DEVELOPMENT OF AUTOMATIC DIGITIZATION OF TRUCK NUMBER IN OPEN CAST MINES USING MICROCONTROLLER

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF TECHNOLOGY

IN

MINING ENGINEERING

BY

KAMAUL HOQUE KHAN

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DEPARTMENT OF MINING ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

ROURKELA – 769 008

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ROURKELA

CERTIFICATE

This is to certify that the thesis entitled, "***Development of Automatic Digitization of Truck Number in Open Cast Mines using Microcontroller***" submitted by **Kamaul Hoque Khan** bearing Roll No. **213MN1493** in partial fulfilment for the award of Master of Technology in Mining Engineering at National Institute of Technology Rourkela, is a record of original research work carried out under my supervision.

The contents of this thesis have not been submitted elsewhere for the award of any degree what so ever to the best of my knowledge.

Date: 23rd May, 2015

Place: NIT Rourkela

Dr. Singam Jayanthu
Department of Mining Engineering
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ABSTRACT

Geological condition in mines appears to be extremely complicated and there are many intelligence security problems. Production is falsely transfer by the unauthorized truck from mine pits also at loading point. It also lifted in wrong ways by malfunctioning of the truck weight in Weigh Bridge. Mining organizations are under the control of mafia and countless can be added to the mines mafia. An intelligence security system is need to monitor truck number in automatically using image acquisition method, automatic detection, recognition process, communication technology, information technology and microcontroller innovation to understand the working specification of the mining region.

Tracking of the number plate from the truck is an important task, which demands intelligent solution. Intelligent surveillance in open casts mine security network using data accession is a prime task that protects the secure production of mines. So automatic truck number recognition technique is used to recognize the registration number of the truck which is used for transferring the mine production as well as track record the amount of the production. It also preserves the mines and thus improving its security. For extraction and recognition of number plate from truck image the system is uses MATLAB software tool. It is assumed that images of the truck have been captured from digital camera. The data acquisition terminal uses the PIC16F877A microcontroller as a core chip for sending data. The data are communicated through USB to TTL converter (RS232) with the main circuit to realize intelligent monitoring. To store the data in permanently it is uses EEPROM chip. Alphanumeric Characters on plate has been extracted and recognized using template images of alphanumeric characters. The proposed system performs the real time data monitoring to recognize the registration number plate of the trucks for getting required important information. It also provides to maintenance the history of data and support access control.

CONTENTS

LIST OF FIGURE

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LIST OF ABBREVIATIONS

SL NO.	ABBREVIATION	DEFINITION
1	AC	Alternating Current
2	ACPR	Adaptive Car Plate Recognition
3	A/D	Analog to Digital Converter
4	ALPR	Automatic License Plate Recognition
5	ANPR	Automatic Number Plate Recognition
6	BOR	Brown out Reset
7	CBQ	Class Based Queuing
8	Cb/Cr	Chroma Components
9	CCTV	Closed Circuit Television
10	CD	Carrier Data
11	CMOS	Complementary Metal Oxide Semiconductor
12	CS	Chip Select
13	CTS	Clear to Send
14	DC	Direct Current
15	DPDT	Double Pole Double Throw
16	DPST	Double Pole Single Throw
17	DSP	Digital Signal Processor
18	DSR	Data Set Ready
19	DTR	Data Terminal Ready
20	EEPROM	Electrically Erasable Programmable ROM
21	EmQCG	Embedded QoS Control Gateway
22	FPGA	Field Programmable Gate Array
23	HD	High Definition
24	LPL	License Plate Localization
25	MATLAB	Matrix Laboratory
26	NPL	Number Plate Localization
27	NTSC	National Television System Committee

28	OCR	Optical Character Recognition
29	PAL	Phase Alternate Line
30	PIC	Peripheral Interface Controller
31	PSP	Parallel Slave Port
32	PWM	Pulse Width Modulation
33	QoS	Quality of Service
34	RC	Reset Capacitor
35	RD	Read Data
36	RGB	Red Green Blue
37	ROI	Region of Interest
38	RTS	Request to Send
39	SPI	Serial Peripheral Interface
40	SSP	Synchronous Serial Port
41	TTL	Transistor-Transistor Logic
42	USART	Universal Synchronous Asynchronous Receiver Transmitter
43	V_{CC}	Voltage Controller current
44	V_{DD}	Voltage Drain to Drain
45	V_{SS}	Voltage Source to Source
46	VXR	Voice Exchange Router
47	ZIF	Zero Insertion Force

CHAPTER 1

INTRODUCTION

- Objective of the Project
- Significance of the Project
- Methodology of the Project
- Organization of the Thesis

1.0 INTRODUCTION

Mines surveillance security system is an active research topic in computer vision that tries to detect recognize and track the truck number over a sequence of images and it also makes an attempt to understand and describe object behaviour, truck activity by replacing the aging old traditional method of monitoring data by human operators. In open cast mines there are two sorts of security framework required, one for person and another for creation as mines region is the high hazard calling and specialized framework which is modestly in opposite [1]. Security system is the most essential factor in open cast mines. Implementation of mine risk free production with proper security protection is the best way to ensure the safety in mines production. Presently in mines region, there are principally taking the following aspects to impact the safety in mine production.

- ✓ Environmental parameters: Carbon Monoxide, Methane, Gas, Temperature, Humidity, Pressure of the roof, Coal Position of the Bunker etc.
- ✓ Electromechanical Parameters: Belt conveyer, Transport fixes, Electric Current, Voltage and so on [2].

With increasing number of truck in mines area, it is getting difficult and time taking for manually taking the truck number. Weigh Bridges are constructed for taking the quantity of mines production but the truck numbers are taking manually. In main entrance and exit of mines area the truck has to stop for checking registration number and others security reasons. Also, traffic enforcement systems are established in mines area to check for truck movement by prescribed rules. All these activities have a scope of development for automatic data monitoring. In the centre of all the systems consist of trucks and others vehicle in mines area. In order to monitor and automate the trucks movements activities and make them more efficient, a system is required to clearly identify a truck or others vehicle in mines area.

In brief, intelligent surveillance open casts mine security system using data acquisition, character recognition is to monitor data that protect the secure production of mine [3]. So automatic truck number digitization technique is used to recognize the registration number of the truck which is used for transporting the mine production as well as track record the amount of the production.

1.1 Objective of the Project

The main objective of the project is development of automatic digitization of truck number in open cast mines using PIC16F877A microcontroller.

1.2 Significance of the Project

Significance of the project may be expressed as follows:

- ✓ In mines region everything is monitored automatically except truck registration number.
- ✓ To monitor the data, mostly digitization the parameters like truck number recognition, record the history of production take out and to be lifted, a mine intelligence security system using data acquisition, character recognition and access control plays an important role to the entire mining region.
- ✓ To avoid the dangerous accident for traffic purpose in mining area [4]
- ✓ It also stores the data and print the quantity of production in Weigh Bridge.
- ✓ It is used for combine management and monitoring of the mines security region.
- ✓ The software part of the system is consisting of truck number monitoring and based on MATLAB 12 software tool.
- ✓ The total system will monitor the real time data with comprised of computer and serial communication interface.
- ✓ In hardware part the system consists of PIC16F877A microcontroller, RS 232 serial communication, relays, DC motor, power supply, ZIF socket etc.

Due to high capacity of open cast mines 10 millions of tonnes of coal per annum and wide deployment of shovel dumper combined utilization of trucks for coal transport. A typical scenario of trucks or dumper loading point and transportation system in open cast coal mines is shown in figure 1.1 and figure 1.2.

Figure 1.1: Trucks or dumpers loading point in open cast mines

Figure 1.2: Transportation system in open cast mines

There is an urgent requirement of digitization of trucks or dumper number for further automation. Recent trend in utilization of trucks or dumpers dispatch with TDS system and fleet management system is shown in figure 1.3, 1.4 and 1.5.

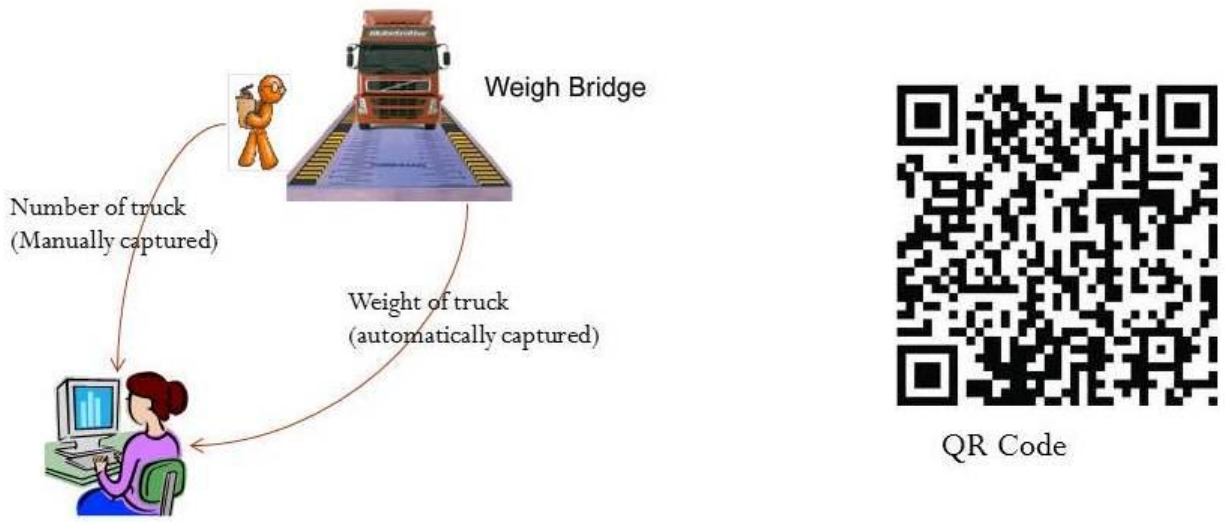


Figure 1.3: Automatic truck number digitization system using QR code

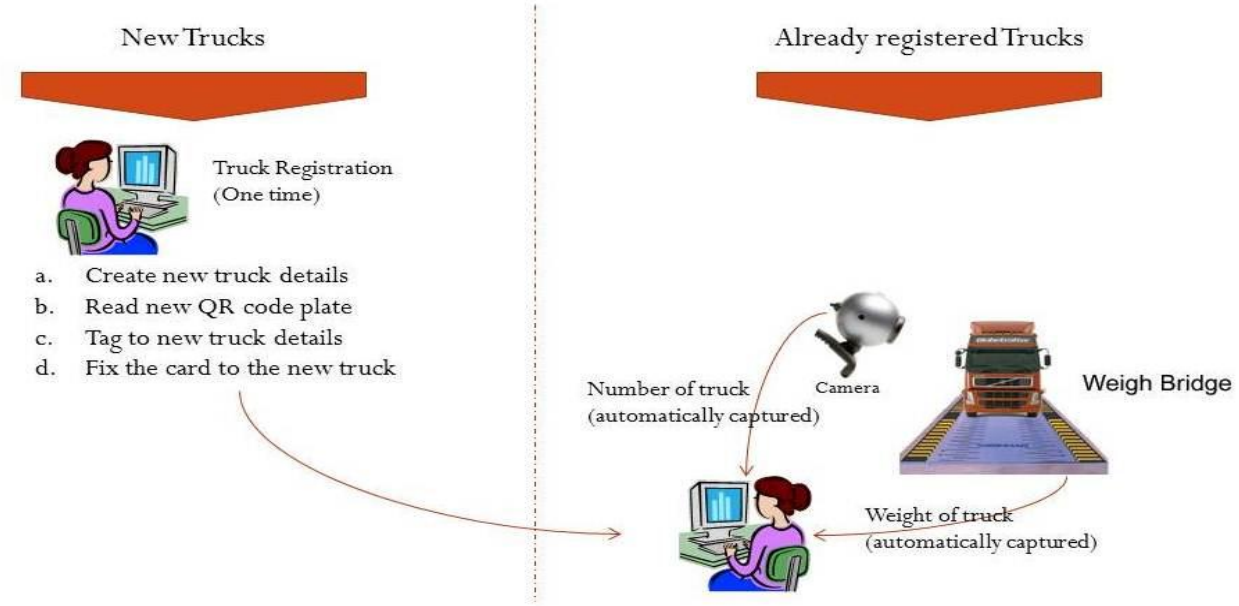


Figure 1.4: Automatic truck number digitization

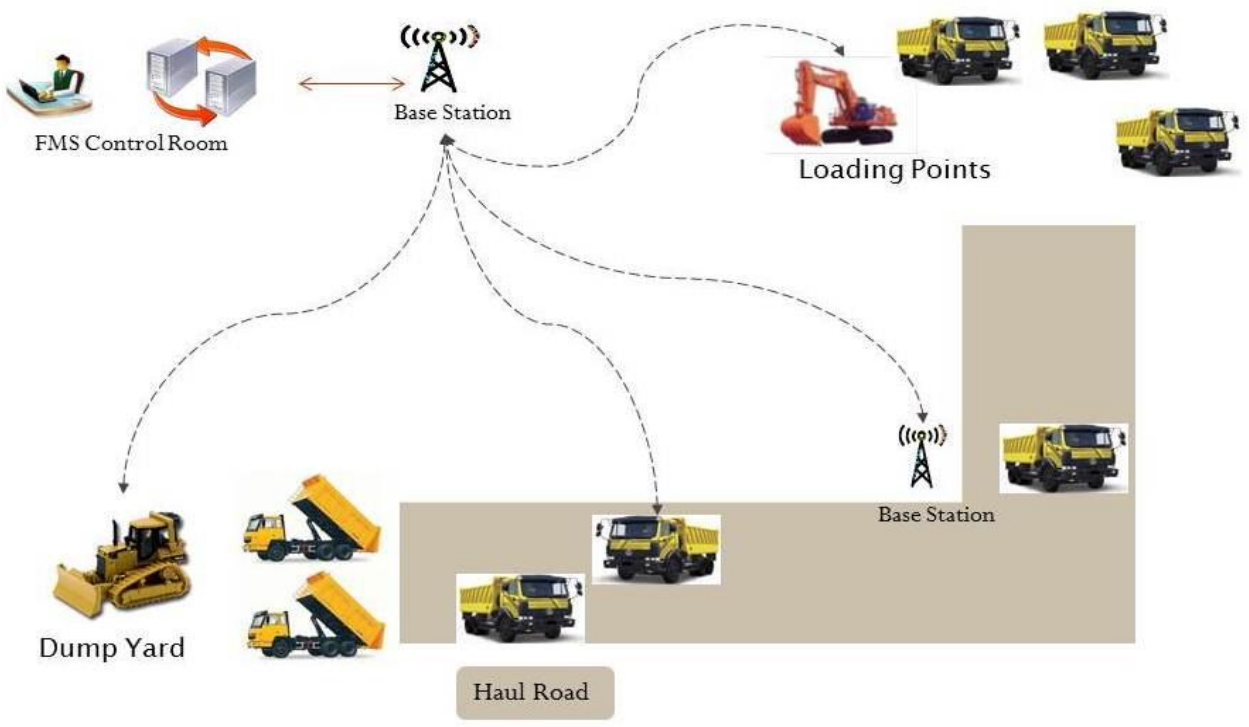


Figure 1.5: Fleet management system in open cast mines

The main motivation of this project is to recognize a number plate from an image provided by a high definition camera and gives the output as a digitized form. An effective algorithm is developed in MATLAB to detect number plate in different lighting constrain. The proposed algorithm detects the number plate from an input image provides by webcam and gives output as a text file.

Automatic digitization of truck number plate system is a mass surveillance security method that uses optical character detection on images to read truck registration number plates. It can use existing closed circuit television or road-rule CCTV cameras, or specify a particular work. It is used as a technique of tracking the truck and categorized the movements of traffic in mines region. Automatic digitization of truck number plate system can be used to record the truck images captured by the cameras as well as the text from the number plate. It can likewise be utilized with a few others configurable to store a photo of the driver. This innovation tends to be place oriented with plate contrast in various place.

PIC16F877A microcontroller is used in this system. The microcontroller is connected through serial bus communication or TTL converter. Serial bus communication will read the analog output through serial communication. The output of the serial communication is amplified and given to the microcontroller analog to digital converter. After that Microcontroller sends this information to the computer through serial bus communication. In algorithm part, MATLAB is used as a software tool to receive the data which are sends from the microcontroller. A webcam is used to take image of the plate number of the truck. When a signal is received from the microcontroller a part of the number plate is taken through the webcam and saved in the computer memory. After acquiring the image it performs gray scale conversion, imfill the image, region of interest selection, segmentation and template matching. After that match the recognized image with the stored database images and gives output as a text file and send serial data to open the gate or not. [2]. Figure 1.1 shows the basic connection of components with microcontroller.

