AUTOMATIC VEHICLE LICENSE PLATE RECOGNITION USING OPTIMAL KNN WITH CNN

A MAJOR PROJECT REPORT

Submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

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MAY, 2021

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CERTIFICATE

This is to certify that the Major project work titled **"Automatic Vehicle License Plate Recognition Using Optimal KNN With CNN"** submitted by Ms. R. Tharuni (Reg.No.17891A0546), Mr. I.V. Sai Vasanth (Reg.No.17891A0528), Mr. M. Vinay Kumar (Reg.No.17891A0536) in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering to the Vignan Institute of Technology And Science, Deshmukhi is a record of bonafide work carried out by them under my guidance and supervision.

The results embodied in this project report have not been submitted in any university for the award of any degree and the results are achieved satisfactorily.

Mrs. P. Lavanya Kumari
Associate Professor
Supervisor

Dr. J. R. V. Jeny
Professor & Head of the Department

Principal

DECLARATION

We hereby declare that major project entitled **"Automatic Vehicle License Plate Recognition Using Optimal KNN With CNN"** is bonafide work duly completed by us. It does not contain any part of the project or thesis submitted by any other candidate to this or any other institute of the university.

Such materials that have been obtained from other sources have been duly acknowledged.

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ACKNOWLEDGEMENT

This is acknowledgement of the intensive drive and technical competence of our major project completion on **"Automatic Vehicle License Plate Recognition Using KNN With Convolutional Neural Network"**. We would like to express my sincere thanks to **Dr. L. Rathaiah**, Chairman of Vignan Institute of Technology and Science, **Mr. Boyapati Sravan**, CEO of Vignan Institute of Technology and Science, Hyderabad, **Dr. G. Durga Sukumar**, Principal of Vignan Institute of Technology and Science, for providing us with all the necessary facilities and his support.

We place on record our sincere thanks to **Dr. J.R.V. Jeny**, Head of Computer Science Department for her whole hearted co-operation, providing excellent facilities, constant encouragement and unfailing inspiration.

We would like to express my gratitude towards our project coordinators **Mr. R. Praveen Kumar & Mrs. P. Lavanya Kumari** for their kind co-operation and encouragement which help me in completion of this project

We also thank our guide **Mrs. P. Lavanya Kumari**, Associate Professor of Computer Science Department. I am extremely grateful and indebted to her for her sincere support and encouragement extended for us. The satisfaction and euphoria that accompany the successful completion of task would be great but in complete with the mention of the people made it possible with here constant guidance and encouragement crowns all the efforts with the success. In this context, we would like to thank all the staff members teaching and non-teaching, who have extended their timely help and eased my task.

Contents

List of Figures

List of Tables

Abstract

License Plate Recognition was a computer system that recognizes any digital image automatically on the number plate. This system includes various operations such as taking pictures, localizing the number pad, truncating characters and OCR from alphanumeric characters. The main idea of this system is to design and develop effective image processing techniques and algorithms to localize the license plate in the captured image, to divide the characters from that number plate and to identify each character of the segment by using the Open Computer Vision Library. This has been implemented in K-NN algorithm and python programming language. Many applications can be implemented by using this system, such as security, highway speed detection, violation of light, identification of handwritten text, discovery of stolen cars, automatic fee collection systems.

Chapter 1

INTRODUCTION

People from different countries interact in a multicultural environment to develop solutions to never-ending problems for men. The Open-Source section is a one of the outstanding contributions in the scientific world is Python. Computer vision in the Intel's research has been producing a fruit called Open Computer Vision (Open CV), which can support the development of computer vision. At present, the use of vehicles is increasing throughout the country. All of these vehicles have a unique vehicle identification number as their main identifier. The ID is actually in the license number that refers to a legal license to participate in the public movement. Each vehicle in the world must have its own number plate that must be installed on its body (at least on the back). They need to Identify the vehicles are increasing in parallel with the number of vehicles. The auto license plate recognizing system replaces the manual license plate number writing process in the computer system.

In order to obtain an appropriate personal recognition, the license plate identification technique consists of three main topics. They are, find the location of the panel of digital images, segmentation the characters from the pictures of the panel and the visual character Recognition. The most dominant and basic step is to determine the exact location of the number plate in the captured image. The localization of a license plate has been recognized either by structural analysis and color analysis method. In the License panel area, unwanted spots are removed by parsing the connected component. ANPR is a collective control system that captures the vehicle image and identifies the license number. Some ANPR system applications are automatic traffic control and tracking system, highway toll collection / automatic parking systems, petrol station automation, flight time monitoring. These systems automate the process of identifying vehicle license number, making it fast, cost effective.

Chapter 2

LITERATURE REVIEW

Searching for license plate recognition is still a challenge. It involves three major steps. They specify number pad space, character segmentation, and character recognition. Each step suggested different ways to improve efficiency.

One of these methods [1] used the adaptive threshold to highlight the characters and suppress the background. In order to remove unwanted image spaces, a component algorithm is first applied to the converted binary image from the original panel. A special algorithm called Image Scissoring is used to divide the Optical Character Recognition engine called tesseract, which returns ASCII to the license number. The entire system has been implemented using open CV.

