Project Proposal

Automatic Number Plate Recognition System

A Computer Vision GUI Application

Author:
Amit Kumar Thakur
B.Tech Electronics & Communication

Project Guide:
XYZ ZYX
Some one at JNU

This page will be erased before sending to DST as it is strictly not allowed to put names of PI, student(s) or guide in the this part..

Department of Electronics & Communication

School of Engineering & Technology

Jaipur National University

Contents

1 Title of the Project **1**

2 Project Summary **1**

3 Technical Details of the Project **2**

3.1 Introduction 2

3.2 Origin of the Proposal 3

3.3 Definition of the Problem 4

3.4 Objectives 4

3.5 Work Plan 5

3.6 Methodology 5

3.7 Organization of Work Elements 11

3.8 Time Schedule 14

3.9 Proposed Outcome 14

4 Details of Facilities to be Provided by Institution **15**

5 Budget Estimates **15**

6 Utilization of the Outcome of the Project **16**

1 Title of the Project

Automatic Number Plate Recognition System

2 Project Summary

Automatic Number Plate Recognition System (ANPRS) is an automatic multi-platform software application based system which tracks vehicles through a live camera, recognizes the number plate, extracts licence number out of the number plate, matches data against a database to identify the owner of the vehicle, and produces log report file with all details in real time.

To ease out workload on existing traffic monitoring system due to ever growing traffic in urban areas and to reduce manpower-time requirement, there is a need of an automatic vehicle identification system. Some existing number plate recognition system lack in the areas of automatic control, night-time monitoring, accuracy in characters recognition, user interface, database integration and hardware independency. These are the targeted areas to improve in this project.

ANPRS can be utilized to monitor traffic rule violations, in intelligent parking system to automatically record the details of vehicle and owner, in traffic enforcement, and security-surveillance systems.

Keywords

Automatic Number Plate Recognition, Optical Character Recognition, Computer Vision, Pattern Recognition Artificial Intelligence, Machine Learning

3 Technical Details of the Project

3.1 Introduction

The Automatic Number Plate Recognition System is a multi-platform software application based system which automates the vehicle number plate identification process using pattern recognition algorithms of computer vision. It recognizes the vehicle number plates from image frames captured by a live video camera, produces the details about identified vehicle on computer screen by matching the vehicle number against a central database and records the events into a log file-all automatically in real time.

The Indian vehicle number plates have black coloured characters on white background (for domestic purpose) or black coloured characters on yellow coloured plate (commercial purpose). The recognition process can be broadly divided into four steps:

1. Image acquisition of vehicle through an infrared IP video camera
2. Localization of the number plate in the video capture and removing other elements in the background
3. Character segmentation of number plate
4. Recognizing the characters by matching them to standard characters pattern, which is called Optical Character Recognition

In this system, an infrared video camera is fixed at some position to monitor a finite visible area. This area can be any place where a vehicle passes through like:

- Entry gate of a vehicle parking
- Road lanes and stop lines
- Toll clearance gates

The camera is connected to a computer through a LAN cable where live video signal is monitored and processed by ANPRS software application. The control can be set both manually and automatically through application settings.

3.2 Origin of the Proposal

With the increasing number of vehicles in urban areas, the workload on existing traffic controlling system has increased tremendously. To reduce this workload, we need to adapt modern technology based automatic controlling systems. Identifying and tracking every vehicle in high-traffic places like roads and parking is quite tedious and solely depends on skills of an individual person. Here are some cases or challenges and possible improvement using ANPRS:

1. Vehicle Parking

At the entry of the parking lots, one has to stop every vehicle for a while to record its details manually before it moves forward. The time duration between entrance and exit is used to calculate the parking charges. This calculation time depends on skills of an individual person.

Possible Solution: ANPRS can recognize the vehicle number plate at the time of entry and exit and calculate time and parking charges automatically.

2. Traffic Rule Violations

The traffic policeman has to first stop the traffic-rule violators to record the details of vehicle like Licence/Number plate take any further action. If the vehicle is moving at very high speed then it is quite tough to stop the offender.