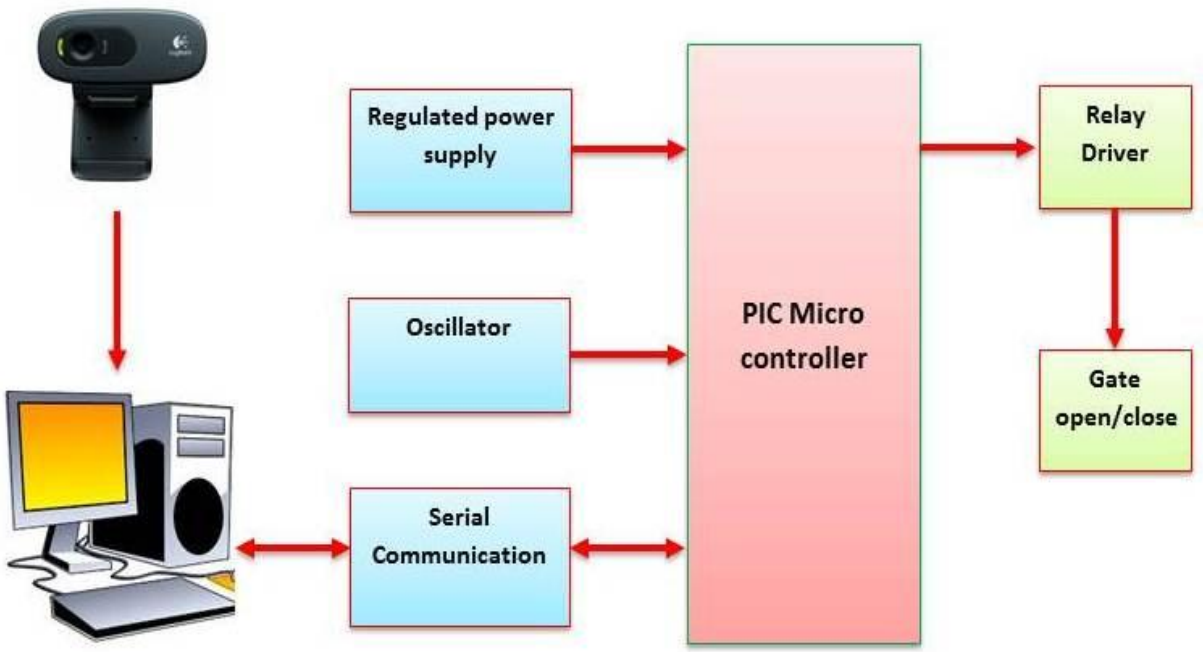


Figure 1.6: Basic connection of components

The procedure for collecting data in terminal uses the PIC language which follows the several functions:

- Every analog sensor parameters gathering the data and transform A/D converter. To control the system its gather the estimation of switch amount, open, stops, and other electrical criterion.
- Data calculation and memory, cautioning judgment, power source administration, and framework self-check.
- It conveys the information exchange with the concentrator taking the electrical cable as the medium through the serial communication.
- To carry on the prime data through the serial communication port for parameter establishment.

1.3 Methodology of the Project

A typical automatic digitization of truck number plate system in mines consists of a camera network, MATLAB as a software tool, PIC16F877A Microcontroller, USB to TTL converter works as a serial communication etc. which processes captured the number plate on-site and transmits the extracted number plate in real time. Here our focus is on the study of algorithmic part as well as real time implementation of such a system. MATLAB algorithm part consist of input image, color to gray conversion, binarization of image, imfill image, region of interest extraction, segmentation and text output. The methodology of the project is described by a flow chart in figure 1.2.

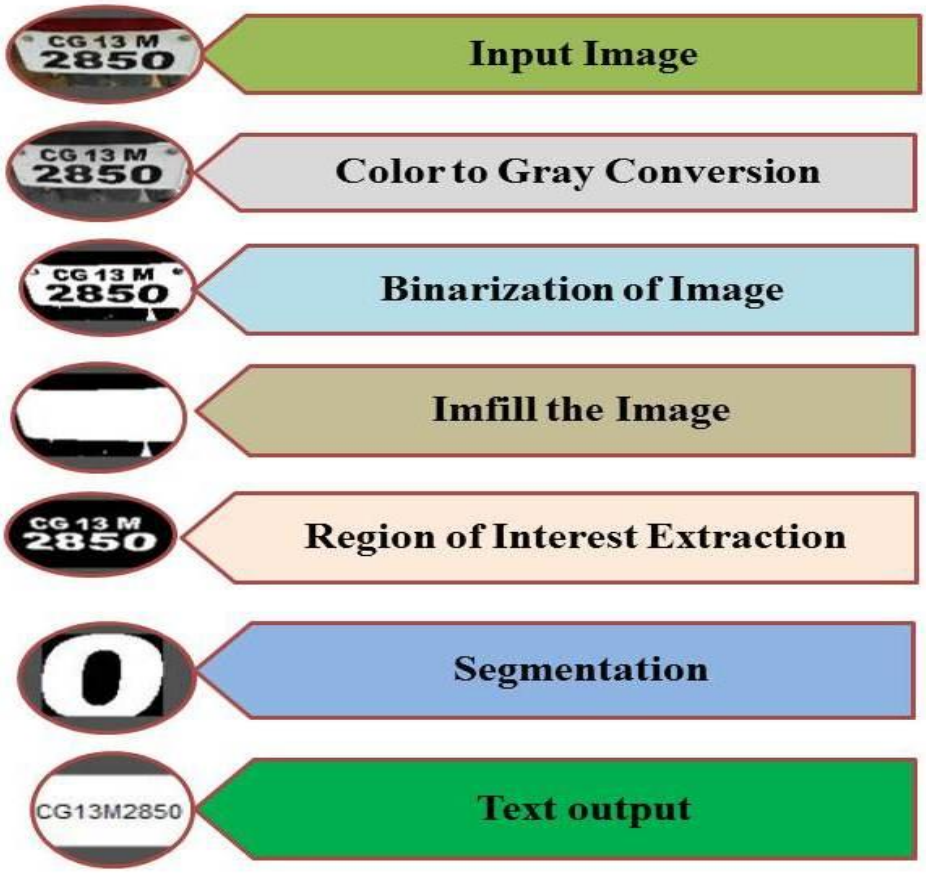


Fig 1.7: Flow chart of the project methodology

1.4 Organization of the Thesis

Chapter 1 contains the Introduction of research work, its importance, objective of the project, methodology of the project and organization of the thesis.

Chapter 2 presents literature review; previous research studies on automatic number plate recognition, fundamental of image processing, application of ANPR technology in mines and work done by other investigators.

Chapter 3 gives the basic components used for hardware implementation, PIC microcontroller, serial communication, relays, DC motor, power supply, transformer, rectifier and voltage regulator.

Chapter 4 presents the system implementation, software development in MATLAB, number plate recognition process, hardware implementation, circuit diagram, circuit development and real time number plate recognition technique.

Chapter 5 contains experimental investigation, results, discussion and analysis

Chapter 6 presents conclusion of the research work and scope for future work

CHAPTER 2

LITERATURE REVIEW

- Literature Review
- Automatic Number Plate Recognition
- Top Hat Transform Technique on License Plate
- Application of ANPR in Mines

2.0 LITERATURE REVIEW

The Automatic Number Plate Recognition (ANPR) was invented in 1976 at the Police Scientific Development Branch in the UK. Different number plate recognition techniques have been developed for the past few years for road enforcement and traffic surveillance. Each of these techniques has their own advantages and disadvantages. This system has been used only in road enforcement for a past few years in many countries like USA, Canada, and UK. Security system in mines area using data acquisition technology mainly monitors the activities such as taking the truck weight, amount of production extracted and to be transported, the date and time of loading the production in the truck.

2.1 Automatic License Plate Recognition

Automatic License Plate Recognition (ALPR) is used in intelligent transportation systems at parking region; track the vehicle during traffic signal disobedience and related applications. ALPR system consists of localization of license plate from vehicle image; segmentation of the characters images from the localized license plate recognition of segmented characters images as license plate number with template matching and gives as a text output which is in digitized form. Localization of license plate from the vehicle images is the most challenging task due to the huge variations in plate shape, size, texture, colour and plate region orientations in such images. License plate localization fails often due to the presence of complex background and non-uniform illumination of license plate due to varying lighting conditions [5].

2.2 Fundamental of Image Processing

A number plate is nothing but an image. An image is utilized to pass on valuable data in a noticeable configuration. An image is a course of action of small components in a two-dimensional plane. These small components are called pixels. An expansive number of pixels consolidate together to shape an image, whether little or extensive. Every pixel speaks to certain data about the image, similar to brightness, shading, light force and luminance. A substantial number of such pixels consolidate together to frame an image. Pixel is the fundamental component used to draw an image. Basically, every pixel in an image is described to in either RGB (Red Green Blue) arrangement or YCbCr position. For RGB picture, all the three

segments, specifically R, G and B join together to pass on data about the shading and brightness of a particular pixel. Every part devours certain memory space at the time of image preparing. In the event of an YCbCr picture, every pixel in a picture is described to as a comprised of Y and Cb/Cr values. Here, Y remains for luminance, which depicts light power, and Cb/Cr remains for Chroma part, which represent shading data for an image. Over the time, it has been found that YCbCr parts of a picture pass on adequate measure of data contrasted with its partners RGB, with less measure of memory space. This is a noteworthy favourable position these days, as the majority of the applications require adequate data at high velocity and less storing space [6].

2.2.1 RGB format

For RGB image format, every pixel is described to by three unique segments R, G and B. Each of these segments requires minimum of 8 bits for their capacity. In case of single pixel there may require upto 8 × 3 bits for its capacity. The configuration of RGB format is shown in figure 2.1

Figure 2.1: Configuration of RGB image format [6]

The estimation value of R, G and B, every component fluctuates from 0 to 255. The estimation of (0, 0, 0) described to a dark pixel, (255, 0, 0) described to a red pixel and (0, 255, 0) described to a green pixel and (0, 0, 255) described blue pixel. Along these lines, 8 bits are required to store value for one segment [6].

2.2.2 YCbCr format

As opposed to RGB design, the YCbCr format is accessible with different type of interleaving. For example, a 4:2:2 YCbCr arrangement recommends that a solitary pixel is described by two segments, Y and C. Cb and Cr segments are interleaved among the pixels. So if one pixel is described by a comprise of Y and Cb, the neighbouring pixel will be spoken to by a mix of Y

and Cr. Aside from this if the Cb and Cr segments are interleaved, its impact is not visible to human eye [4]. Configuration of pixel in YCbCr format is shown in figure 2.2.

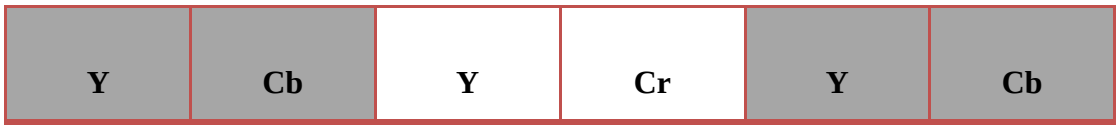


Figure 2.2: Configuration of YCbCr format [6]

The estimation values of Y, Cb and Cr changes from 0 to 255. Each of these segments requires minimum of 8 × 2 bits for their capacity which is less compared to that required by RGB format. The format for the type of storage is shown in figure 2.3.

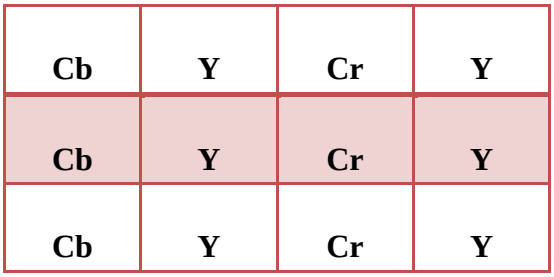


Figure 2.3: Frame buffer storage for input video frames [6]

In figure 2.3, it is seen that the storage capacity begins with a C segment and afterward a Y part. Consequently, at the 0th area, one can see the C segment while at the 1st and interchange areas of frame buffer one can see the Y part [6].

2.2.3 NTSC and PAL standards

NTSC and PAL are the two most regularly utilized norms utilized for television. NTSC remains for National Television System Committee. This standard is being utilized in most parts of Northern America and nations like South Korea, Japan. Features showed utilizing NTSC standard contains a succession of images with resolution of 720 × 480 pixels. The feature is shown at the edge rate of 30 casings every second. PAL stands for Phase Alternate Line. PAL standard is utilized principally as a part of nations like India, China, and United Kingdom. These

standard backing the feature resolution of 720 × 576 pixels at the edge rate of 25 edges every second [6].

2.3 Top Hat Transform Technique on License Plate

Arulmozhi .K et al. [7] proposed a smart, simple and efficient algorithm for Indian license plate localization using top hat transformation, which smoother the background of image and removes the non-uniform illumination. One of the important utilizations of these changes is in removing object from an image by utilizing a structuring component as a part of the opening operation that does not fit the items to be evacuated. The object removed by the top hat transform can be controlled by the decision of the organizing component. The greater the structuring component, the bigger the components removed from the gray scale image. The distinction operation then yields an image in which just the removed segments remain. The top hat transform is utilized for light protests on a dark background. A critical utilization of top hat transform is in revising the impacts of non-uniform light. The background image is smothered by top hat transform. Binary image is subjected to vertical edge identification calculation. The calculation recognizes the number plate region in the image, utilizing the arrangement of associated pixels. For this reason, morphological closing operation is performed on the edge held picture. The number plate is recognized by finding biggest associated part.

2.3.1 Mathematical morphological operators

Taking into account set theory, numerical morphology is built up by acquainting major operators applied with two sets [5]. One set is image and other is structuring component. Let P implies a grey scale 2D image, Q implies structuring element. The primary mathematical morphological operative is erosion and dilation, obtained from these, opening and closing operations are also defined. Dilation of a grey-scale image P (a, b) by a grey-scale structuring element Q(r, s) is denoted by

$$((P \oplus Q)(a, b) = \max \{P(a - r, b - s) + q(r, s)\} \ldots\ldots (1)$$

The domain of P, Q is the dilation of the domain of P by the domain of Q.

Erosion of a grey-scale image P (a, b) by a grey-scale structuring element Q(r, s) is denoted by

$$(P \oplus Q)(a, b) = \min \{P(a - r, b - s) + q(r, s)\} \ldots\ldots (2)$$

The domain of P, Q is the erosion of the domain of P by the domain of Q. Opening of a grey-scale image P (a, b) by a grey-scale structuring element Q(r, s) is denoted by

$$P \circ Q = (P \ominus Q) \oplus Q \quad \text{(3)}$$

Closing of a grey-scale image P (a, b) by a grey-scale structuring element q(r, s) is denoted by

$$P \bullet Q = (P \ominus Q) \oplus Q \quad \text{(4)}$$

The edge of image P, denoted by T (P), is defined as the difference set of the dilation domain of P, and the domain of P. This is also known as dilation residue edge detector

$$T_d(P) = (P \oplus Q) - 1 \quad \text{(5)}$$

Equivalently, the edge of image P, denoted by T (P), can also be defined as the difference set of the domain of P and the erosion domain of P. This is also known as erosion residue edge detector

$$T_e(P) = P - (P \ominus Q) \quad \text{(6)}$$

The opening top-hat transformation of image P, denoted as U (P), is defined as the difference set of the domain of P and the opening domain of P. It is defined as

$$VU_0(P) = 1 - (P \ominus Q) \quad \text{(7)}$$

2.3.2 Edge detection

Edge detection operation performed on the resultant gray scale image arrived due to top hat transformation. Some of the commonly used edge detectors are Sobel, Canny, Laplacian, Roberts etc. In this work to find edges of the license plate vertical Sobel edge detector is used. As the license plate areas containing more vertical edges, vertical edge detector is used.

2.3.3 Localization of number plate region

The area and aspect ratio values are used to detect the license plate region. The edge components having area in the range 0.2 to 0.99 and aspect ratio within the range 0.2 to 5 is retained and the others are eliminated. These ranges were chosen in accordance with the height and size of characters in the license plate. A region is a set of connected pixels. Hence, to recognize the number plate area in the image, the set of connected pixels need to be found out. For this purpose, morphological closing technique is used on the edge retained image. Closing operation on binary image is performed by applying morphological dilation on the image followed by morphological erosion. Closing operation tends to enhance the breaking points of limits regions

in an image and differentiation background shading gap in such regions [5]. Figure 2.4 shows the number plate extraction using top hat transform.

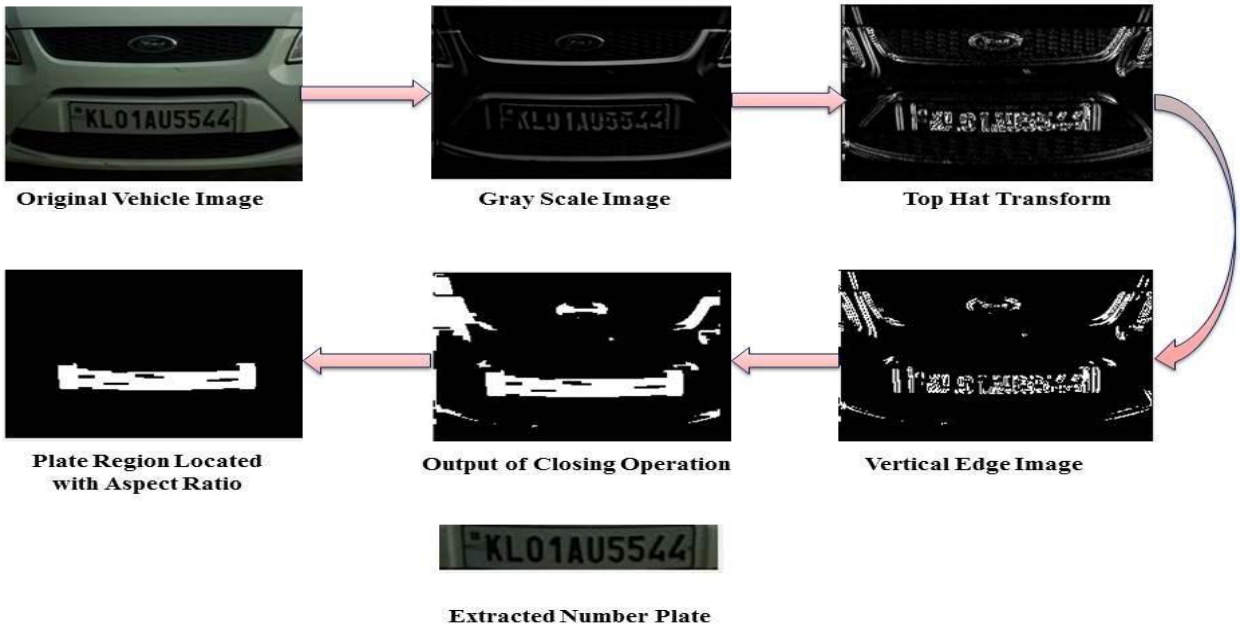


Figure 2.4: Number plate extraction using top hate transform technique [5]

Arth. C et al. [8] depicted the system in which number plate is recognized utilizing confidence related forecasts. As numerous recognitions are accessible for single number plate, post handling techniques are connected to combine every recognized district. Apart from this; trackers are utilized to point of confinement the pursuit locale to specific region in an image. Kwasnicka at el. [9] proposes an alternate methodology of recognition utilizing binarization and removal of not needed areas from an image. In this methodology, starting image preparing and binarization of an image is done in light of the differentiation in the middle of characters and background in number plate. In the wake of binarizing the picture, it is separated into distinctive high contrast areas. These locales are gone through removal stage to get the last area having most likelihood of containing a number plate [6]. In the year 2004, Percival. M. E et al. described street enforcement applications for mobile ANPR systems [10]. In this method the database was equipped with software that sought matches between database entries and license plate. Various ANPR techniques are being used from a long time in with the help of different instruments for different applications like tool collection, parking etc.

