaussian filter and color inversion to improve its efficiency for text extraction. The extraction engine itself is restricted to a particular language and a particular domain of characters to increase its efficiency and reduced computation time required. The processed image is then passed on to the text extraction engine which extracts the text and filters out the result as per the regular expression defined. This string is passed onto the online system which bills the corresponding due against the vehicle's owner. Raspberry Pi gets power via a 5V, 2A adapter.

4.2 Performance of the System

The table 4.1 shows the performance of the system as compared to the existing traditional methods of toll collection that involves the employment of human resources.

Features	Existing System	Proposed System
Need for Human Resource	Yes	No
Wait time at Toll Stations	High	Very Low
Facility to pay later/online	No	Yes
Cost of implementing	High (Worker's wages keep increasing)	One time cost only

Table 4.1: Comparison between existing system and proposed system

The table 4.2 shows the performance of the proposed system when compared to alternative automation prototypes.

Features	Alternative Prototypes	Proposed System
One time installation of tags	Required	Not required
Need for Human Resource	Yes (For vehicles without installed tags)	No
Facility to pay later/online	Yes	Yes
Challenges in implementation	Complex Machinery required	Only a simple camera required

Table 4.2: Comparison between Alternative Prototypes and proposed system

The alternative prototypes may include barcode tags based automation, Infrared tags based automation, NFC tags based automation and automation using a high definition video stream as input.

4.3 Results

The proposed system has successfully helped in reducing waiting time at toll stations and has reduced the dependence on human resource at toll stations. The human resource if at all required will be only for system updation or maintenance. As compared to other automation models available there is no need for a one time installation or any component such as a bar code tag or a NFC tag or a IR tag on all vehicles. The system provides an option of paying later/online as per one's convenience. This eliminated the extra waiting incurred due to the lack of exact change to tender.

The main driving factors for the adoption of this system are reducing reliance on human resource and reduction in wait time at toll stations.

The testing was successfully done. The results show that the proposed system is an ample replacement for the existing toll collection system.

Chapter 5

Conclusions and Future Work

5.1 Conclusion

The implementation of automated toll system will significantly contribute to improve travel conditions by addressing delay caused by both recurring and nonrecurring congestion. People hate the delay at tollbooths. This system collects toll from the vehicles driving on toll roads without making the vehicle stop at Tollbooths. These systems include benefits to both toll authorities and facility users, in terms of time and cost saving, improved security, increased capacity and greater convenience. This system provides a broad overview for collecting toll and thus provides advantage to toll operators and commuters alike.

Thus a system used as an Automated Toll collection booth, based on image processing saves the time at toll booth, minimizes the fuel consumption during the idle condition of the vehicle. In turn we can save the environment from emission of extra carbon monoxide . Hence we can save our country. The system helps attain automation of toll stations, the only human resource needed after the implementation of this system will be for updation and maintenance. Also it serves in providing the tracking system for theft vehicle which is secured and highly reliable can be obtained. It can be used to remove all drawbacks with the current system such as time and human effort and it also doesnt require any tag to be attached to all the vehicles,the only thing required is a good quality camera and fixed font number plate on each vehicle.

5.2 Future Scope

This system has many more options of advancement and expansion. This can be used to track and alert when it scans any number plate that has been flagged as a stolen vehicle. The system can be extended to recognize the color and shape of the vehicle and sort them. This can be used to identify illegal modifications and changing the color of the vehicle without updating in the registry and without paying the fees for the same. Using the vehicle classification the system can analyze and check if the vehicle registration number displayed on the vehicle matches the vehicle type as per the database or the vehicle is using a fake registration number.

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