Possible Solution: ANPRS can automatically record the number plate of the offender into a log file on a computer and this data can be used to take further action.

3. High Security Places like Border

Every vehicle is checked and identified by matching the records from a central database. This is done manually by a person operating a computer terminal.

Possible Solution:ANPRS can automatically recognize the number plate and retrieve the related data from the database.

4. Tracking Stolen Vehicles

Tracking every vehicle moving at certain speed is almost comparable to impossible without automatic tracking machine.

Possible Solution: ANPRS can track the stolen vehicles by recording the location and timestamp at the time of vehicle number recognition.

Other improvements are possible at places like toll clearance, reading train rolling-stock codes, traffic flow study and control etc.

3.3 Definition of the Problem

1. To minimize the background noise and correctly locate the the licence plate in the video capture
2. To maximize the accuracy of character segmentation on the number plate
3. To maximize the recognition rate of the character through neural network training
4. To minimize the character recognition time by using efficient algorithm

3.4 Objectives

To develop a computer based GUI ANPRS software application which:

1. Captures image frame of a vehicle and optimize it for image processing
2. Automatically locates the licence plate on the vehicle in the live video and recognize the vehicle number plate characters in least possible time
3. Automatically produces the details and about the vehicle and its owner, from the pre-populated database stored on the computer, in graphical form on the computer screen in real time
4. To record the time-stamp, snapshot and licence plate number and details of the vehicle in a log file

3.5 Work Plan

The whole work plan is divided into following broad steps (described in section- Organization of Work Elements):

1. Study and survey of real life challenges
2. Finding effectiveness and drawbacks of existing technologies
3. Experimentation with image processing techniques
4. Setting up a virtual environment for ANPRS
5. Developing cross platform GUI software application
6. Purchasing the required equipments and machines
7. Testing the application in virtual environment
8. Improving algorithms- based on feedback
9. Testing the application in real environment
10. Improving algorithm- based on results
11. Final packaging and documentation

3.6 Methodology

The proposed methodology to achieve the objectives is explained through details of tools and techniques used:

Tools and equipments to be used

Hardware

1. **IP Camera:** An Internet Protocol camera, or IP camera, is a type of digital video camera commonly employed for surveillance, and it can send and receive data via a computer network and the internet.
2. **Network cable:** Networking cables are used to connect one network device to other network devices.

Software

1. **OpenCV C++ Library:** OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. It 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. It runs on the major desktop platforms and some of the mobile platforms.

2. **Qt GUI Library:** Qt is a cross-platform application framework that is widely used for developing application software with a graphical user interface (GUI), and also used for developing non-GUI programs such as command-line tools and consoles for servers.

3. **MinGW Compiler:** MinGW (Minimalist GNU for Windows), formerly mingw32, is a distribution of the GNU Compiler Collection (GCC) and GNU Binutils for use in compiling native Microsoft Windows applications. It carries along a set of freely distributable header files and static import libraries to enable use of the Windows API. MinGW can function either as a cross compiler targeting Windows or as a self-hosted toolchain which can be run on Windows itself.

4. **Qt Creator:** Qt Creator provides a cross-platform, complete integrated development environment (IDE) for application developers to create applications for multiple desktop and mobile device platforms. It is available for Linux, Mac OS X and Windows operating systems.

Techniques to be Employed

1. **Image acquisition:**
   The video of vehicle is captured using infrared IP camera and sent to computer using network cable. Video frames are tested and best frame is used for further processing. The camera must have shutter speed of 1/1000 to capture high speed vehicles images. The infrared illuminator must be fitted adjacent to camera for best capture.