2.4 Application of ANPR in Mines

Intelligence surveillance security like automatic digitization of truck number plate system in mines area is to be required to monitor the data in automatically. The system utilizes automatic recognition of truck number, communication and microcontroller innovations to understand the operational parameter smart monitor management of truck or vehicle registration number to the whole mining range. Utilizing information procurement system fundamentally screens the parameter, for example, amount of production extracted and to be transported, the date and time of stacking the mines in the truck, access control thus on and additionally the fundamental generation to stop the switch parameter of mine generation security data, [11]. Contrasted and the traditional system, this framework subordinate controls PC and uses the CCTV camera, microcontroller chip with expanded accuracy of the information securing, the expert framework module can give the arrangement way when the mine remarkable operation is considered. Equipment some piece of the framework is involved information obtaining terminal, information concentrator and primary control PC. Programming part of the framework is consisting of mine monitoring data management framework taking into account MATLAB. It is utilized for incorporated administration and checking of the entire mining zone. The entire framework will exchange the real information to fundamental control PC checking program through the serial communication interface, to show, store, inquiry and print the mine amount and also record the image of the number plate utilizing camera [1]. Figure 2.5 shows the PC interfacing unit with MATLAB.

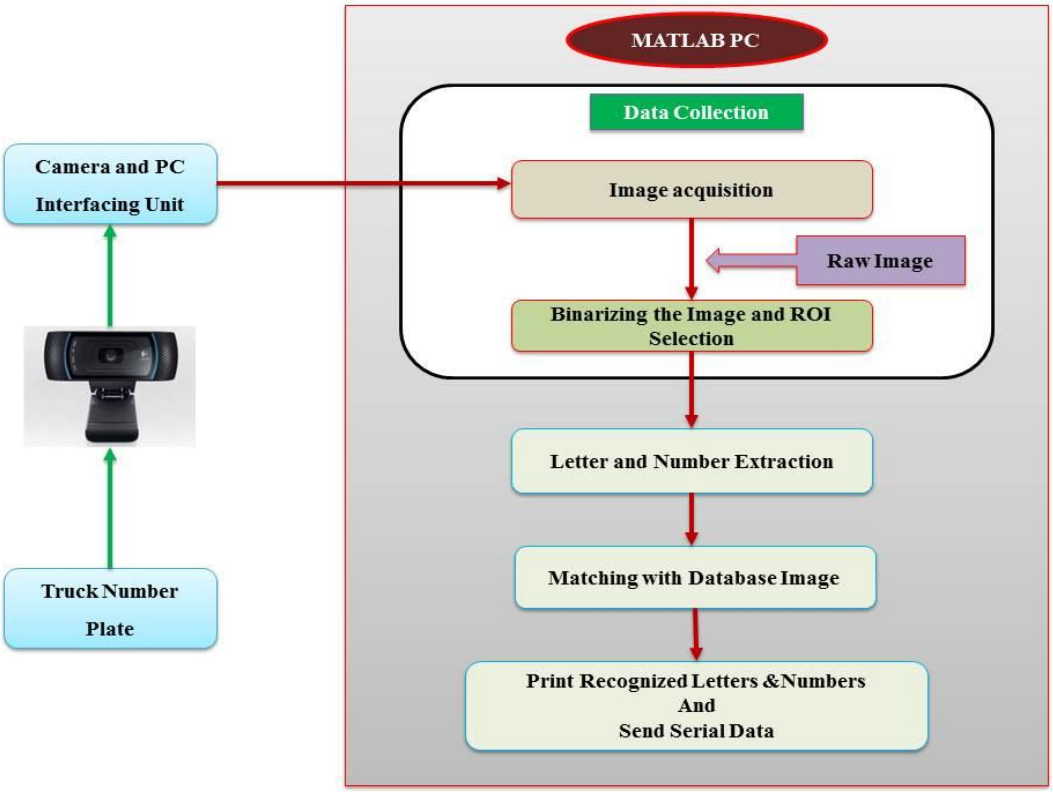


Figure 2.5: PC interfacing unit with MATLAB

There are various works done by different investigators on automatic number plate recognition technique for various applications. Some of the important findings by other investigators related to application of automatic number plate recognition are presented in table 2.1.

Table 2.1: Work done by other investigators

Year	Author	Important Finding	Conclusion
2004	Percival. M.E et al.	This paper presents on prototype based street enforcement application for mobile ANPR. The system has been based on high powered PCs working on video feeds from full size cameras. The database was equipped	An overview of mobile ANPR technologies has been presented. The authors have summarized the test scenario around 95% of the number plates of cars parked on-street

		with software that sought Matches between database entries and license plate readings. The match algorithm was able to offer wild card matching so that the match tolerance could be adjusted. This meant that partial matches, for example, where there was all but one character matched, would be signalled as a positive match.	were read, between 80% and 99% of the cars read had an 80%+ confidence level [10].
2005	Syed. Y. A et al.	The authors have dealt with the plate finding module and plate division module. In the beginning stage, search is being made for a forthcoming number plate on the premise of a percentage of the neighbourhood highlights contained in its fuzzy geometry. The second module uses a fuzzy C means based grouping over the concluded plate-patch to bunch the eight-associated segments in it into coveted and undesired areas. Division continues just over the group containing the desired plate areas.	The authors have tested many images with various backgrounds conditions. Of these, some images failed to locate the license plates; the rate of success was 98.82%. Experiments for character segmentation were carried out on the remaining plates. Of which, some plates were not properly segmented; the success rate was 95.36%. The combined rate for the two stages of their number plate recognition algorithm was 94.24% [11].
2008	Tseng. P. C et al	In this paper they proposed adaptive car plate recognition (ACPR) algorithm which is divided into 4 phases: detection of an alphanumeric plate region, pre-processing of the plate, contrast with saved database,	Taking into the consideration of those results mechanism were embedded in the EmQCG test bed. The ACPR was implemented in PXA255 embedded system.

		and element character highlight calculation. A QoS-aware control portal (EmQCG) was embedded in a trial vehicle network implemented by means of class-based queuing (CBQ) transfer speed management in a genuine Cisco 7204 VXR router. The EmQCG differentiate forwarded movement under congested data transfer capacity constrained experimental conditions.	Experimental results confirmed the presented ACPR embodiment yields recognition performance in terms of accuracy rate of 90.30% in the authorized case [12].
2009	Kulkarni. P et al.	They have proposed an algorithm like Feature-based number plate Localization' for locating the number plate, 'Image Scissoring' for character segmentation and statistical feature extraction for character detection; which are mainly designed for Indian number plates. In designing this system, various Image Processing algorithms were designed in MATLAB and implemented on the Digital Signal Processor TMS320DM6437 which is used for video and image processing applications.	The system was tested with a set of images not used during testing, having wide variations in illumination conditions. The system works satisfactorily for wide variations in illumination conditions and different types of number plates commonly found in India. It is definitely a better alternative to the existing manual systems in India [13].
2010	Pan. R et al.	In this paper they have proposed a new technique. First, the plate image is partitioned into a set of 5*5 non-overlapping blocks. The local orientation of each block is estimated	This paper algorithm is implemented in grey level images. It reduces much processing time. Due to the estimation of the orientation

		by incline of pixels in the block. The horizontal incline angle of number plate is recognized by the local maximum of the direction angle histogram. The plate image is changed according to this angle. Then, the vertical deformation of number plate image was corrected by the single-character projection technique. The experimental results indicate the great robustness and accuracy of proposed method. Their experimental results demonstrate that the proposed technique is ability of finding controlling direction of the skew license plate.	field using gradients, their method fully utilizes the feature information lying in an image. That makes it highly sensitive to direction feature in the image and robust to interference. Another advantage of their technique is that their approach is straightforward and simple. Experimental results in this paper provide a big convenience for the subsequent segmentation process [14].
2011	Mai. V. D et al.	They proposed a new LPL algorithm for Vietnam license plates, which combined pre-processing, morphology operation on grayscale image, image subtract operation on grayscale image, image binarization based on threshold, edge detection use Canny operator, morphology operation on binary image, finding the number plate angle & rotating number plate based radon transform and bilinear interpolation.	Their proposed approach is more efficient than some of the existing system earlier developed and very satisfied with Vietnam license plates. The efficiency of processing of the proposed algorithm is improved and mean rate of efficiency of the LPL is 97.27%, and proposed method is suitable for all of colour number plates. But there are still some images failed to show the proper output in the system and their algorithm still

			needs further research [15].
2012	Arulmozhi. K et al.	They propose a smart, simple and efficient algorithm for Indian license Plate Localization using Top Hat Transformation, which suppresses the background of image and remove the non-uniform illumination. The algorithm is tested with live ALPR field images, confirming the robustness of the proposed method against adverse imaging condition.	A new vehicle license plate locating method is discussed in this paper. This method restrains background by top-hat transform, coarsely locate the license plate by apply the vertical edge detection algorithm and find the license plate by using Morphological closing operation [7].
2013	Zhai. X et al.	They proposed a system for NPL, character segmentation and character recognition in a SD ANPR system .The system is to be implemented on a single stand-alone FPGA-based processing unit. An approach to extend the SD ANPR system to HD ANPR system without significantly increasing the computational cost is then introduced. Field Programmable Gate Arrays (FPGAs) and Digital Signal Processors (DSPs) are becoming a viable solution for requirements of high-performance and low power image processing application, which provided us to examine them as minimum cost effective for increase such computationally intensive tasks.	In this paper, all three stages of an ANPR system (i.e. NPL, CS and OCR) have been successfully linked together, implemented and tested using the Mentor Graphics RC240 FPGA development board. The entire system consumes only 80% of the available on-chip slices of a Virtex-4 FPGA runs with a maximum frequency of 57.6 MHz and is capable of processing one image in 11 ms with a successful recognition rate of 93% [5].

CHAPTER 3

COMPONENTS USED FOR HARDWARE IMPLEMENTATION

- PIC Microcontroller
- RS 232 Serial Communication
- MAX 232 Dual Driver/Receiver
- Relays
- DC Motor
- Power supply
- IC 7805

3.1 PIC Microcontroller

☑ **Microcontroller core features**

- High-Performance RISC CPU
- All instruction are single cycle instructions but program branches are two-cycle
- Operating speed: 20 MHz DC clock with 200 ns input instruction cycle
- Flash Memory upto 8K x 14 bytes, Data memory 368 x 8 bytes and EEPROM memory 256 x 8 bytes
- Pinout compatible with others like 28, 40, and 44 pin PIC16FXXX microcontroller [16].

☑ **Microcontroller peripheral features**

- Timer0: 8 bit timer or counter
- Timer1: 16 bit timer or counter
- Timer2: 8 bit timer or counter
- Pulse width modulation modules, two compare , capture
- 16 bit capture with maximum resolution is 12.5 ns
- 16 bit compare with maximum resolution is 200 ns
- Maximum resolution for pulse width modulation is 10-bit
- Synchronous serial port (SSP) with SPI and I2C (Master or Slave)
- 9 bit address detection for USART

☑ **3.1.3 Microcontroller analog features**

- Analog to digital converter (A/D) up to 8 channel with 10 bit
- Analog Comparator module with:
    - Two analog comparators
    - Programmable on-chip voltage reference (VREF) module
    - Programmable input multiplexing from device inputs and internal voltage reference
    - Comparator outputs are externally accessible.

3.1.1 PIN diagram of microcontroller

Figure 3.1 shows the PIN diagram of PIC16F877/874 microcontroller.

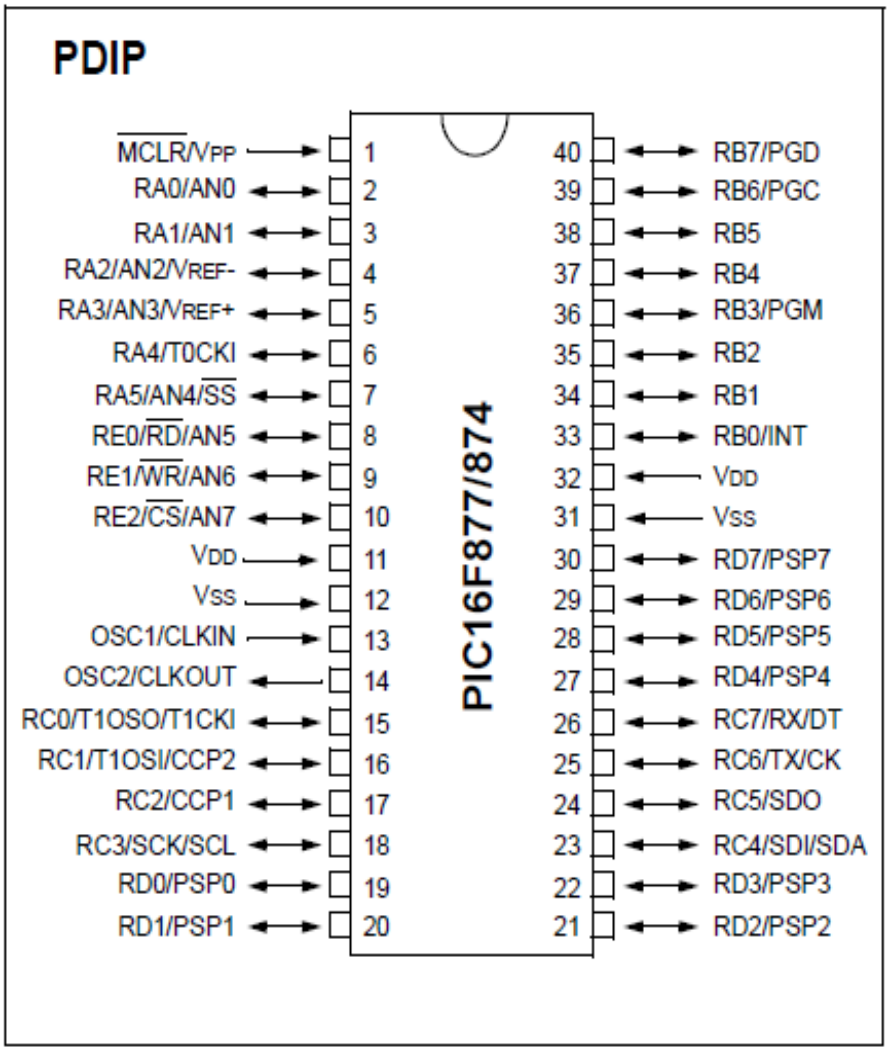
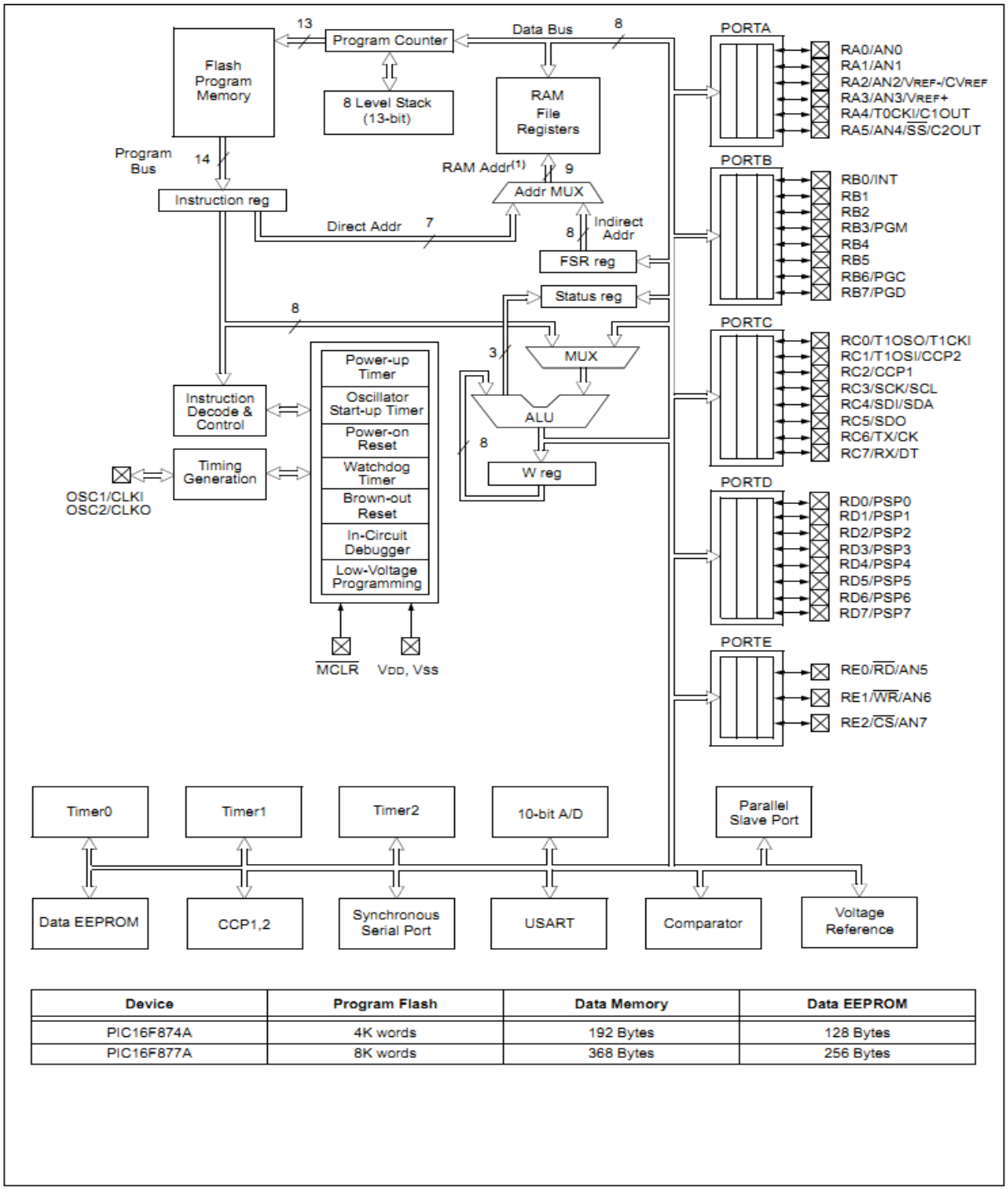


Figure 3.1: PIN diagram of PIC16F877/ 874 microcontrollers [16]

3.1.2 Architecture of microcontroller

Architecture of PIC16F877/874 is shown in figure 3.2.