Another method [2] is to deploy the forward background feed method for character classification. The neural network is developed by using the backward-propagation algorithm. Normalization, scale and edge detection are included in the steps of the preprocessing. The horizontal and vertical graph and component survey are able to address the problem of character fragmentation.

[3] Another way in which character areas are selected is through binarization, connected component analysis. The Point Analysis method removes unwanted points and combines split points and split points. This unit achieves a 97.2% accuracy rate in character segmentation. The reliability of the recognition was 90.9%.

[4] Offers an approach that relies on effective morphological operation and the detection method of Sobel Edge. This approach is simplified to divide all letters and numbers used in the number pad using the surround box method. After the template is fragmented, the matching policy is used to recognize numbers and characters. This whole system was implemented using MATLAB.

In [6] the author studies a comparison of four algorithms that are sequentially using statistical properties, the Hough Transform and Contour algorithm, the medium transformation approach and morphological processes and their results.

The handwritten text [7] is fragmented by the watershed algorithm. Noise removal, slope correction, budgeting and normalization were eliminated in pre-treatment. After fragmentation

the process of extracting a segmented image is done by a reverse integer to convert the wavelet integer. The classification is then sorted by neuroscience

2.1 Existing System

In many countries ANPR methods have been implemented such as Australia, Korea and a few other countries. In the development of ANPR system in many countries the number plate standards are strictly implemented. These systems use standard features for license plates such as: panel dimensions, panel borders, color and letter characters, etc., which help to easily localize the number pad and specify the car license number. In India, plate number standards are rarely followed. There are wide variations in font types, text, size, position, and colors of number plate. In a few cases, there are other undesirable decorations on the number panel. Also, different other countries, there are no special features on Indian number panel to facilitate recognition. Thus, only manual recording systems are currently being used and ANPR has not been commercially developed in India.

2.2 Proposed System

In India, basically, there are two kinds of license-plates, black characters in white plate and black characters in yellow plate, the former for private vehicles and latter for commercial, public service vehicles. The system tries to address these two categories of plates, the high-level block diagram of the proposed system shown below.

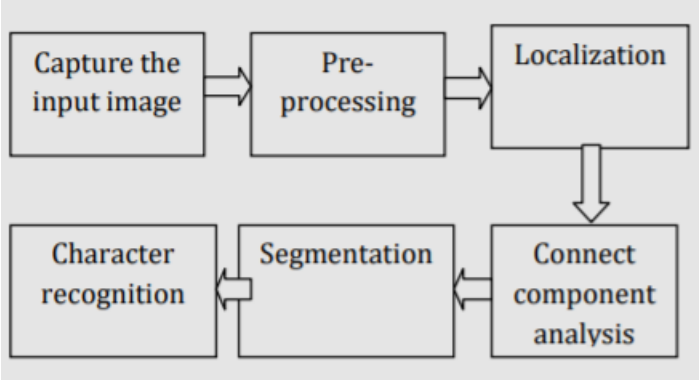

Figure 2.1: Proposed System Architecture

CAPTURE THE INPUT IMAGE

The car's number pad is taken from a high-resolution camera. The resolution of the number plate recognition system depends on the captured image. The image captured in RGB format must be converted to a gray image

PRE-PROCESSING

Pre-processing is a set of algorithms applied to the image to improve the quality by which the gray image is converted to a binary image. Before converting to a binary image, the image is smoothed to reduce noise. Pre-processing can be done by the threshold algorithm. There is a different kind of threshold like

- Global threshold
- Adaptive mean threshold
- Adaptive Gaussian threshold

Global threshold The threshold is a nonlinear process where two levels are assigned to pixels lower or bigger than the threshold value specified. The threshold value is constant. The grayscale picture is converted to convert the binary image.

Average adaptive threshold The value of the threshold is the average area of the neighborhood.

Gaussian Adaptive Threshold Threshold value is the sum of the values of the values of the neighborhood where the weights are a Gaussian window. The gray picture is then converted to a binary picture by the adaptive threshold method. The threshold is the simplest way to divide objects from the background. If the background is relatively same, the global threshold can be used. For large change in background intensity the adaptive threshold is used.

NUMBER PLATE LOCALIZATION

The license plate is extracted using either a shape analysis or a color analysis method. In the General License Panel has in form of a rectangular shape. Thus, algorithms look for geometrical shapes of a rectangular proportion. In India, most license plates are white or yellow, and therefore can also use color analysis. Before you find the rectangle in an image, the image must be in a binary image or the edges of the image should be detected. Then you should find and connect to the relevant rectangular corners..

CONNECT COMPONENT ANALYSIS

To remove the unwanted image space, the algorithm of the component connected to the binary filter is applied first. The parsing of the connected component is done to determine the characters in the image. The basic proposal is to pass through the image and find a connected pixel. Each component (dots) is distinguished and extracted.

SEGMENTATION

Once the license plate has been extracted, each character must be fragmented. For component division, the component label is used to see the computer in order to discover the connected areas in binary digital images. The label of connected components works by scanning a pixel-in-pixel image from top to down to find connected pixels and connected pixel cards.