2. **Preprocessing:**
   It is easier to detect patterns in images if they are converted to binary images. This conversion along with other preprocessing techniques generates right candidate image for further processing. The techniques are:

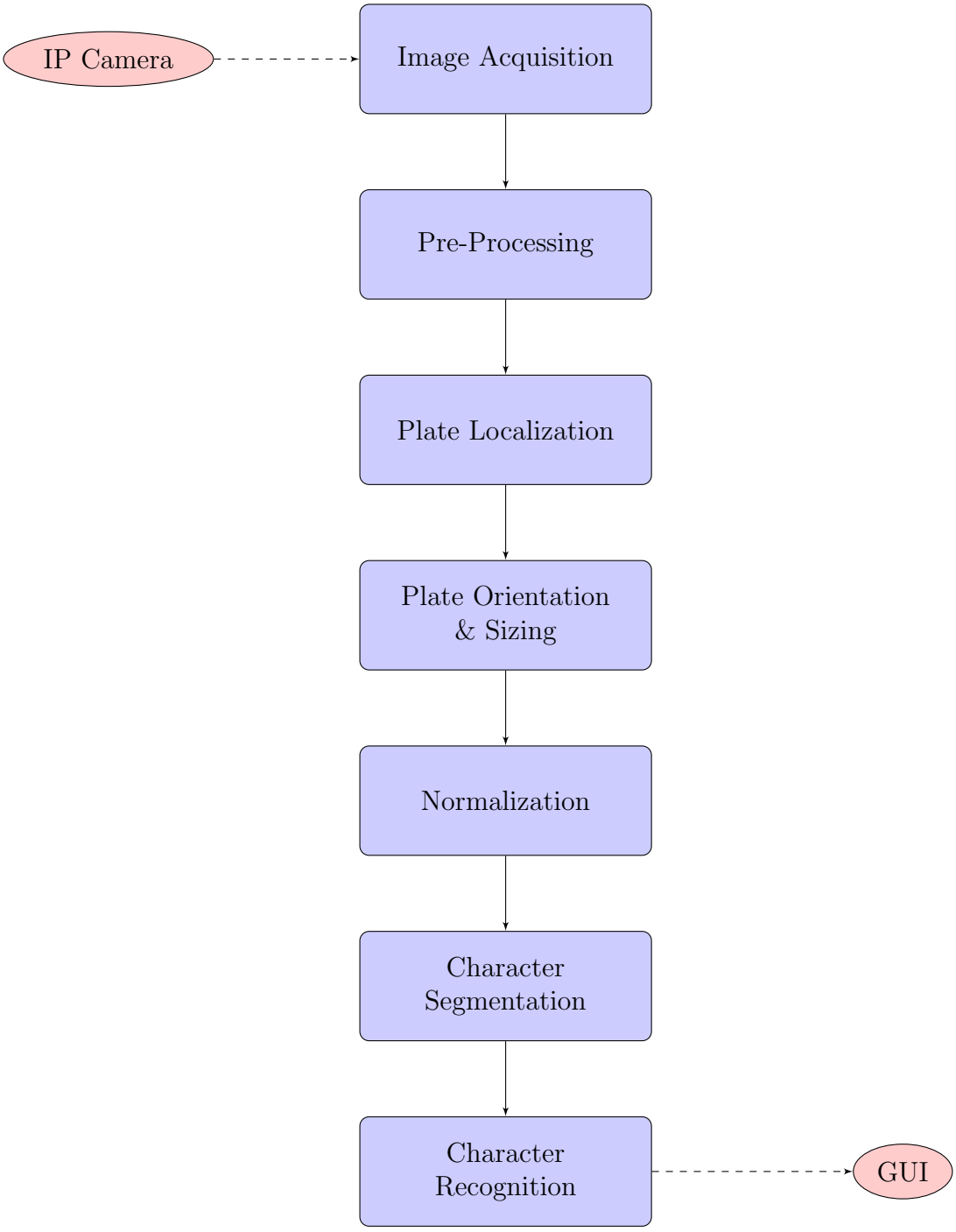

Figure 1: Flow Chart of Techniques used

(a) **Re-Sizing:**
The raw image size may be too large, so it is good idea to save memory and computing time by re-sizing image to required aspect-ratio.

(b) **RGB to Grayscale Colorspace Conversion:**

$$gray(i,j) = 0.59 \cdot R(i,j) + 0.30 \cdot G(i,j) + 0.11 \cdot B(i,j)$$

where i and j are colorspace component.