Device	Program Flash	Data Memory	Data EEPROM
PIC16F874A	4K words	192 Bytes	128 Bytes
PIC16F877A	8K words	368 Bytes	256 Bytes

Figure 3.2: Architecture of PIC16F877/874 microcontroller [16]

- **Input and output ports of microcontroller**

A few pins for these input and output ports are multiplexed with a substitute function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be utilized as a general purpose input and output pin.

PORTA and TRISA Register

PORTA is a 6-bit wide, bidirectional port. The relating information direction register is TRISA. Setting a TRISA bit (= 1) will make the relating PORTA pin an input (i.e., put the comparing output driver in a High-Impedance mode). Clearing a TRISA bit (= 0) will make the relating PORTA pin an output (i.e., put the substance of the output latch on the particular pin). Perusing the PORTA register reads the status of the pins, while keeping in touch with it will write in touch with the port latch. All wright operations are read-adjust write operations. In this manner, a write with a port infers that the port pins are read; the value is adjusted and afterward written with the port information latch. Pin RA4 is multiplexed with the Timer0 module clock input to turn into the RA4/T0CKI pin. The RA4/T0CKI pin is a Schmitt Trigger input and an open-channel output [16].

PORTB and TRISB Register

PORTB is an 8-bit wide, bidirectional port. The comparing information direction register is TRISB. Setting a TRISB bit (= 1) will make the comparing PORTB pin an input (i.e., put the relating output driver in a High-Impedance mode). Clearing a TRISB bit (= 0) will make the comparing PORTB pin an output (i.e., put the substance of the output latch on the chose pin). Three pins of PORTB are multiplexed with the In-Circuit Debugger and Low-Voltage Programming capacity: RB3/PGM, RB6/PGC and RB7/PGD [16].

PORTC and TRISC Register

PORTC is an 8-bit wide, bidirectional port. The relating information direction register is TRISC. Setting a TRISC bit (= 1) will make the relating PORTC pin an input (i.e., put the comparing output driver in a High-Impedance mode). Clearing a TRISC bit (= 0) will make the relating PORTC pin an output (i.e., put the substance of the output latch on the chose pin). PORTC is

multiplexed with a few peripheral functions. PORTC pins have Schmitt Trigger input buffers [16].

- **PORTD and TRISD Register**

PORTD is an 8-bit port with Schmitt Trigger input buffers. Every pin is separately configurable as an input or output. PORTD can be arranged as an 8-bit wide microchip port (Parallel Slave Port) by setting control bit, PSPMODE (TRISE <4>). In this mode, the information supports are TTL [16]

- **PORTE and TRISE Register**

PORTE has three pins (RE0/RD/AN5, RE1/WR/AN6 and RE2/CS/AN7) which are exclusively configurable as inputs or outputs. These pins have Schmitt Trigger input buffers. The PORTE pins turn into the I/O control inputs for the chip port when bit PSPMODE (TRISE <4>) is set. In this mode, the client must make sure that the TRISE <2:0> bits are set and that the pins are designed as computerized inputs. Additionally, guarantee that ADCON1 is arranged for computerized I/O. In this mode, the input supports are TTL. PORTE pins are multiplexed with analog inputs. At the point when chosen for analog data, these pins will read as '0's. TRISE controls the direction of the RE pins, notwithstanding when they are being utilized as analog inputs. The client must make a point to keep the pins arranged as inputs when utilizing them as analog inputs [16].

3.1.3 I2C Mode

The MSSP module in I2C mode completely executes all master and slave capacities (counting general call sup-port) and gives hinders on Start and Stop bits in equipment to focus a free bus (multi-master capacity). The MSSP module executes the standard mode details, and additionally 7-bit and 10-bit addressing.

Two pins are used for data transfer

- Serial clock (SCL) – RC3/SCK/SCL
- Serial data (SDA) – RC4/SDI/SDA.

3.1.4 Analog to Digital Converter (A/D) Module

The Analog-to-Digital (A/D) Converter module has five inputs for the 28-pin device and eight for the 40/44-pin device. The change of an analog data signal results in a relating 10-bit computerized number. The A/D module has high and low-voltage reference input that is programming selectable to some combination of V_{DD}, V_{SS}, RA2 or RA3. The A/D converter has a remarkable highlight of having the capacity to work while the device is in Sleep mode. To work in Sleep, the A/D clock must be derived from the A/D's internal RC oscillator [16].

3.1.5 Pulse Width Modulation Mode (PWM)

In Pulse Width Modulation mode, the CCPx pin provides up to a 10-bit resolution PWM output. Since the CCP1 pin is multiplexed with the PORTC data latch, the TRISC<2> bit must be cleared to make the CCP1 pin as an output.

3.2 RS 232 Serial Communication

RS 232 is straightforward, widespread, surely knew and bolstered however it has a few genuine weaknesses as an information interface. The benchmarks to 256 kbps or less and line lengths of 15M (50 ft.) or less however today we see fast ports on our home PC running high speeds and with high capacity cable distance has expanded enormously. The general guideline for the length an information link relies on upon velocity of the information and nature of the link. Figure 3.3a and 3.3b shows the male and female serial communication.

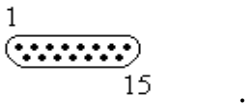


Figure 3.3a: Sub-D15 male

Figure 3.3b: Sub-D15 female

This is a standard 9 to 25 pin cable layouts for asynchronous data on a PC at serial cable. The details connection of serial communication is shown in table 3.1. Figure 3.4 and 3.5 shows layout and PIN diagram of RS 232. Table 3.2 shows details PIN connection of RS 232.

Table 3.1: Details connection of the serial cable

Description	Signal	9-pin DTE	25-pin DCE	Source DTE or DCE
Carrier Detect	CD	1	8	From Modem
Receive Data	RD	2	3	From Modem
Transmit Data	TD	3	2	From Terminal/Computer
Data Terminal Ready	DTR	4	20	From Terminal/Computer
Signal Ground	SG	5	7	From Modem
Data Set Ready	DSR	6	6	From Modem
Request to Send	RTS	7	4	From Terminal/Computer
Clear to Send	CTS	8	5	From Modem
Ring Indicator	RI	9	22	From Modem

Figure 3.4: Layout of RS 232

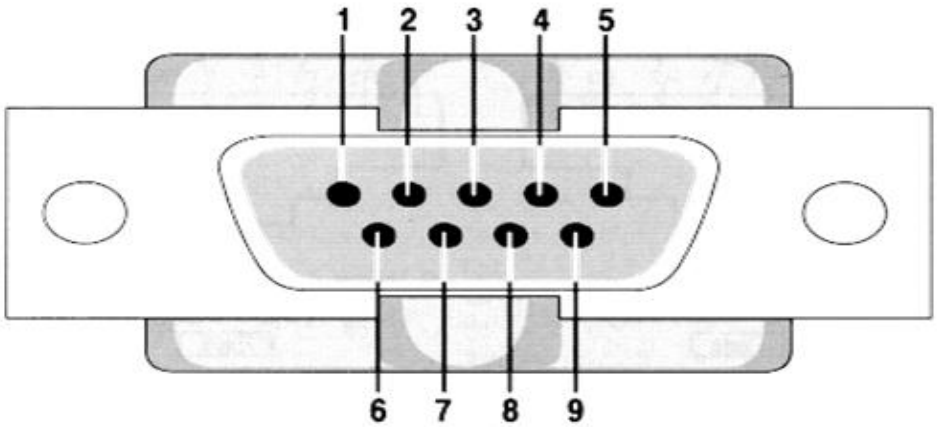


Figure 3.5: PIN diagram of RS 232

Table 3.2: Details PIN connection of RS 232

Pin	Signal
1	Data Carrier Detect
2	Received Data
3	Transmitted Data
4	Data Terminal Ready
5	Signal Ground
6	Data Set Ready
7	Request to Send
8	Clear to Send
9	Ring Indicator

3.3 MAX232 Dual Driver/Receiver

Description

The MAX232 device is a dual driver/receiver that consists of a capacitive voltage generator to supply EIA 232 voltage levels from a single 5V supply. Each receiver translates EIA 232 inputs to 5V TTL/CMOS levels. These receivers have a typical threshold of 1.3V and a typical hysteresis of 0.5V, and can accept 30V inputs. Each driver translates TTL/CMOS input levels into EIA 232 levels [17].

- **Basic features of MAX 232**

  - Operates with single 5V power supply
  - Technology used for MAX 232 is Lin Bi CMOS
  - It consists of two receivers and two drivers
  - Its input level voltage is 30V
  - Typically its supply current is very low (8 mA)

Figure 3.6 and 3.7 shows the top view and typical operating circiut of MAX 232.

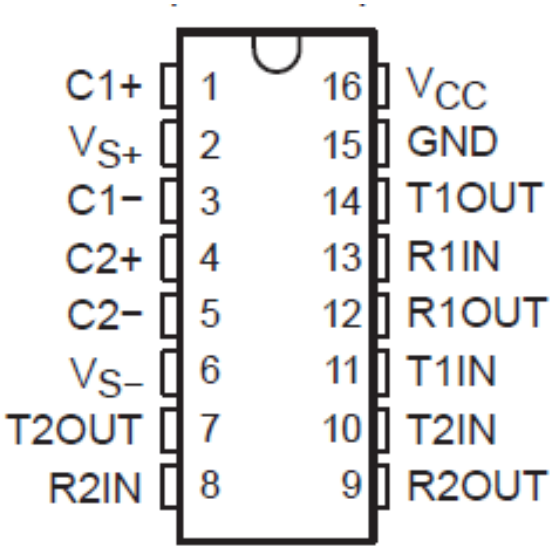


Figure 3.6: Top view of MAX 232 [17]

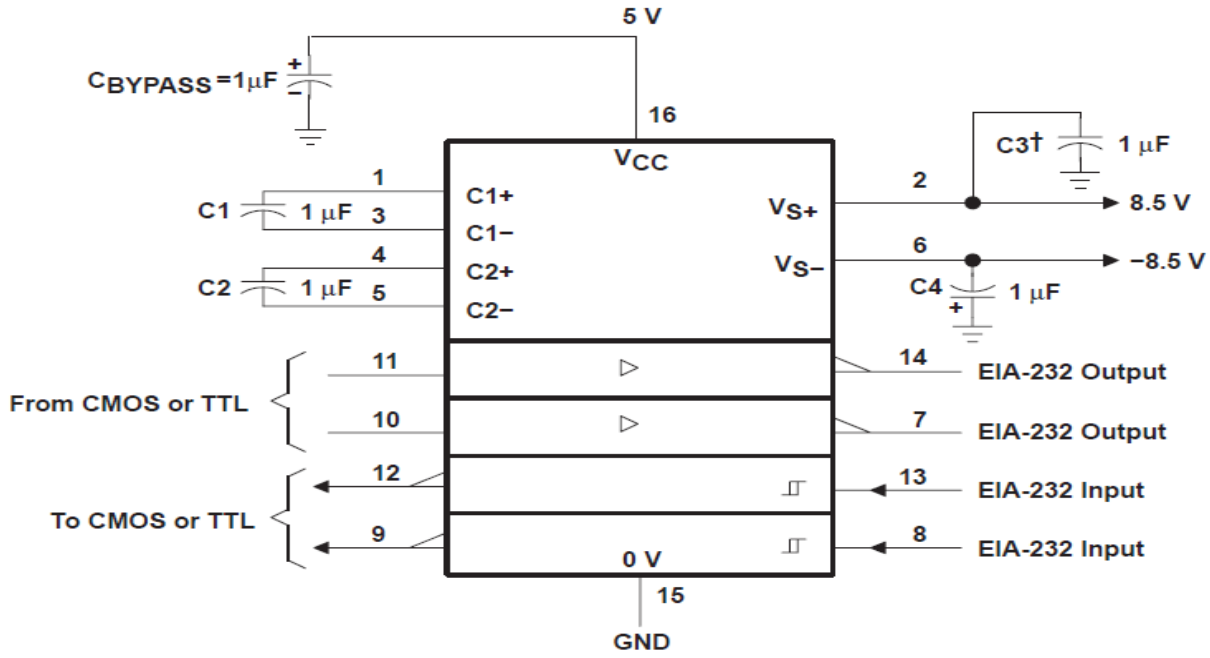


Figure 3.7: Typical operating circuit of MAX 232 [17]

- **Absolute maximum ratings**
  - Supplied input voltage range is V_{CC}**:** – 0.3 V to 6 V
  - Output voltage for +ve range**:** $V_S + V_{CC}$ – 0.3 V to 15 V

- Output voltage for -ve range**:** V_S – 0.3 V to –15 V
- Input voltage range (VI) for driver 0.3 V to V_{CC} + 0.3 V and for receiver 30 V
- Output voltage range (VO) for T1, T2 VS –0.3 V to VS+ + 0.3 V and R1, R2 –0.3 V to V_{CC} + 0.3 V.

Figure 3.8 shows the circuit diagram of MAX 232.

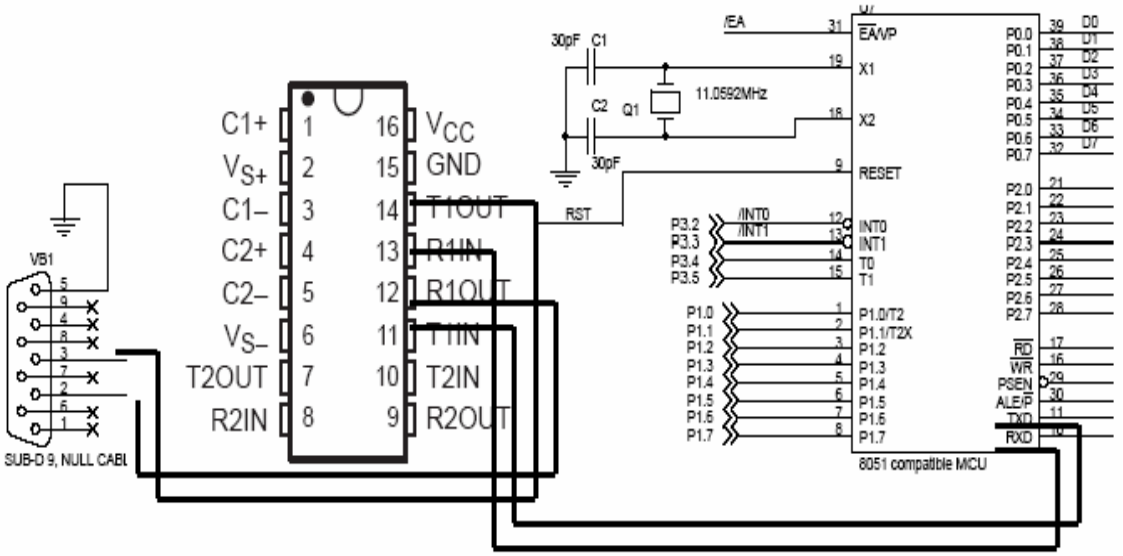


Figure 3.8: Circuit diagram of MAX 232 [17]

3.4 Relays

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier. A sugar cube relay shown in figure 3.9.

Figure 3.9: Sugar cube relay [17]

A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways:

- **Normally Open (NO)** contacts connect the circuit when the relay is activate d; the circuit is disconnected when the relay is inactive. It is also called a FORM A contact or "Make" contact.
- **Normally Closed (NC)** contacts disconnect the circuit when the relay is activated; the circuit is connected when relay is inactive. It is also called FORM B contact or" break" contact.
- **Change over or double throw** contacts control two circuits; one normally open contact and one normally closed contact with a common terminal. It is also called a Form C "transfer "contact. The typical relay circuit is shown in figure 3.10.