CHARACTER RECOGNITION

To identify characters, the segmented characters in the license panel must match the templates that are already created. The recognition process returns the license number in ASCII format and saves it in a text document. In this recognition is a two-track process. In the first pass, an attempt was made to identify each word in turn. Each satisfactory word is passed to the adaptive workbook as training data. The adaptive workbook gets an opportunity to learn the text more accurately.

Chapter 3

IMPLEMENTATION

3.1 Requirements

3.1.1 Hardware Requirements:

- Processor : Intel i3 and above
- RAM : 4GB and Higher
- Hard Disk : 500GB: Minimum

3.1.2 Software Requirements:

- Programming Language : Python
- IDE : Anaconda
- Web Framework : DJango
- UI Technologies : HTML, CSS, JavaScript
- Database : SQLite

3.2 Libraries

Numpy

Numpy is a general-purpose array-processing package. It provides a high-Performance multidimensional array object and tools for working with these Arrays. It is the fundamental package for scientific computing with Python. It contains various features including these important ones.

- A powerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and FORTRAN code
- Useful linear algebra, Fourier transforms, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined using Numpy which allows Numpy to seamlessly and speedily integrate with a wide variety of databases.

Pandas

Pandas are an open-source Python Library providing high-performance data manipulation and analysis tool using its powerful data structures. The name Pandas is derived from the word Panel Data – an Econometrics from Multidimensional data. In 2008, developer Wes McKinney started developing pandas when in need of high performance, flexible tool for analysis of data. Prior to Pandas, Python was majorly used for data munging and preparation. It had very little contribution towards data analysis. Pandas solved this problem. Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data — load, prepare, manipulate, model, and analyze. Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, Statistics, analytics, etc. Standard Python distribution doesnt́ come bundled with Pandas module. A lightweight alternative is to install NumPy using popular Python package installer, pip. pip install pandas

Open CV

OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection. In this tutorial, we explain how you can use OpenCV in your applications. OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection.

Computer Vision

Computer Vision can be defined as a discipline that explains how to reconstruct, interrupt, and understand a 3D scene from its 2D images, in terms of the properties of the structure present in the scene. It deals with modeling and replicating human vision using computer software and hardware. Computer Vision overlaps significantly with the following fields Image Processing It focuses on image manipulation Pattern Recognition It explains various techniques to classify patterns. Photogrammetry It is concerned with obtaining accurate measurements from images. Computer Vision Vs Image Processing Image processing deals with image-to-image transformation. The input and output of image processing are both images. Computer vision is the construction of explicit, meaningful descriptions of physical objects from their image. The output of computer vision is a description or an interpretation of structures in 3D scene.

Features of OpenCV Library

- Using OpenCV library, you can Read and write images Capture and save videos Process images (filter, transform)
- Perform feature detection
- Detect specific objects such as faces, eyes, cars, in the videos or images.
- OpenCV was originally developed in C++.

3.3 Image Processing

Capture The Image Capture The image of the vehicle is captured using a high-resolution photographic camera. A better choice is an Infrared (IR) camera. The camera may be rolled and pitched with respect to the license plates. Starting from point one of capturing the image, OpenCV library has highly optimized algorithms for all image processing operations. The following code snippet explains how to interface an in-built web camera and capture a frame.

Figure 3.1: Captured Image

B. Preprocessing

Preprocessing is the set algorithms applied on the image to enhance the quality. It is an important and common phase in any computer vision system. For the present system preprocessing involves two processes: Resize – The image size from the camera might be large and can drive the system slow. It is to be resized to a feasible aspect ratio. Convert Colour Space – Images captured using IR or photographic cameras will be either in raw format or encoded into some multimedia standards. Normally, these images will be in RGB mode, with three channel. Number of channels defines the amount colour information available on the image. The image has to be converted to grayscale. The original image is resized to the dimensions specified in the thumbnail object. Colour space conversion

The above line of code converts the original image to gray. More image conversion codes are available at the OpenCV Wiki.

C. Localize

Localize Rear or front part of the vehicle is captured into an image. The image certainly contains other parts of the vehicle and the environment, which are of no requirement to the system.

Figure 3.2: Processed Image

The area in the image that interests us is the license plate and needs to be localized from the noise. the image is converted to black and white. There are two motivations for this operation –

- Highlighting characters
- Suppressing background.

Threshold operation is performed in this phase.
To retain the image quality, adaptive threshold algorithms are to be used. Previous researches have concluded that Otsu's thresholding algorithm is the efficient way of binarizing the image. OpenCV provides complex and efficient adaptive thresholding algorithms including Otsu method. The above line of code returns a binary image which is adaptively thresholded. The arguments follow the order:

- Source image
- Destination image,
- Threshold value,
- Resultant value
- Type of threshold

D. Connected Component Analysis

In order to eliminate undesired image areas, a connected component algorithm is first applied to the binarized plate candidate. Connected component analysis is performed to identify the

characters in the image. Basic idea is to traverse through the image and find the connected pixels. Each of the connected components (blobs) are labelled and extracted. bellow Fig. shows the filtered blobs. cvBlobsLib is a library to perform binary images connected component labelling. It also provides functions to manipulate, filter and extract results from the extracted blobs. The library provides two basic functionalities:

Extract 8-connected components in binary or grayscale images.