(c) **Median Filtering:**
It replaces the gray value of each pixel with the median value of gray values in the neighbouring pixels.

(d) **Enhancing the Contrast:**
We enhance the contrast using histogram equalization technique.

3. **Plate Localization:**
Now we have to exactly locate the plates in the video capture. Usually characters on the number plate are dark-coloured font on a white or yellow background. This contrast between them produces frequent sharp variations in the intensity of Grayscale image. Also the Number Plate is a rectangular shaped object, so we would look for both horizontal and vertical straight edges using edge detection techniques. Here are the some techniques to be used:

(a) **Edge Extraction:**
As said above, the sharp variation of intensity is the key to find edges. We can extract edges by Gaussian and Laplacian techniques. The former finds the maximum and the minimum in the first derivative, the later finds the zero crossings in the second derivative of the image.

(b) **Sobel Operator:**
The Sobel operator finds the 2-dimensional spatial gradient at each point of an image in x and y direction. Number plates are most probably present in the block or row having large intensity variations between characters.

(c) **Bounding Box (Width, Aspect Ratio):**
It is a box with minimum width and height having all the required points. We can also fix the threshold limits on the aspect ratio range to narrow down identified objects. After identifying the possible candidate we crop down it to best bounding box.

4. **Plate orientation & Sizing:**
   Sometimes the video capture may be tilted or there may be very small skew due to camera angle or orientation of camera with respect to vehicle. This increases the complexity in character recognition. Therefore we de-skew the plate segment after detecting the skew angle using edges.

5. **Normalization:**
   To control the brightness and contrast to optimum level for easy character segmentation.

6. **Character Segmentation:**
   Here we find each individual character on the candidate number plate obtained in last step. It is easier to identify characters if they are arranged in a uniform pattern. Fancy fonts and design makes the segmentation difficult. Indian licence plates vary a lot in size-shape of plate, font and background. They need extra focus while applying segmentation techniques. The techniques for character segmentation are:

   (a) **Histogram analysis and Thresholding:**
   This histogram is a graph showing the number of pixels in an image at each different intensity value found in that image. For an 8-bit grayscale image there are 256 different possible intensities, and so the histogram will graphically display 256 numbers showing the distribution of pixels amongst those grayscale values.

   (b) **Connected component Analysis:**
   Connected-component labeling is used to detect connected regions in binary digital images. The vertices contain information required by the comparison heuristic, while the edges indicate connected neighbors. This algorithm traverses the graph, labeling the vertices based on the connectivity and relative values of their neighbours.

   (c) **Morphological technique:**
   To remove small texture pretending like the actual characters

   After this we are ready with segmented characters and pass it to Character recognition module.

7. **Character Recognition using Artificial Neural Networks:**
   Here our goal is to recognize the characters by matching them with standard characters. with the help of artificial neural network. Artificial Neural Network is presented as system of interconnected neurons

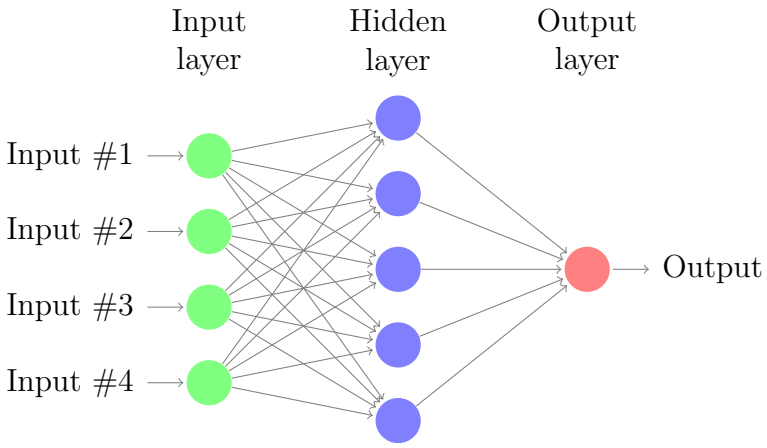

Figure 2: Artificial Neural Network

that can compute values from inputs by feeding information through the network.