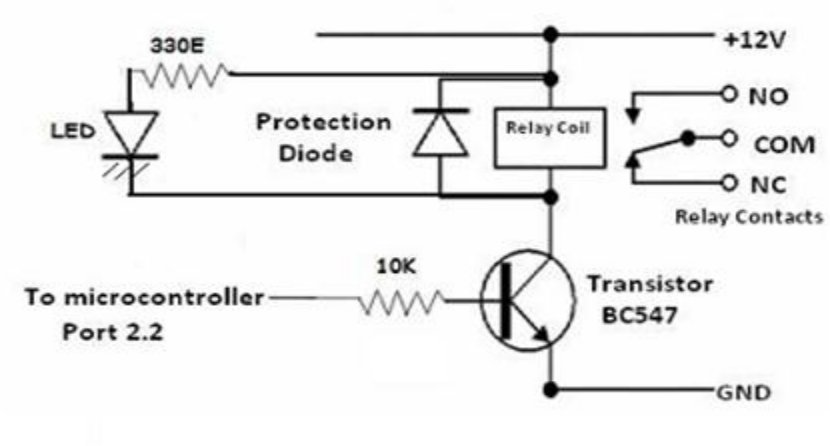


Figure 3.10: Relay circuit

3.5 DC Motor

Gear box is made of white hard glass filled nylon; gears are made of metal rotating on steel pins. Easy to mount by using a single M14 nut, hole required to insert the motor is 13.7 mm ø Over-loading of motor may result in short life or damage to gearbox. Figure 3.11 and 3.12 shows the DC motor and direction of rotation of DC motor.

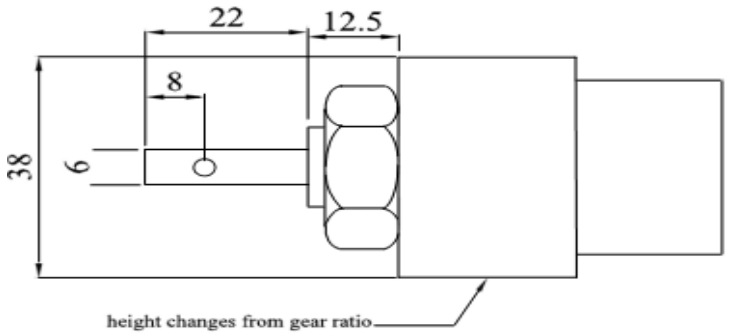


Figure 3.11: DC motor

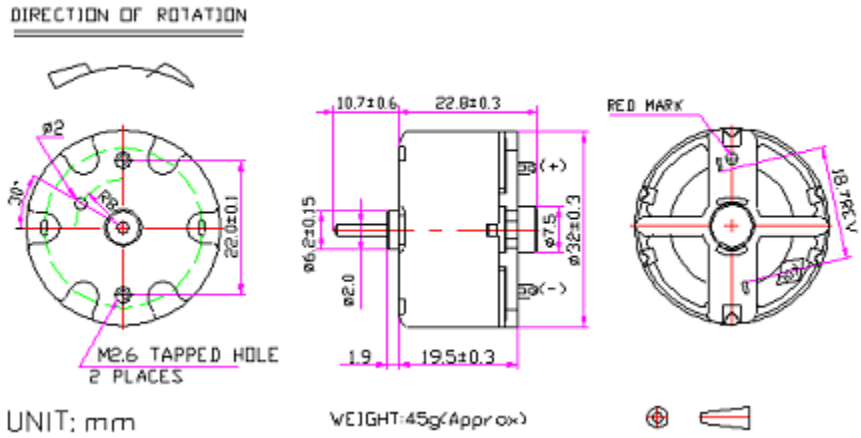


Figure 3.12: Direction of rotation of DC motor

Table 3.3: Details feature of DC motor

Model		**Voltage**		**No Load**		**At Maximum Efficiency**					**Stall**		
		Opera-ting Range	Nomi-nal	Speed	Cur-rent	Speed	Cur-rent	Torque		Output	Torque		Curr-rent
		V		rpm	A	rpm	A	mN. M	g.cm	w	mN. m	g.cm	A
K Series	12560	3.0-18	12	2700	0.02	2200	0.08	0.98	10.0	0.23	5.88	60	0.5

3.6 Power supply

Regulated power supply plays an important role in any circuit. It is require for all digital circuits. In this stage we are describe how to get a regulated positive supply from the mains power supply. Figure 3.13 shows the block diagram of power supply.

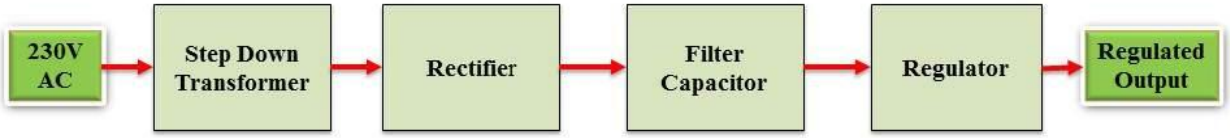


Figure 3.13: Block diagram of power supply

3.6.1 Transformer

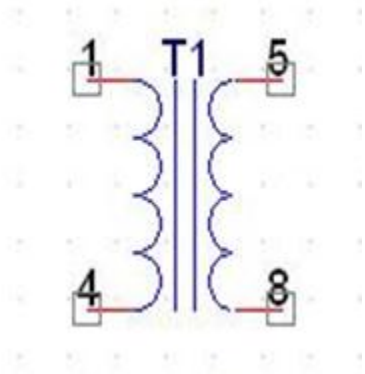


Figure 3.14a: Transformer

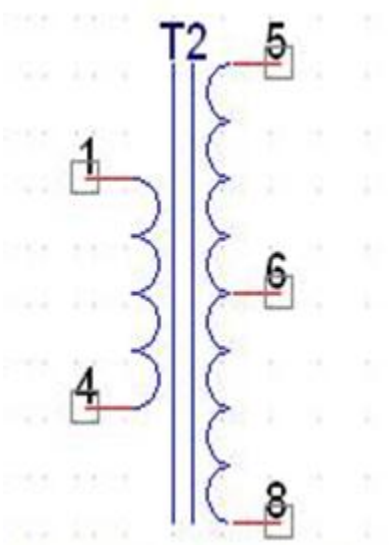


Figure 3.14b: Center tapped transformer

From the above figure, a transformer consists of two coils also called as “windings” namely primary & secondary. They are linked together through inductively coupled electrical conductors also called as core. A changing current in the primary causes a change in the magnetic field in the core & this in turn induces an alternating voltage in the secondary coil. If load is applied to the secondary then an alternating current will flow through the load. If we consider an ideal

condition then all the energy from the primary circuit will be transferred to the secondary circuit through the magnetic field.

$$P_{primary} = P_{secondary}$$

So, $$I_p V_p = I_s V_s$$

Where Ip is primary current

Vp is primary voltage

Is is secondary current

Vs is secondary voltage

The secondary voltage of the transformer depends on the number of turns in the Primary as well as in the secondary.

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Where Np is the number of loops in primary coil

Ns is the number of loops in secondary coil

3.6.2 Rectifier

A rectifier is a device that changes over an AC signal into DC signal. For amendment reason we utilize a diode, a diode is a device that permits current to pass just in one direction i.e. at the point when the anode of the diode is positive concerning the cathode likewise called as forward biased condition & bock current in the reversed biased condition. Rectifier can be divided as follows.

- **Half wave rectifier**

The half wave rectifier is an easy type of rectifier as shown in figure 3.7.1 which consists of only one diode. The diode is forward biased when an AC signal is applied to it during positive half cycle and current flows through it. It is reverse biased & no current flows through it for negative half cycle. It is very ineffective to be used in power supplies as only one half of the input reaches the output. Figure 3.15 shows the circuit diagram of half wave rectifier.

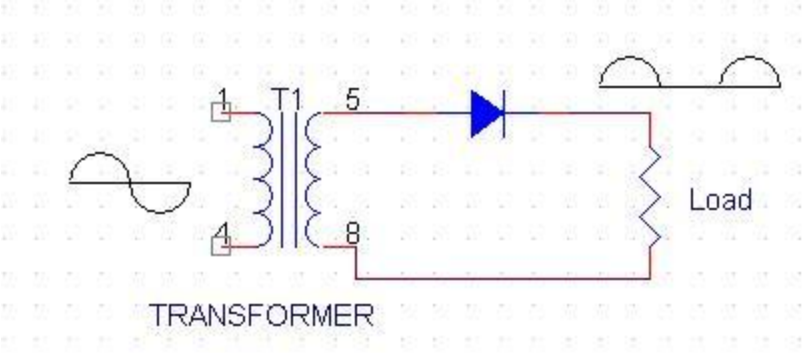


Figure 3.15: Half wave rectifier

- **Full wave rectifier**

Full wave rectifier consists of two diodes D1 and D2. In positive half cycle diode D1 is forward biased and current flows through it but diode D2 remains in reverse biased condition. Diode D2 flow current during negative half cycle but diode D1 became in reverse condition and no current flows through it. So we get both positive and negative half cycles across the load. The circuit diagram of full wave rectifier is shown in figure 3.16.

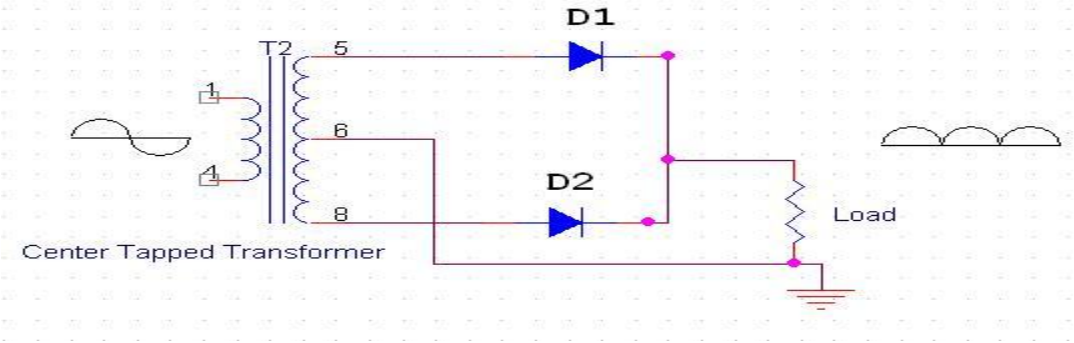


Figure 3.16: Full wave rectifier

- **Bridge rectifier**

Span rectifier changes over both the positive & the negative half cycle into DC in this way it is considerably more effective than half wave rectifier & that too without utilizing a canter tapped transformer. It comprises of four diodes in namely D1, D2, D3 and D4. For positive half cycle diodes D1 & D4 conduct and in the negative half cycle diodes D2 & D3 conduct. In this way the

diodes continue exchanging the transformer connection so we get positive half cycles in the output. Figure 3.17 shows the circuit diagram of bridge rectifier.

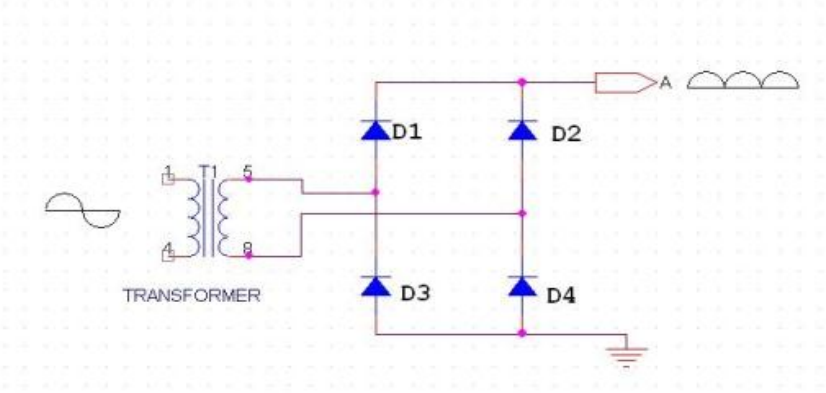


Figure 3.17: Bridge rectifier

3.6.3 Voltage regulator

A Voltage regulator is a device which changes over changing input voltage into a consistent managed output voltage. It is two types

- Linear voltage regulator
- Switching regulators.

Figure 3.18 shows the circuit diagram of voltage regulator.

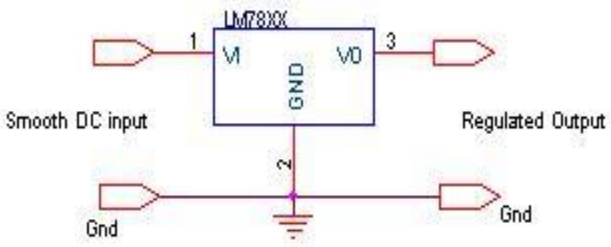


Figure 3.18: Voltage regulator

3.6.4 Circuit diagram of power supply

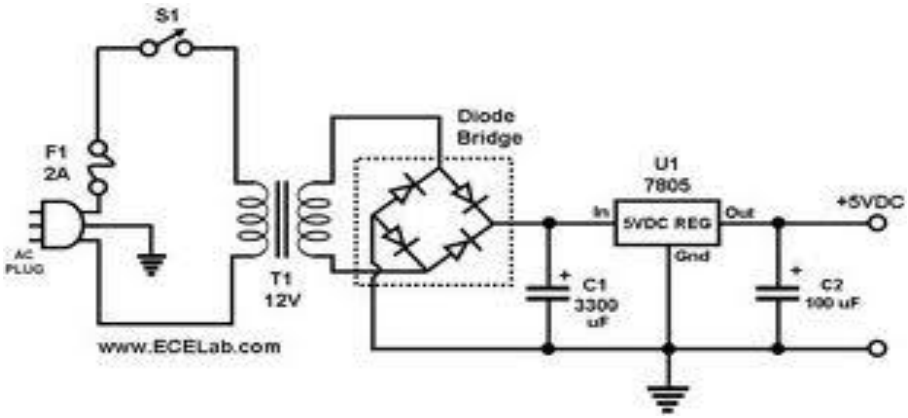


Figure 3.19: Circuit diagram of power supply

3.7 IC 7805

7805 is an incorporated three-terminal positive fixed linear voltage controller. It works with an input voltage of 10-35V and output voltage of 5V and current rating of 1 amp. The 7805 will consequently decrease output current in the event that it gets excessively hot. The last two digits suggest to the voltage; for example, the 7812 is a 12 volts controller. Table 3.4 shows the specification of IC 7805.

Table 3.4: Specifications of IC 7805

Specification	IC 7805
V_{out}	5V
$V_{ein} - V_{out}$ difference	5V – 20V
Operation ambient temperature	0 – 125^{o}C
Output I_{max}	1A

CHAPTER 4

SYSTEM IMPLEMENTATION

- Software Development
- Number Plate Digitization Process
- Hardware Implementation
- Working Principle
- Circuit Diagram
- Circuit Development with Microcontroller
- Real Time Recognition Process
- Access Control

The total system consists of two parts namely;

- Software Development
- Hardware implementation

4.1 Software Development

☑ **Description**

Software parts are developed in MATLAB. It is an intense programming tool used to execute the undertakings that require far reaching computation. It gives simple and snappier usage of algorithm compared with C and C++. The key highlight in MATLAB is that it contains rich library capacities for image handling and information investigation. This makes MATLAB a perfect software tool for speedy usage and check of any calculation before really executing it on genuine equipment. Many times, investigating of error on genuine equipment ends up being an extremely difficult work. MATLAB gives a simple way to deal with troubleshooting and redress of error in any calculation. Apart from this, MATLAB contains numerous highlights including workspace, plot, imread, imhist, imshow, and so on for information analysis and image preparing, which settles on it a superior decision over other programming language like C and C++ [6].

Considering the above favourable circumstances, we have at first developed an algorithm for number plate recognition utilizing MATLAB. The algorithm at first utilized different inbuilt capacities and executed few client characterized schedules identified with image processing. Once the algorithm was created, it was checked with numerous info images containing vehicle number plates. The data image contained number plates that were adjusted on a horizontally plane and also at some edge from horizontal axis. Once the algorithm was totally confirmed, the in-constructed elements of MATLAB were supplanted by client characterized capacities [6].The algorithm implemented in MATLAB consists of different step. First, input image is taken from webcam connected to the computer through USB cable or it is taken from saved image containing vehicle registration number. The block diagram of number plate digitization process in MATLAB is shown in figure 4.1.

4.1.1 Number plate digitization process in MATLAB

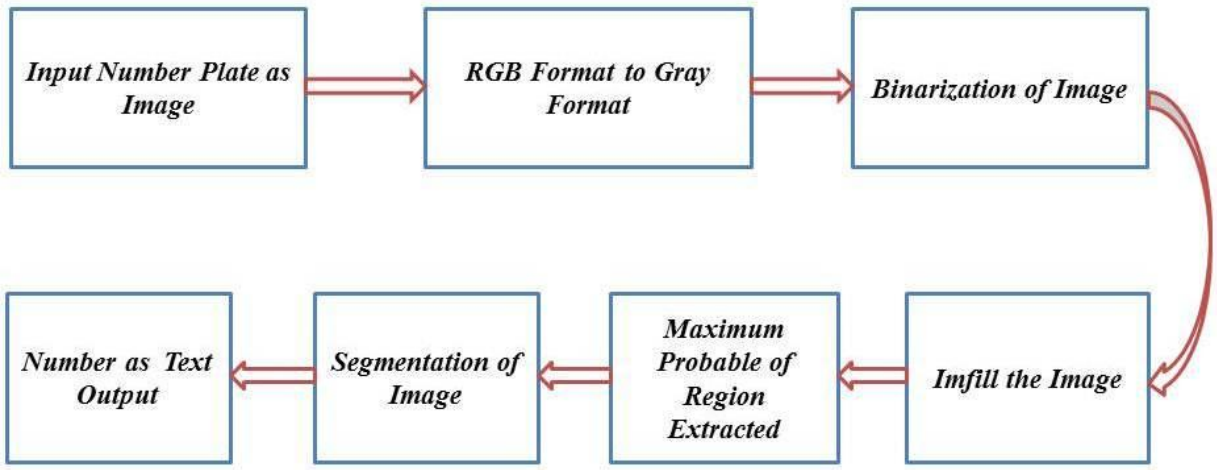


Figure 4.1: Block diagram of number plate digitization process in MATLAB

4.1.2 Colour to gray image conversion

The software developed here in MATLAB is independent of colour images. It is required gray images for processing and extracting the required information. Colour image in RGB (Red, Green and Blue) format are not readable in MATLAB in build function. So, if the input image containing number plate region is colour, it is converted into gray image before further processing and extracting required information. The original input image and gray scale image shown in figure 4.2a and 4.2b.