- Filter the obtained blobs to get the interest objects in the image. This is performed using the Filter method from CBlobResult.
- The connected components are labelled using the above code snippet. filter_blobs method is used to filter out the blobs of required dimensions.

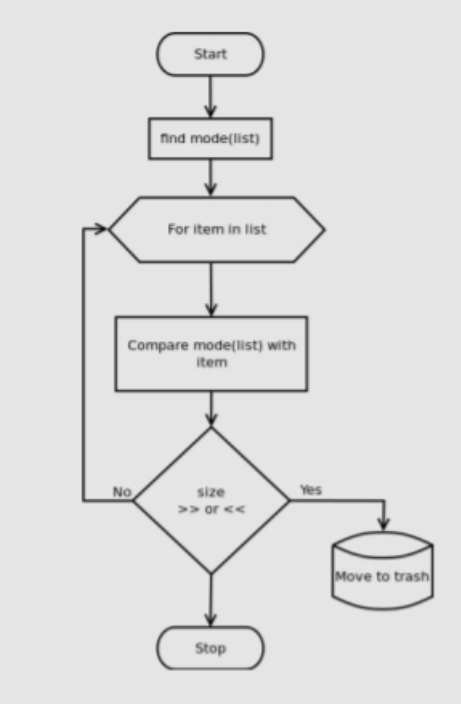

Figure 3.3: Aspect ratio-based elimination And Pixel coordinate based selection

Figure 3.4: Component Analysis

E. Segmentation

Segmentation is the process of cropping out the labelled blobs. These blobs are expected to be the required portion of the license number. A special algorithm called Image Scissoring is introduced here. In this algorithm, the license plate is vertically scanned and scissored at the row on which there is no white pixel and the scissored area is copied into a new matrix.

Figure 3.5: Segmented Image

Image Scissoring is hard-coded in Python by scanning the image vertically and cropping out white portions. The algorithm, is fast and efficient than compared to other predefined image cropping techniques. Segmentation phase also involves classification of the collected blobs and recording only the essential ones. Undesirable blobs occur even after segmentation. These are removed by two methods:

- Aspect ratio-based elimination
- Pixel coordinate based selection. Aspect ratio-based elimination: The aspect ratio (row/column) of each blob is calculated and recorded

A binarized candidate is sure of containing more characters than unwanted blobs. The mean of

the aspect ratios is calculated and compared to all the blobs in turn. If anyone of them has a larger deviation, that blob is removed from the candidate. This algorithm was deviced based on research and experiment throughout the process. The dynamic nature of Python is exploited in every step of this algorithm. Pixel coordinate based selection: This algorithm thrives on the fact that license numbers are occurring in the plate in a single set of rows. Effectively, we can detect the edge of the license plate, and select the blobs coming between the minimum and maximum row coordinates. This can reduce the number of unwanted blobs and make the system more accurate.

Character Recognition Finally, the selected blobs are sent to an Optical Character Recognition (OCR) Engine, which returns the ASCII of the license number. Tesseract OCR engine has a Python wrapper, which make character recognition quick and easy.

3.4 Algorithm

1. Begin
2. Input: Original Image
3. Output: Characters
4. Method: K-Nearest Neighbors
5. LP: License Plate
6. Convert RGB image to Grayscale
7. Filter Morphological Transformation
8. Transforms Grayscale image to binary image
9. Filter Gaussian for Blurs image
10. Finding all contours in image
11. Search recognize all possible character in image
12. Crop part of image with highest candidate LP
13. Crop the LP from original image
14. Apply steps from 6 to 11 again on crop image
15. Print the characters in LP
16. End

3.5 K-Nearest Neighbors algorithm (KNN)

KNN algorithm is one of the simplest classification algorithm and it is one of the most used learning algorithms. KNN is a non-parametric, lazy learning algorithm. Its purpose is to use a database in which the data points are separated into several classes to predict the classification of a new sample point.

When we say a technique is non-parametric, it means that it does not make any assumptions on the underlying data distribution. In other words, the model structure is determined from the data. Because in the "real world", most of the data does not obey the typical theoretical assumptions made (as in linear regression models, for example). Therefore, KNN could and probably should be one of the first choices for a classification study when there is little or no prior knowledge about the distribution data.

KNN Algorithm is based on feature similarity: How closely out-of-sample features resemble our training set determines how we classify a given data point:

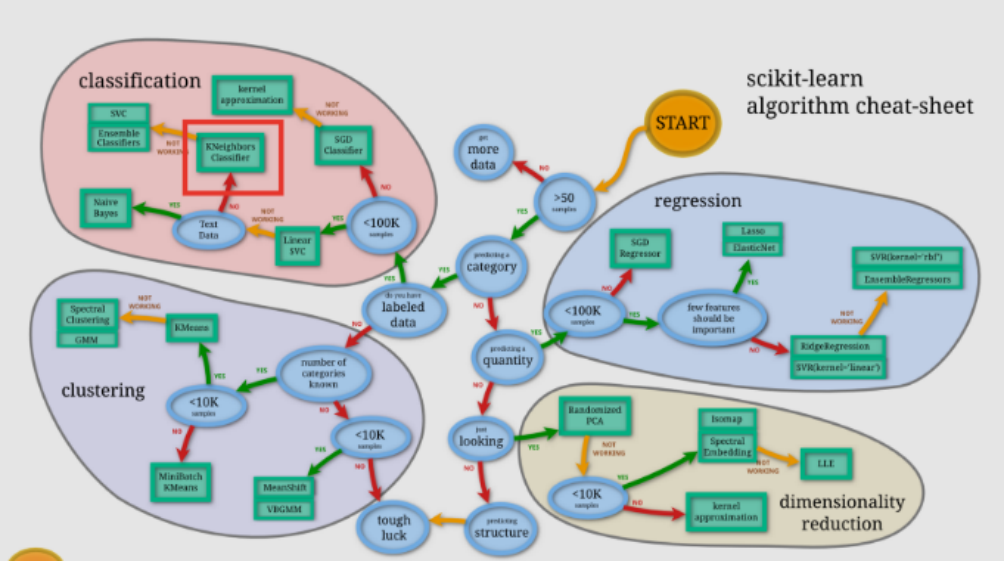

Figure 3.6: Segmented Image

A Few Applications and Examples of KNN

Credit ratings — collecting financial characteristics vs. comparing people with similar financial features to a database. By the very nature of a credit rating, people who have similar financial details would be given similar credit ratings. Therefore, they would like to be able to use this existing database to predict a new customer's credit rating, without having to perform all the calculations.

More advance examples could include handwriting detection (like OCR), image recognition and even video recognition.

Some pros and cons of KNN

Pros:

- No assumptions about data — useful, for example, for nonlinear data
- Simple algorithm — to explain and understand/interpret
- High accuracy (relatively) — it is pretty high but not competitive in comparison to better supervised learning models
- Versatile — useful for classification or regression

Cons:

- Computationally expensive - because algorithm stores all training data
- High memory requirement
- Stores all (or almost all) of the training data
- Prediction stage might be slow (with big N)
- Sensitive to irrelevant features and the scale of the data

Quick summary of KNN

- The algorithm can be summarized as:
- A positive integer k is specified, along with a new sample
- We select the k entries in our database which are closest to the new sample
- We find the most common classification of these entries
- This is the classification we give to the new sample
- A few other features of KNN:
- KNN stores the entire training dataset which it uses as its representation.

- KNN does not learn any model.

KNN makes predictions just-in-time by calculating the similarity between an input sample and each training instance.