An ANN is typically defined by three types of parameters:

(a) The interconnection pattern between different layers of neurons

(b) The learning process for updating the weights of the interconnections

(c) The activation function that converts a neuron's weighted input to its output activation

The first layer has input neurons, which send data via synapses to the second layer of neurons, and then via more synapses to the third layer of output neurons. More complex systems will have more layers of neurons with some having increased layers of input neurons and output neurons. The synapses store parameters called weights that manipulate the data in the calculations.

In the neural network for character recognition, a set of input neurons may be activated by the pixels of an input image representing a letter or digit. The activations of these neurons are then passed on, weighted and transformed by some function determined by our requirement, to other neurons, etc., until finally an output neuron is activated that determines which character was read.

We finally get the recognized characters and it can be written to a text file and log file.

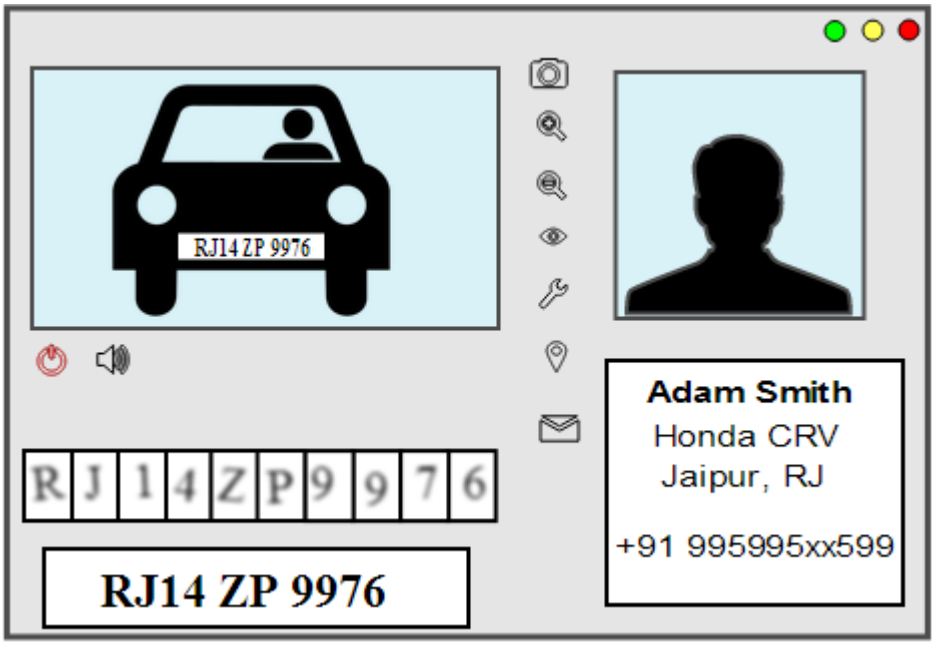

Figure 3: ANPRS GUI Application

8. **Retrieving the details from the central database to GUI:**
   The application will automatically retrieve relevant details from central database of vehicle registration like owners name, photo, vehicle model, location, contact etc. as shown in the figure: In GUI there will be live video streaming box, segmented characters and final recognized vehicle number plate characters.

9. **Updating the log file:**
   The vehicle licence number, timestamp, photo-capture and location will be recorded into a log file in real time as soon as the number plate is recognized.

3.7 Organization of Work Elements

The entire work-plan has been divided into elementary tasks to achieve to all objectives:

3.7.1 Study and Survey of Real Life Challenges

1. Environment: Visibility, speed of vehicle, locations of usage
2. Vehicle Number Plate size-shape irregularity
3. Traffic behaviour and volume

3.7.2 Finding Effectiveness and Drawbacks of Existing Technologies

1. Recognition accuracy: How much accurate it is in identifying characters
2. Time of computation: How much fast the application/technology is
3. Platform dependency: Whether any pre-installed software/hardware is required or not
4. Usability: How much easier is its usage in real life application