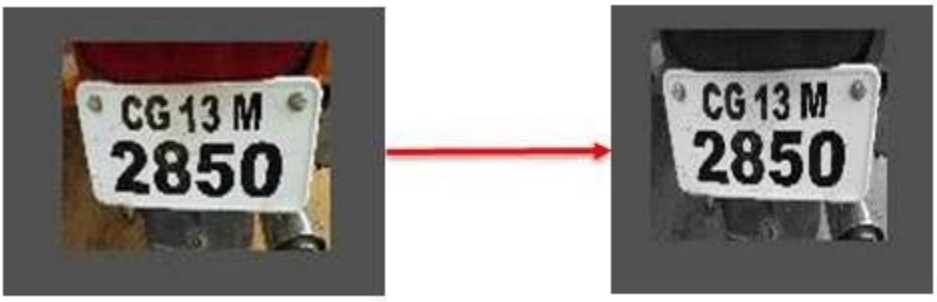


Figure 4.2a: Colour Image **Figure 4.2b: Gray Image**

4.1.3 Binarization of image

In this process the given image is improved by filling holes, sharpen the edges, and connect the broken lines and expand the luminance. It is also helped to remove the noise of an image.
With the help of edges sharper, the distinction of gray scale value between neighbouring pixels at the edge can be expanded. This is called edge recognition. In number plate recognition, the image of a truck number plate may not generally contain the same luminance and shades. In this way, the given image must be changed over from RGB to gray scale structure. However, amid this change, certain vital parameters like contrast in shading, lighter edges of image, and so on may get lost. The given figure 4.3 shows the binarization of an image.

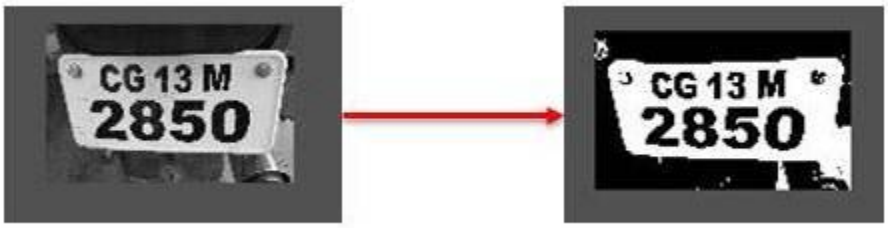


Figure 4.3: Binarization of image

4.1.4 Imfill the image

The next step is imfill the image. This step performs a flood fill operation on binary and gray scale image. In binary images, imfill changes joined background pixels (0s) to foreground pixels (1s), halting when it achieves object limits. For gray scale images, imfill brings the force estimations of dark zones that are encompassed by lighter ranges up to the same power level as encompassing pixels. (In actuality, imfill evacuates regional minima that are not joined with the image boundaries) This operation can be valuable for removing unnecessary item from the image. Imfill of the image is shown in figure 4.4.

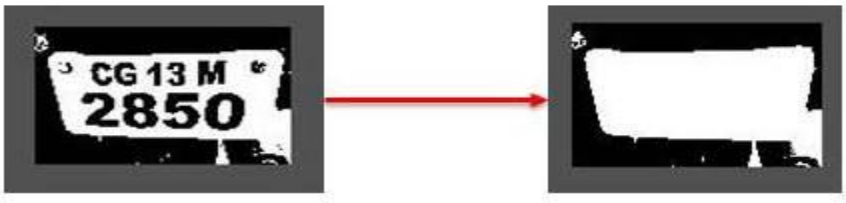


Figure 4.4: Imfill the image

4.1.5 Region of interest extraction

The region of interest extraction implies that have most extreme likelihood of containing a number plate. Out of these areas, the one with the greatest histogram quality is considered as the most likely locale for number plate. All the region of number plate are prepared column wise and column wise to locate a typical region having greatest even and vertical histogram value. This is the area having maximum probability of containing a number plate. Figure 4.5 shows the region of interest extraction from an imfill image.

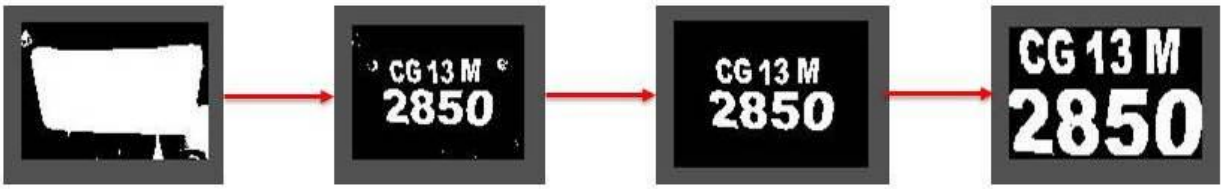


Figure 4.5: Region of Interest Extraction

4.1.6 Segmentation

Image segmentation is the procedure of separate an advanced image into different portions (sets of pixels, otherwise called super pixels). The objective of segmentation is to re-arrange and/or change the representation of an image into something that is more important and simpler to examine [18]. Image segmentation is normally used to find characters and boundaries (lines, bends, and so on.) in images. All the more unequivocally, Image segmentation is the procedure of allocating a mark to each pixel in an image such that pixels with the same name share certain attributes.

The outcome of image segmentation is a situated of portions that all things considered spread the whole image, or an arrangement of shapes removed from the image. Each of the pixels in a district is comparative regarding some attributes or processed property, for example, shading, force, or surface. Neighbouring locales are fundamentally diverse regarding the same attributes [18]. At the point when connected to a mass of images, common in medical imaging, the

subsequent forms after Image segmentation can be utilized to make 3D reproductions with the help of addition algorithm.

This step is to discover all the locales in an image that has high likelihood of containing a number plate. Co-ordinates of all such likely areas are put away in a cluster.

4.1.7 Text output

The input of truck number plate which is an image file is converted into digitalized form and saves as a text file. In access control, number plates are utilized to distinguish the truck. At the point when a truck comes before the door, number plate is naturally perceived and put away in database and black listed number is not given authorization. At the point when a truck later leaves the spot through the entryway, number plate is perceived again and combined with the first put away in the database and it is taken a check. Automatic truck number plate recognition frameworks can be utilized as a part of access control. Case in point, this innovation is utilized as a part of numerous organizations to give get to just to vehicles of approved work force. Figure 4.6 shows digitized output from of number plate and also date with time.

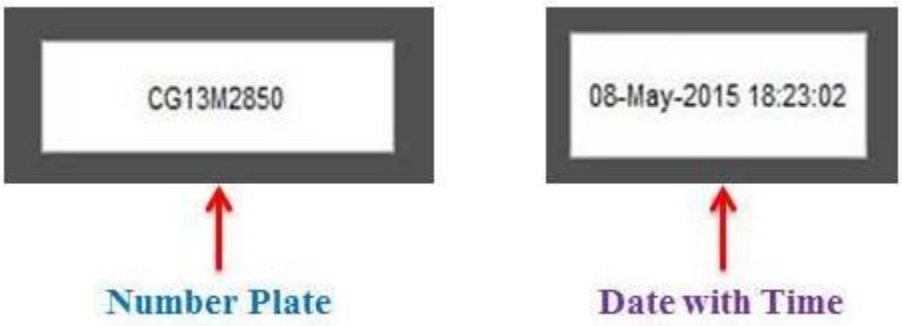


Figure 4.6: Text output

The number plate digitization process in MATLAB template is shown in figure 4.7.

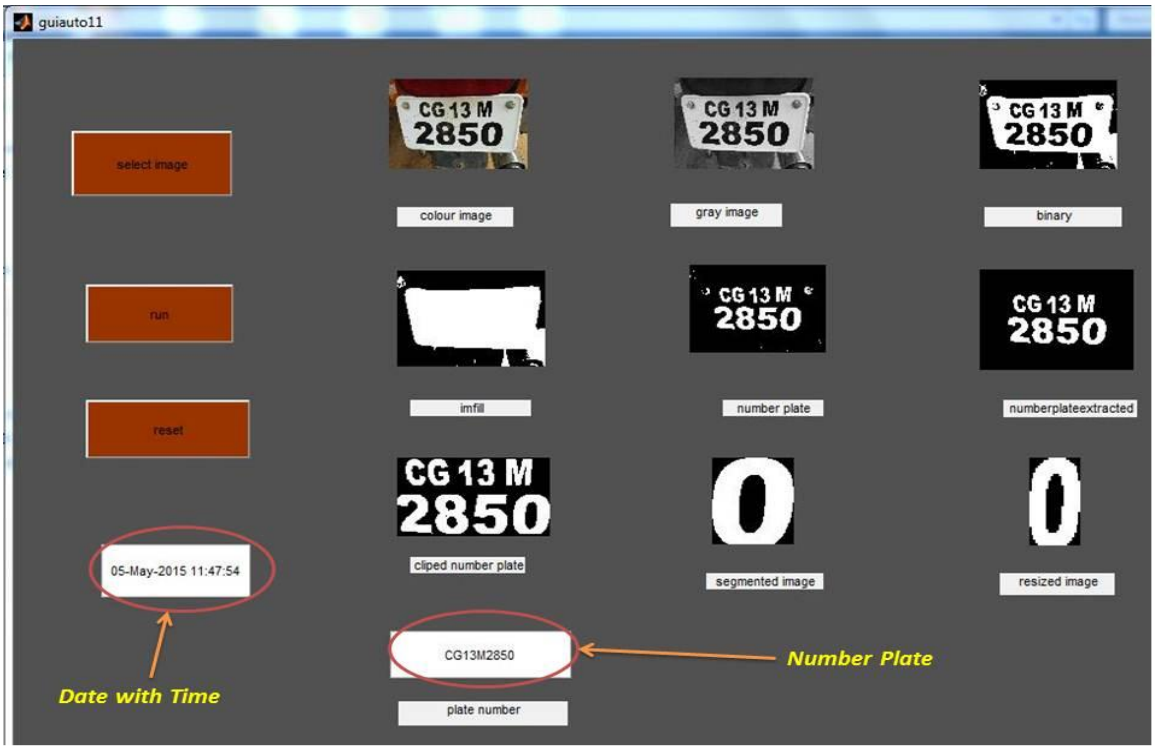


Figure 4.7: Number plate after digitization in MATLAB template

4.2 Hardware Implementation

Automatic truck number plate digitization system utilizes optical character recognition (OCR) on images taken by webcam. At the point when Dutch vehicle enrolment plates changed to an alternate style in 2002, one of the progressions made was to the text style, presenting little gaps in a few letters, (for example, P and R, B and 3) to make them more particular and hence more clear to such technique. Some number plates positioning utilization varieties in text dimensions and situating. This technique must have the capacity to adapt to such contrasts keeping in mind the end goal to be genuinely efficient. More complex systems can adapt to global variations, however numerous projects are separately custom-made to every nation.

The camera utilized can incorporate existing street standard authorization or CCTV camera, and portable units, which are generally connected to vehicles. A few systems use infrared camera to take a clearer picture of the plate.

☑ **Description**

The hardware parts are developed as a security system. The image which contains number plate is captured through webcam. The webcam is fitted with the PC and when vehicle comes before it, it distinguishes and catches the picture alongside the number plate. The PC stacked with MATLAB programming procedures RGB to gray scale change, binarization, and segmentation and so ahead of the picture and stores the number plate in content document alongside date and time. At that point MATLAB sends commands to parallel port of the PC and with the hardware alongside serial communication, the entryway is opened if the vehicle is approved. MATLAB again sends command for automatically closed the gate.

4.2.1 Working principle

- **Image acquisition**

The proposed technique is intended for on-going number plate extraction. Data to the technique is a picture which contains the number plate, captured from the digital camera of the front or back of the vehicle and its Output is the number plate area.

- **Create database**

Procure image of each characters in order and letters change to gray and binary then resize all pictures to one size and save as format in MATLAB memory.

- **Testing phase**

In the wake of capturing the picture perform gray scale transformation, picture binarization, filtration and picture upgrade, binarization and smoothing process and character segmentation horizontally and vertically. At that point coordinate the removed picture with the stored database pictures and print the perceived characters and send to serial communication to open a gate or not. Table 4.1 shows the details hardware components for system implementation.

Table 4.1: Hardware components details

SL No.	Components	Quantity
1	40 Pin PIC with IC Base	1
2	20 MHz crystal oscillator	1
3	Capacitor 33 pF, 0.1 µF, 1000 µF	2, 1, 1
4	Resistor 470 Ω, 1 KΩ, , 2.2 KΩ	1, 3, 2
5	Reset Switch	1
7	LED	5
9	DC Socket	1
10	IC DB107	1
11	IC 7805	1
13	Burg Stick	1
14	PIC Project Board	1
15	12 Volt DC Relay	2
16	Transistor BC 547/ BC 548	4
20	4 Pin Connector with Cable	1
21	Screw Connector	2
22	2 Relay PCB	1
23	USB to TTL Converter	1
24	Geared DC Motor	1
25	Transformer (230V to 12V)	1
26	AC Cable	1
27	DC Jack	1
28	3 Pin Connector with Cable	1
29	Web Camera	1
30	PIC Kit2 USB Programmer	1
31	ZIF socket	1

Table 4.2: Details connection of components

No.	Components	Legend
1	40 Pin PIC with IC Base	IC2
2	20 MHz crystal oscillator	Q1
3	Capacitor 33 pF	C2, C3
4	Reset Switch	S5
5	Resistor 1 KΩ	R5
6	Resistor 470 Ω	R1
7	LED	LED 1
8	Capacitor 0.1 µF	C8
9	DC Socket	J1
10	IC DB 107	B2
11	IC 7805	IC 1
12	Capacitor 1000 µF	Filter Capacitor Near Bridge
13	Burg Stick	NA
14	PIC Project Board	NA

4.2.2 Circuit diagram

In PIC16F877A microcontroller pin 11 is connected to the 5V VCC. Pin 12 is connected to the ground and pin 13 and pin 14 are connected to the oscillator. Transmitter pin 25 is connected to the receiver of serial communication and receiver pin 26 is connected to the transmitter of serial communication. Pin 31 and 32 are connected to the ground and 5V VCC. Pin 33 and 34 are connected to the 2 relays interface unit. Figure 4.8 shows the Circuit diagram with PIC16F877A microcontroller interfacing.