3.6 Flow Chart

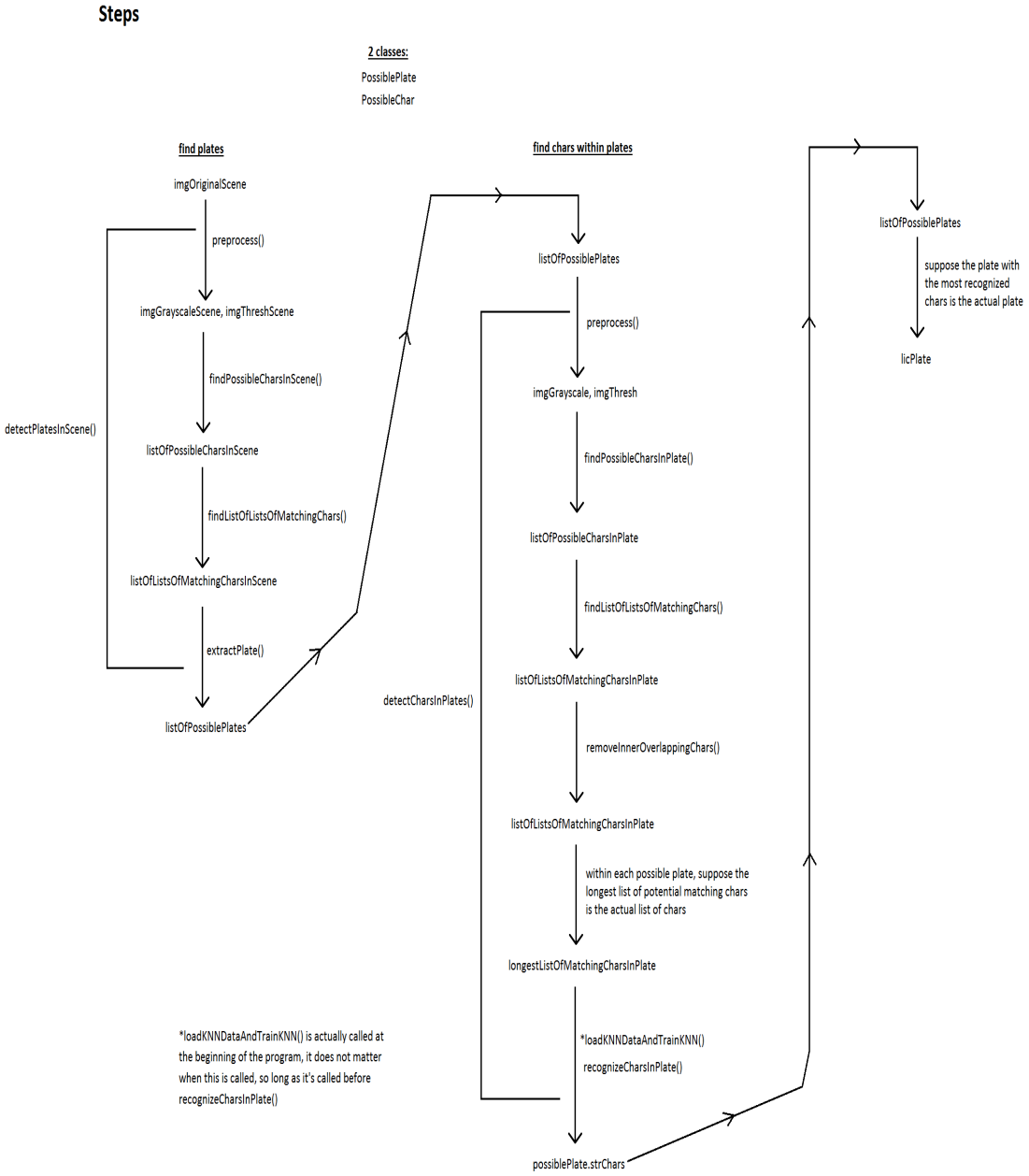

Figure 3.7: Flow Chart

3.7 Image Processing Process Flow

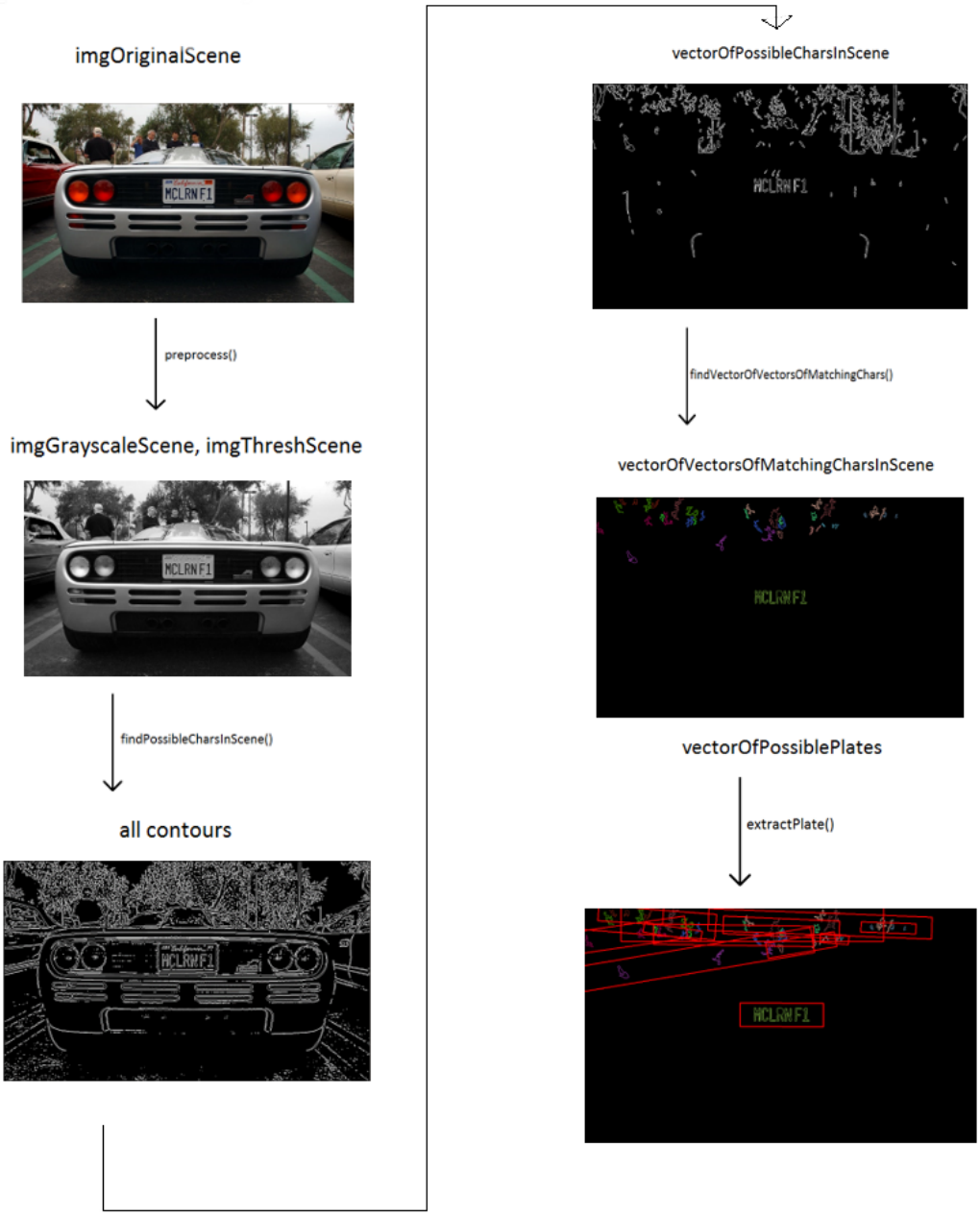

Figure 3.8: Image Processing - Process Flow

3.8 Text Recognition from the processed Image

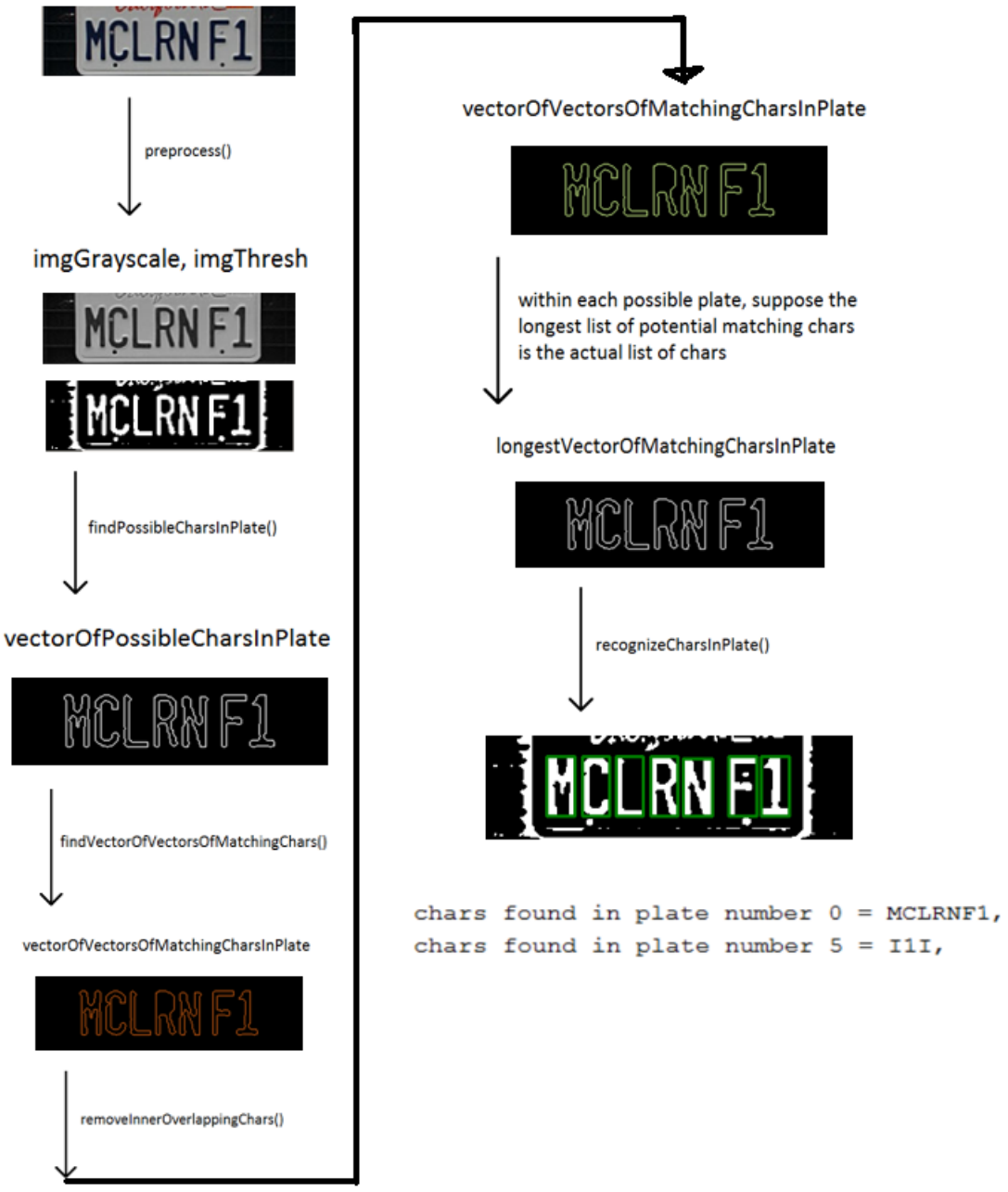

Figure 3.9: Text Recognition Process Flow

Chapter 4

RESULT AND DISCUSSION

4.1 Input and Output

Input Image:

Figure 4.1: Input Image

Console Output:

Figure 4.2: Console Output

4.2 User Interface

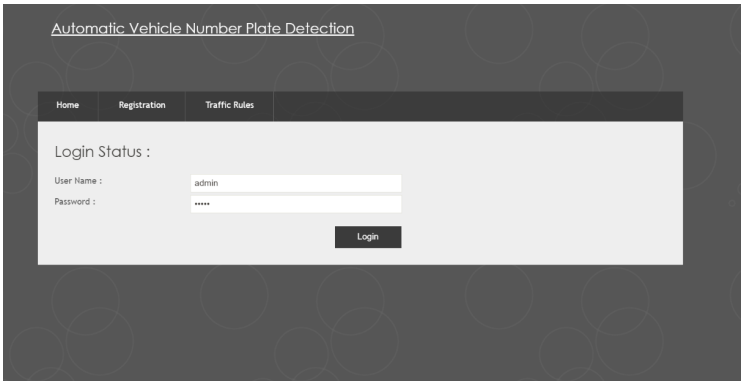

Figure 4.3: User Interface - Login Page

Whenever a vehicle is to be fined, The admin logins using the Username and Password and then he/she can file the fine for the registered vehicle.