3.7.3 Experimentation with Image Processing Techniques

1. Setting up image processing software environment on computer
2. Testing filters and transformation on different type of test images
3. Finding out best threshold value for different filters

3.7.4 Setting Up a Virtual Environment for ANPRS

1. Recording video at traffic places during day and night
2. Creating a dummy database of vehicle registration
3. Creating blurred and skewed characters on machine

3.7.5 Developing Cross Platform GUI Software Application

1. Setting up Qt creator, MinGW compiler, Qt-GUI framework and OpenCV Library on computer

2. Developing the GUI using Qt framework and C++
3. Implementing the image processing techniques using OpenCV libraries

3.7.6 Purchasing the Required Equipments and Machines

1. Night Vision-Infrared IP Camera for ANPR
2. LAN cables, power cables and electrical equipments

3.7.7 Testing the Application in Virtual Environment

1. Using pre-recorded video as a source video stream to test GUI
2. Using pre-populated dummy database to extract out the details of the vehicle
3. Modifying the blur, skew, structure and font parameters of characters using control buttons
4. Training artificial neural network to recognize characters
5. Calculating the performance in terms of accuracy and recognition time

3.7.8 Improving Algorithms Based on Feedback

1. Changing threshold values according to previous results
2. Training artificial neural network with variety of characters

3.7.9 Testing the Application in Real Environment

1. Optimizing the algorithm based on results in last step
2. Improving the software interface according to user feedback

3.7.10 Final Packaging and Documentation

1. Packaging release version of the software into installer file
2. Writing documentation for the usage and technical specification

3.8 Time Schedule

The projected time schedule is described as follows:

Sr. No.	Work Elements	2013				2014			
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1	Study and Survey of existing techniques and challenges								
2	Experimenting with Image Processing techniques								
3	Setting up virtual environment for ANPRS								
4	Software Development: GUI and database								
5	Purchasing the required tools and equipments								
6	Testing the application in virtual environment								
7	Improvement: Phase I								
8	Testing the application in real environment								
9	Improvement: Phase II								
10	Final packaging and documentation								

Figure 4: Time Schedule

3.9 Proposed Outcome

1. Highly accurate algorithm to recognize more than one number plate and the characters on them reliably
2. User friendly software application which can be run on any computer with any configuration supporting large varieties of camera
3. Customization options to integrate into multiple applications
4. A versatile application working both day and night 24/7

4 Details of Facilities to be Provided by Institution

Sr. No.	Infrastructural Facility	Yes/No/Not Required
1.	Workshop Facility	Yes
2.	Electricity	Yes
3.	Laboratory Space & Furniture	Yes
4.	AC Room	Yes
5.	Internet Access & Library	Yes
6.	Computational Facilities	Yes
7.	Computer Network & Server	Yes

Table 1: Facilities Provided by Institution

5 Budget Estimates

Type	Sr. No.	Item	Cost* (INR)
Major Equipments	1.	IP Camera	7500
	2.	Network Cable + Socket	500
Minor Equipments	3.	Power Strip + Cord	500
	4.	Other Utilities	500
Consumables	5.	Stationery Items	500
	6.	Storage Devices	500
Report Writing	-	-	1000
Contingency & Other costs	-	-	1500
		TOTAL	**12500**

Table 2: Budget Estimate

*Market Price at the time of writing proposal. It may change +(-)10 %

6 Utilization of the Outcome of the Project

The outcomes of the project can be utilized in number of ways. Some of the applications are:

1. **Intelligent Transportation System:**
   ANPRS can be utilized to understand and analyse the traffic volume and behaviour by measuring and recording travel time measurement, speed and other vehicle data

2. **Public Transit Security System:**
   To track any suspicious movement and for other security surveillance purpose

3. **Entry Access Monitoring:**
   To give give access to few vehicles in private parking places

4. **Tolling System:**
   To exactly know the time and location of vehicle to calculate toll charges

5. **High Security Monitoring:**
   To monitor each and every vehicle getting inside or going outside the premises of high security places like Military Zones, Govt. Buildings, Institutions etc.