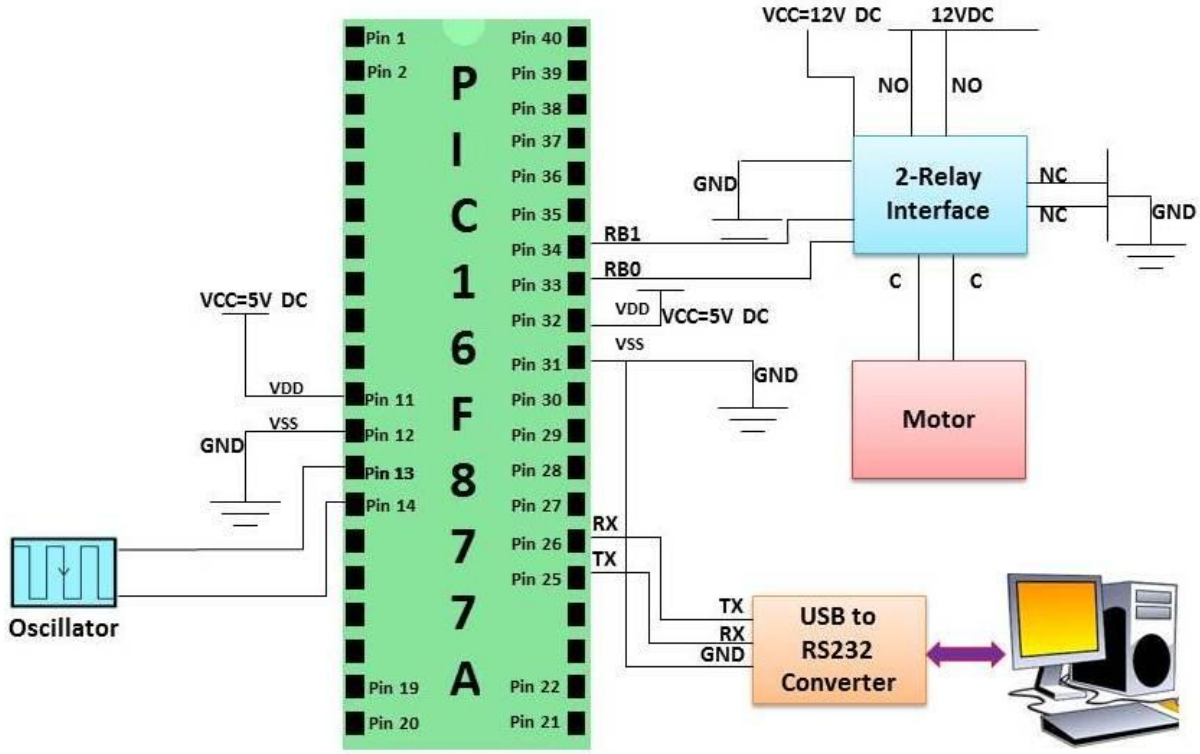


Figure 4.8: Circuit diagram with PIC16F877A microcontroller interfacing

4.2.3 Circuit development

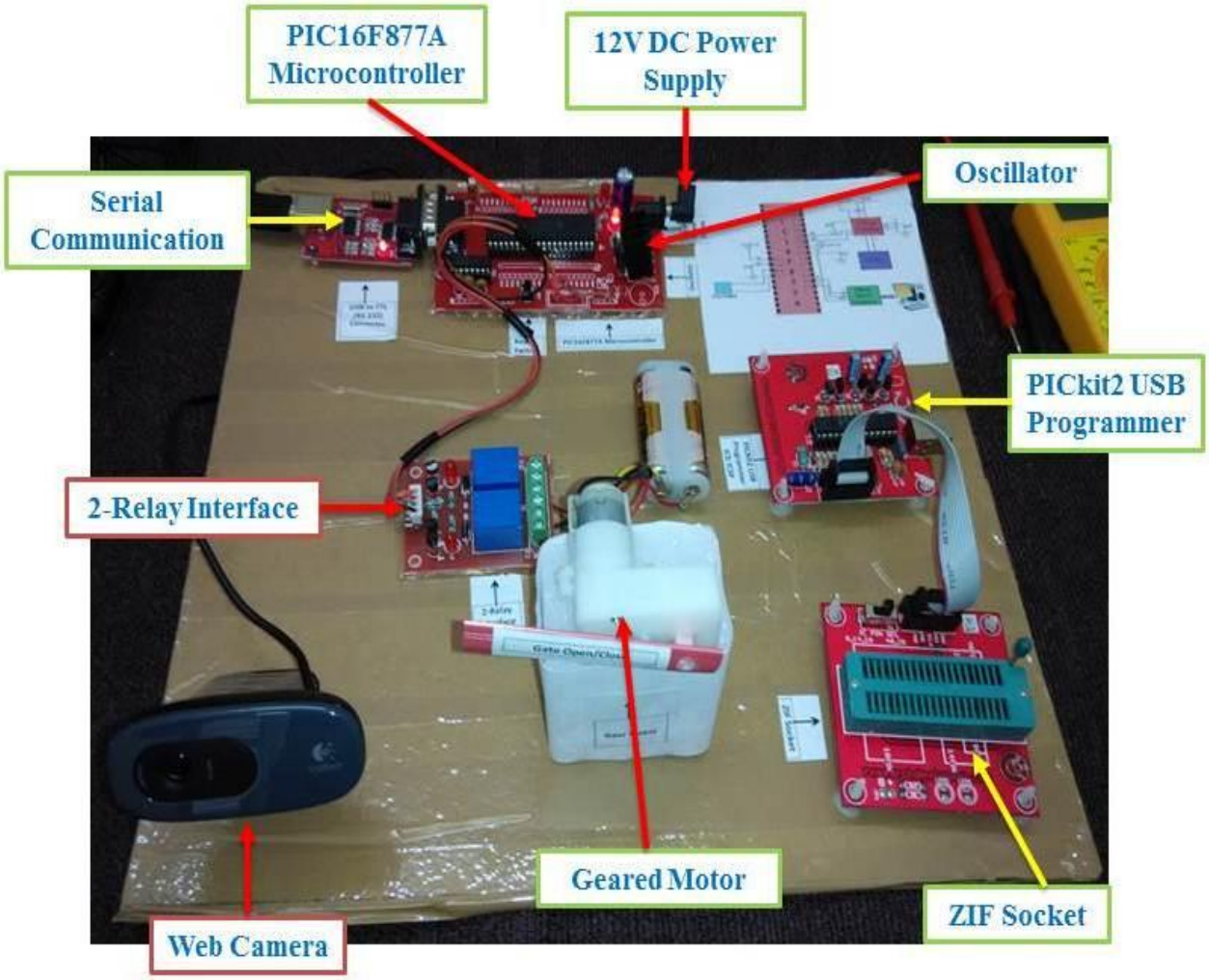


Figure 4.9: Circuit development for hardware implementation

4.2.4 Real time number plate digitization with microcontroller interfacing

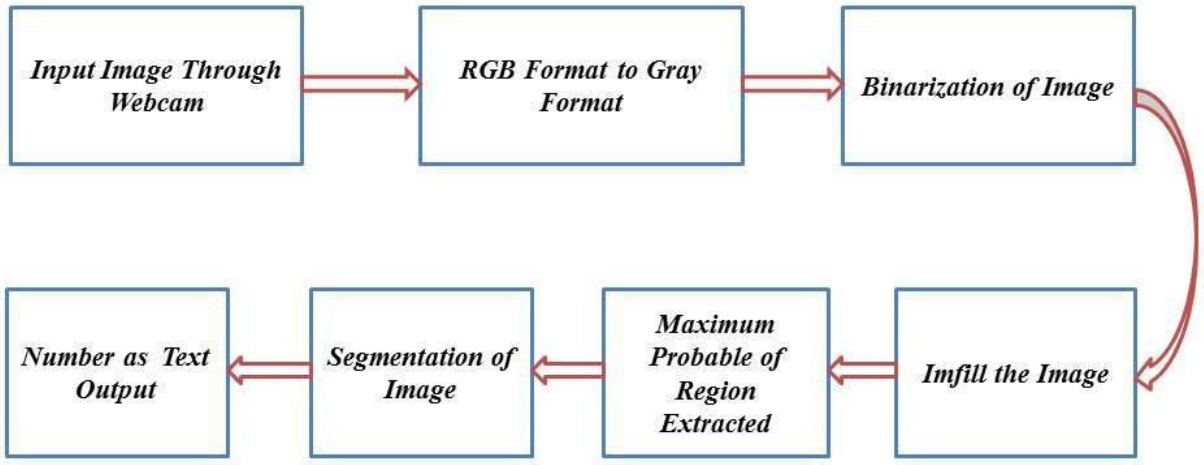


Figure 4.10: Block diagram for real time digitization process in MATLAB

☑ **Image acquisition**

In this step image is captured from web camera. Image should be taken from fixed angle parallel to horizontal. The captured image containing number plate is saved in MATLAB database for further process.

☑ **Colour image into Gray image Conversion**

The algorithms developed in MATLAB are independent of colour image. So, the captured image which is in RGB (Red, Green and Blue) format is converted into gray scale image for getting important information and extracting the number plate region.

☑ **Binarization of Image**

In this process the given image is improved by filling holes, sharpen the edges, and connect the broken lines and expand the luminance. It is also helped to remove the noise of an image. With the assistance of edges sharper, the distinction of gray scale esteem between neighbouring pixels at the edge can be expanded. This is called edge recognition. In number plate digitization, the picture of a truck number plate may not generally contain the same luminance and shades. Consequently, the given picture must be changed over from RGB to gray structure. However,

amid this change, certain critical parameters like contrast in shading, lighter edges of characters, and so may get lost.

4.2.5 Recognition of individual character

For recognition of individual alphanumeric character, template based recognition method is used. In this algorithm, segmented image is compared with one image which is stored in MATLAB database named as template image. In both images best matched similarity is compared. This similarity is matched with statistical method correlation. The image for which the correlation coefficient for template image is maximum that image is best matched. The template images are shown in given figure 4.11.

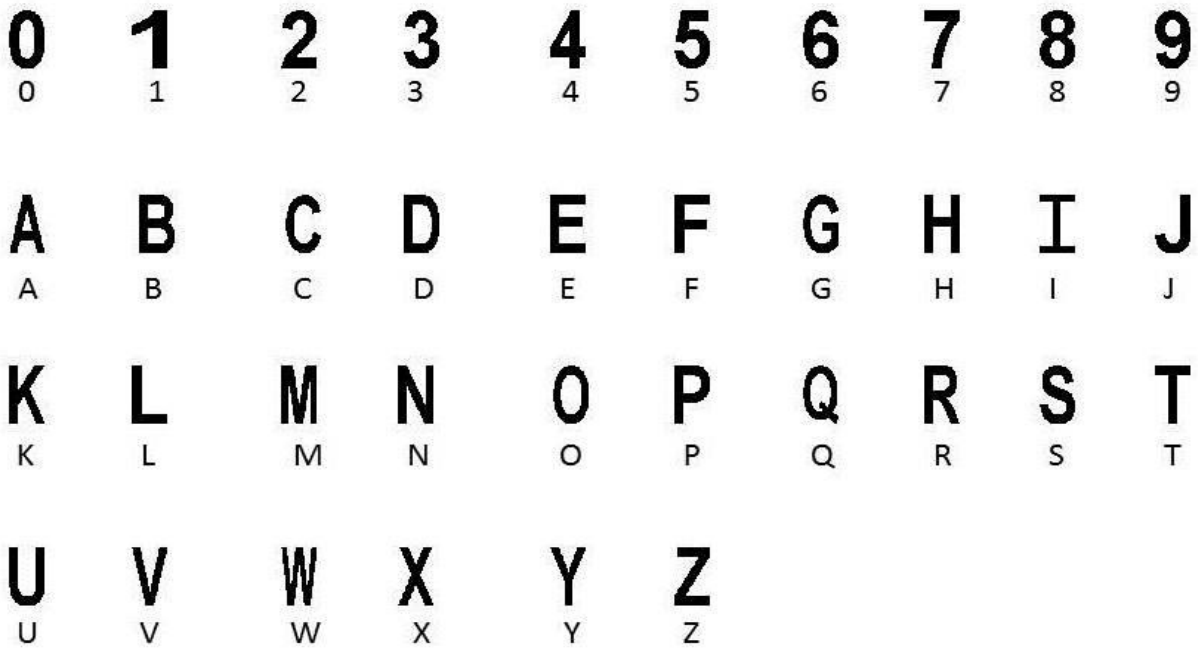


Figure 4.11: Template images

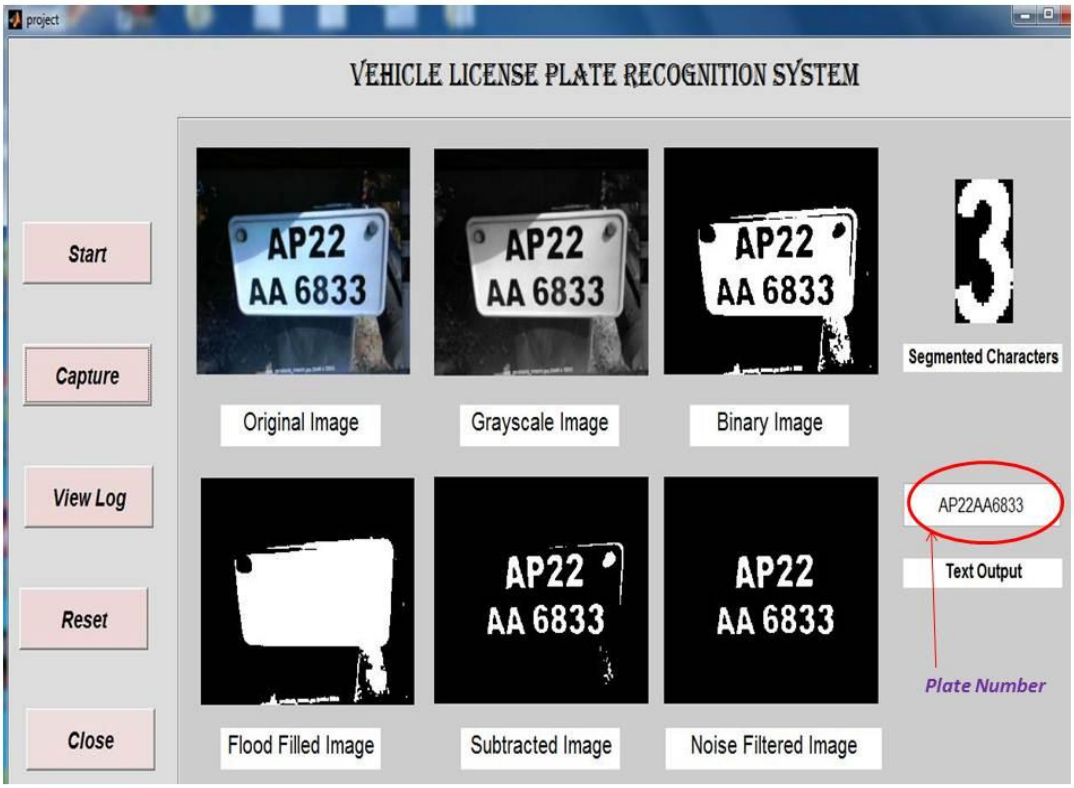


Figure 4.12: Number plate after real time digitization in MATLAB template

4.2.6 Storing in a file

After extracting and matching with template images, the vehicle number plate is stored in a file with some important information like time, date etc. The given figure shows store file which contains vehicle number, date and time.

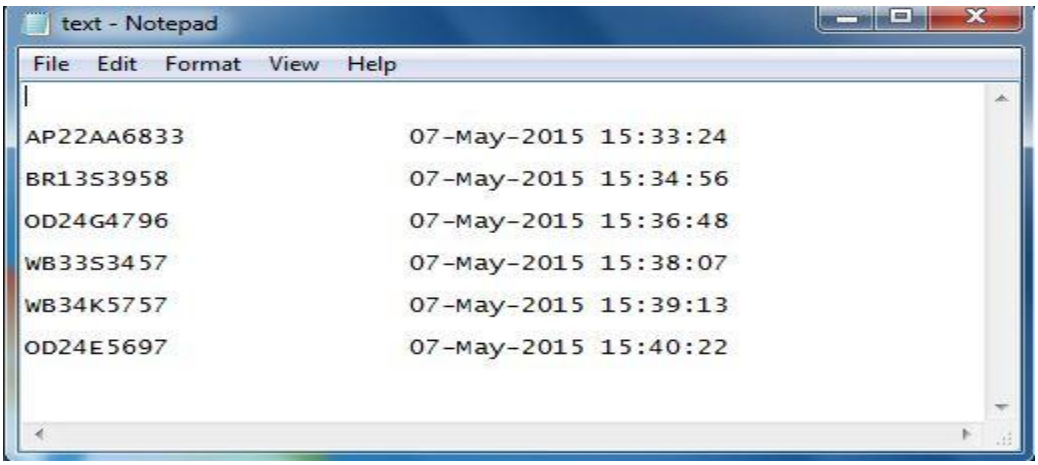


Figure 4.13: Extracted number plate store in a file

4.2.7 Access control

If the number plate is matches with the saved database then gate will open means the vehicle is authorized. But if the number plate is not matches with the saved database then gate will not open which means the vehicle is unauthorized. Figure 4.14 shows access control with microcontroller interfacing.

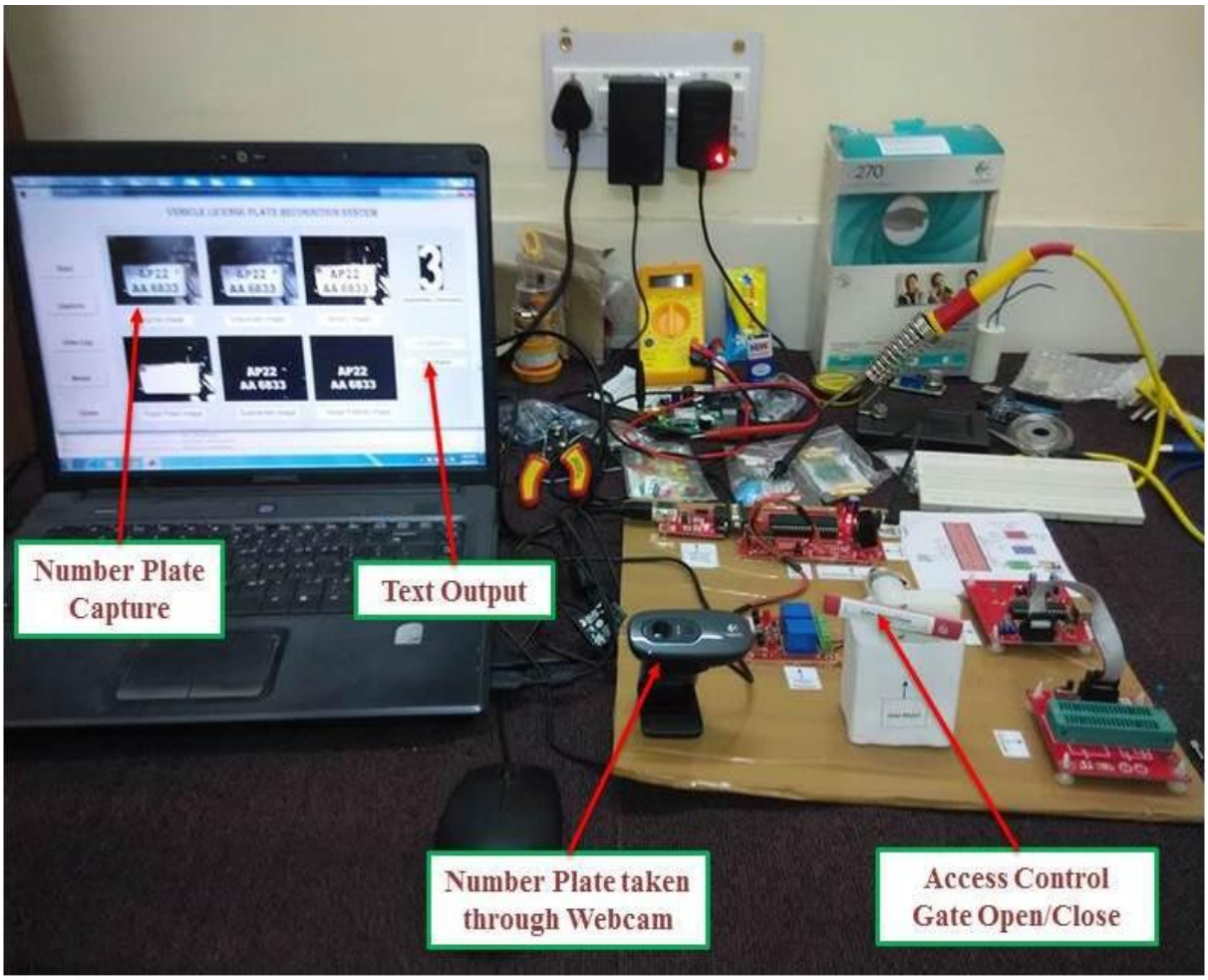


Figure 4.14: Access control with microcontroller interfacing

CHAPTER 5

EXPERIMENTAL RESULT AND DISCUSSION

- Experimental Result
- Accuracy Rate for Number Plate Recognition
- Analysis

5.1 Experimental Result

We have tested the algorithm in MATLAB for both saved vehicle number plate images and real time number plate recognition which has been taken from web camera. Analyses have been performed to test the proposed technique and to quantify the exactness of the method. In real time recognition system webcam captures the vehicle number plate for further process. The system is designed in MATLAB 12 for number plate recognition. The input images to the proposed system are colour images. The resolution of image is in between 1600*1200 and sizes 1.3 to 2.0 MP for getting best result. The test images were taken under various lighting and plate variation conditions. Different types of images has been tested including all types of license plates like plates having different background colour, different size, different lighting condition, standardized license plate, license plate with good contrast, low resolution license plate and skewed license plate. Some of their accuracy is measured for both in saved images and real time recognition through webcam.

$$Accuracy\ Rate = \frac{Number\ of\ License\ Plate\ Correctly\ Recognized}{Total\ Number\ of\ test\ Images\ Taken}$$

Total 25 vehicle number plates are taken for test out of 15 which are standard number plate with good contrast and proper lighting condition. Remaining 10 are non-standard with low resolution and skewed number plate. The following figures show the experimental result of number plate digitization.

Table 5.1: Number plate capture

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly Capture	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	10	100

Table 5.2: Colour to gray scale conversion

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly colour to gray conversion	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	10	100

Table 5.3: Binarized of the number plate

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly binarized	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	10	100

Table 5.4: Imfill the number plate

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly imfill	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	10	100

Table 5.5: Region of interest extraction of number plate

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly ROI extraction	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	8	80

Table 5.6: Segmentation of number plate

SL No	Types of Number Plate	No. of Number Plate Taken	Correctly Segmentation	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	9	90

Table 5.7: Text output of the number plate

SL No	Types of Number Plate	No. of Number Plate Taken	Text Output	Accuracy Rate in %
1	Standard number plate with good contrast and proper lighting condition	15	15	100
2	Non-standard with low resolution, skewed number plate	10	7	70

5.2 Analysis

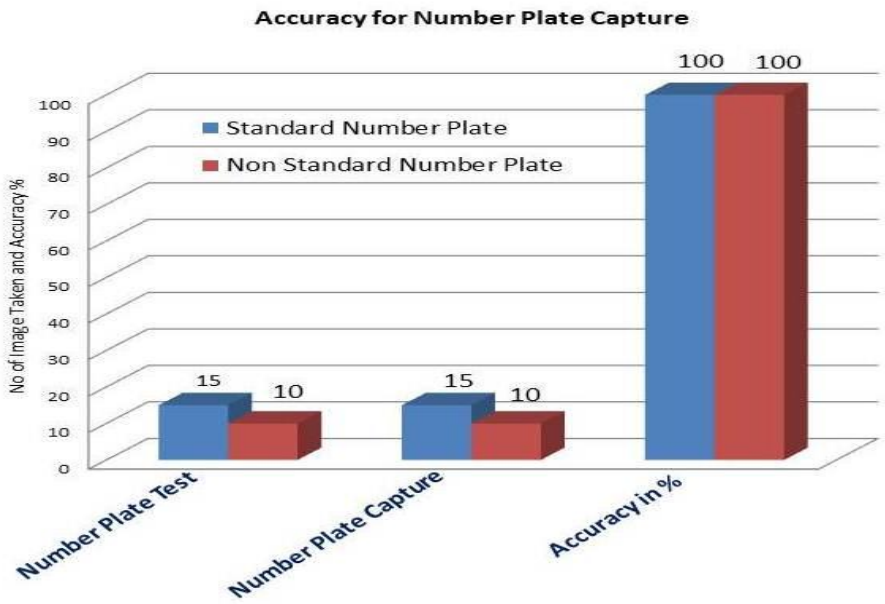


Figure 5.1: Accuracy rate for number plate capture

The above figure shows in both types of number plate's gives 100% accuracy for capture the image.

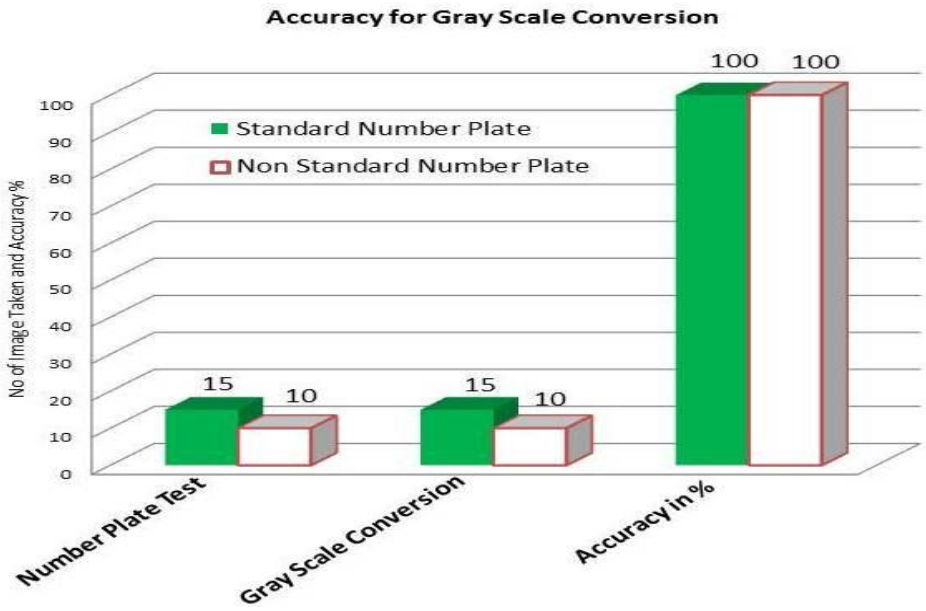


Figure 5.2: Accuracy for gray scale conversion

The figure 5.2 shows 100% accuracy for conversion of colour (Red, Green and Blue) image to gray scale image. The following table shows the accuracy for gray scale image conversion.

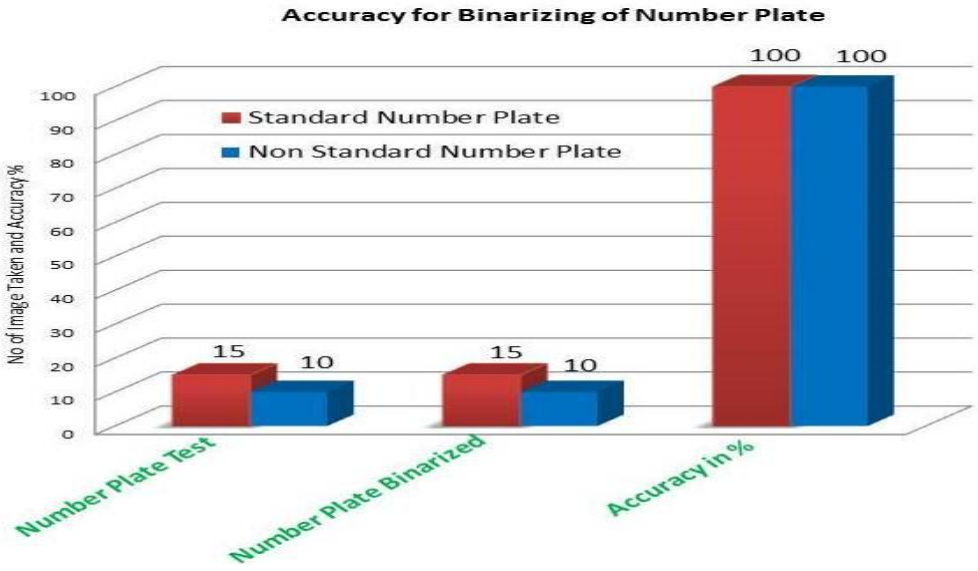


Figure 5.3: Accuracy for binarized the image

After gray scale conversion it is important for binarized the image to get the required information about the number plate. The above figure shows 100% accuracy for binarized the image in both types of number plate.

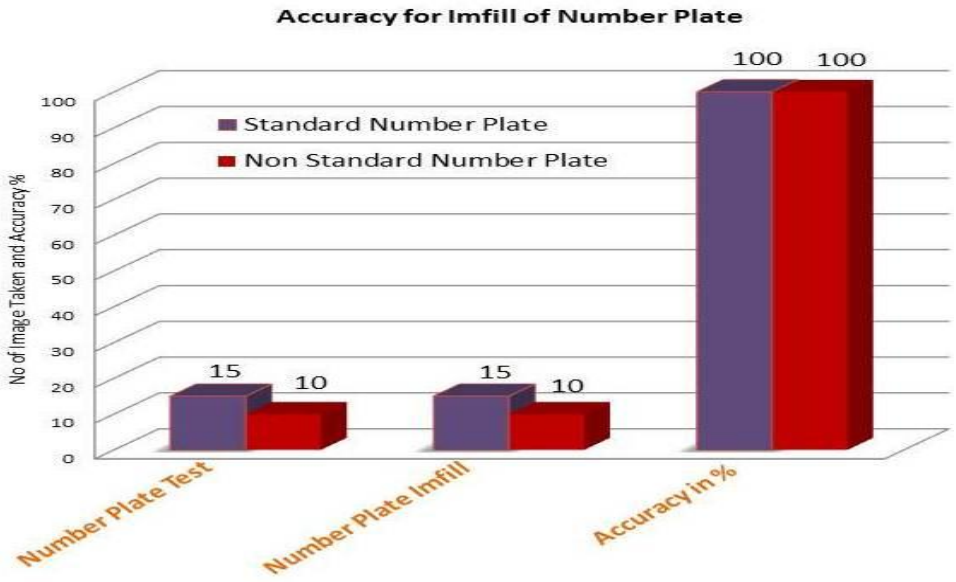


Figure 5.4: Accuracy for imfill the number plate

The next step is imfill an image. For gray scale images, imfill brings the force estimations of dark zones that are encompassed by lighter ranges up to the same power level as encompassing pixels. The figure 5.4 shows accuracy rate for imfill both types of number plate are 100%.

Figure 5.5: Accuracy for region of interest extraction

The region of interest extraction implies that have most extreme likelihood of containing a number plate. The above figure shows accuracy for standard number plate with good contrast and proper lighting condition is 100%. But due to low resolution and angle distortion the remaining plates shows 80% accuracy.

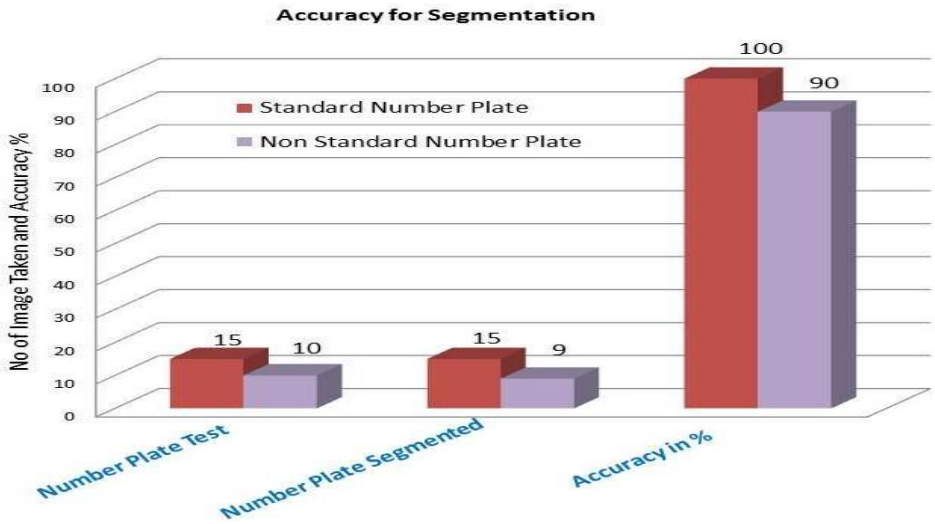


Figure 5.6: Accuracy for segmentation of number plate

Image segmentation is the procedure of separate an advanced image into different portions like sets of pixels, otherwise called super pixels etc. The objective of segmentation is to re-arrange and/or change the representation of an image into something that is more important and simpler to examine. The figure 5.6 shows number plates which are standard with proper lighting condition shows 100% accuracy. Some extra characters, numbers or letters are segmented in non-standards number plates and due to this its shows low accuracy 80% compared to the standard number plate.

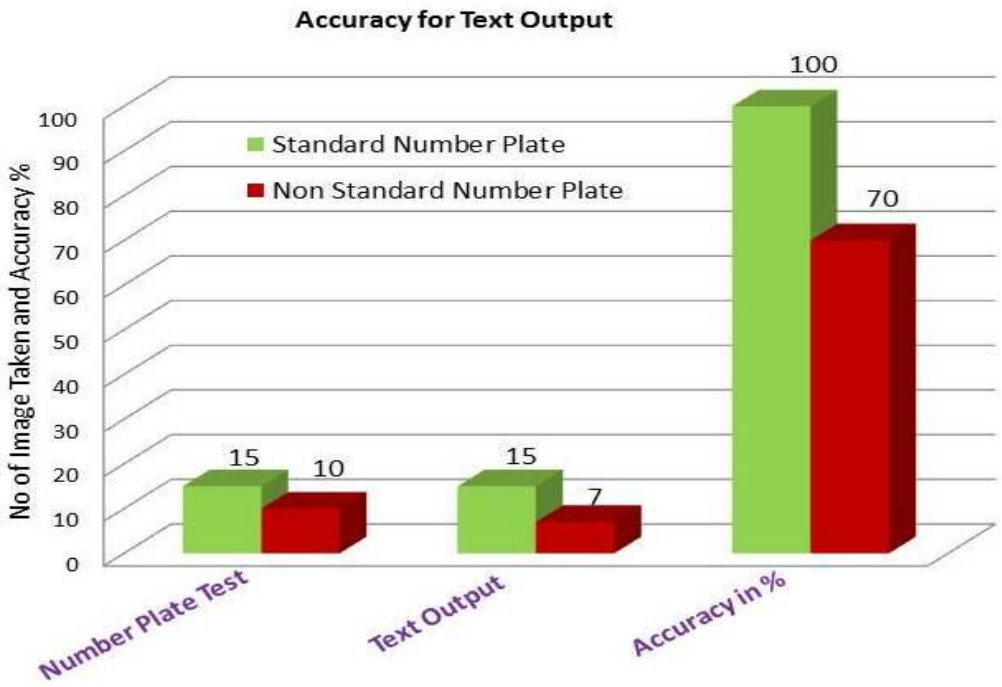


Figure 5.7: Accuracy for text output

The final step is test output. The basic motivation of this project is to digitalize the number plate which is taken as images. After complete all the processes the number plates gives the output as a text file. The figure 5.7 shows 100% accuracy for standard number plates which are correctly matches and saved as a test file. But for non-standard number plates it shows only 70% accuracy and all the plates number are not correctly matches.

CHAPTER 6

CONCLUSION AND SCOPE FOR FUTURE WORK

- Conclusion
- Scope for Future Work

6.1 Conclusion

The project is proposed remembering the mechanization of the number plate digitization technique for security reason that could restore the present arrangement of manual section.

In this thesis, the methods for automatic digitization of truck number plate system have been presented and the work on character recognition, license plate extraction and real time database matching are carried out. For number plate recognition, a study on different technologies available in the literature chapter has been studied and their performance tests on the different process are given. It should be noted that automatic truck number plate recognition in mines area is a critical task and its performance is always affected by the presence of darkness, noisy plate, varying illumination, background motion, shadow etc.

The system has been tested with different types of vehicle number plate for real time recognition. It shows 100 % accuracy for some standard license plate with good lighting condition. Some license plates which are not standard and low lighting condition shows in between 80-90 % accuracy.

Communication Technology, Information Technology, Microcomputer Technology and Automatic Data detection technology are used to understand the operational parameter like automatic data monitored system of the whole mining region. This method involves critical attribute, the real time information cautioning which shows with sorts of representation. With the help of high definition (HD) CCTV camera, it carries on image collecting and process distant control. Build with real time data monitor information security system technology using the MATLAB it makes the system protection and suitable for processing each and every types of information. This acute security technique in mines area pleased the users to monitor real-time data in the region of mine production. It is very useful for automatic monitoring the quantity of mines production and weight of a particular truck. The system also provides the important information regarding illegal mines transport which is most beneficial for mines companies.
There is an immediate need of such kind of automatic truck number plate recognition system in mining industries of India as there are problems of wrongly lifted of mines production, production is transfer by wrong way, dangerous accidents, traffic etc. This change will help in the progress of the nation.

6.2 Scope for Future Work

The objective of this project is automatic digitization of truck number plate in mines. However, the other segments of our suggested system should be improved; truck matching procedure and also focus on improving the accuracy measure for number plate recognition. The experimental setup can be further improved by introducing wireless CCTV camera, sensor technology. All the truck number plate should be written in standard format so that it can be easily recognized with 100 % efficiency. Because if there is a 1 % error means 10 truck missing for every 1000 number of truck which are very cost effective for companies.

The system will also be applicable in different areas like;

- ✓ **Parking**

Figure 6.1: ANPR use as parking

The plate number is used to automatically enter pre-paid members and calculate parking fee for non-members by comparing the exit and entry times.

- ✓ **Access control**

Figure 6.2: ANPR use as access control

A gate automatically opens for authorized members in a secured area, thus replacing or assisting the security guard. The events are logged on a database and could be used to search the history of events.

- ✓ **Tolling**

Figure 6.3: ANPR use as toll collection

The car number is used to calculate the travel fee in a toll-road, or used to double-check the ticket.

Border control

This installation covers the borders of the entire Country. Each vehicle is registered into a central database and linked to additional information such as the passport data. This is used to track all border crossings.

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