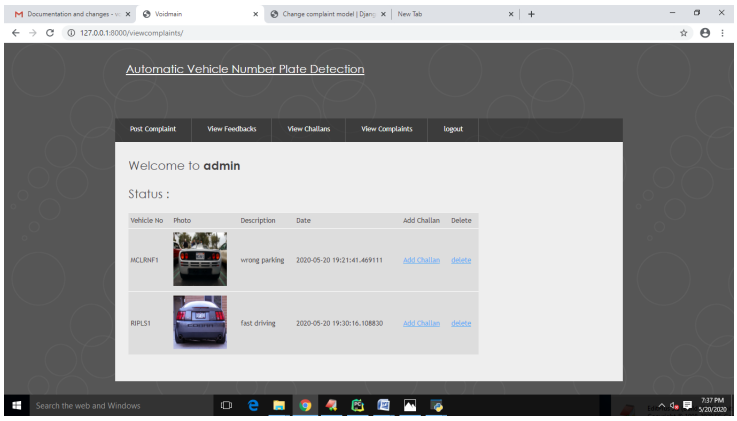

Figure 4.4: User Interface - Complaints

In the above figure the admin files a complaint for the above vehicles with description.

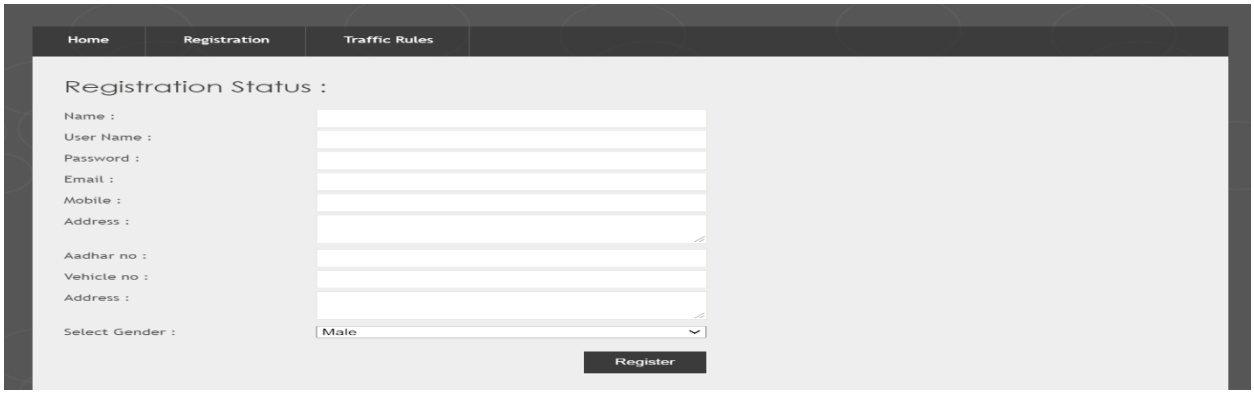

Figure 4.5: User Interface - Registration

Initially the user has to register with the numberplate of the vehicle. Only when the user is registered, admin can file a complaint and fine the vehicle.

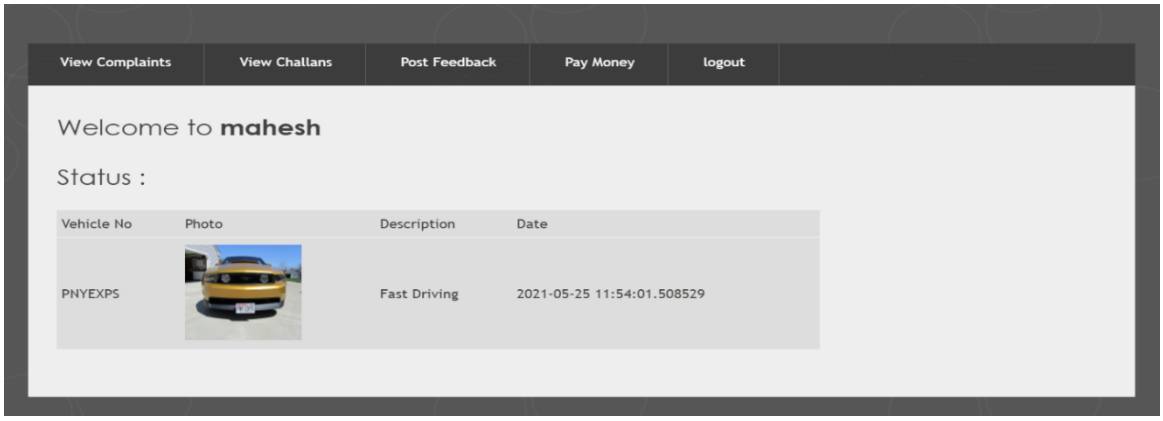

Figure 4.6: User Interface - Vehicle Status

After the registration, user can login with their credentials and then check the complaints and the fines imposed.

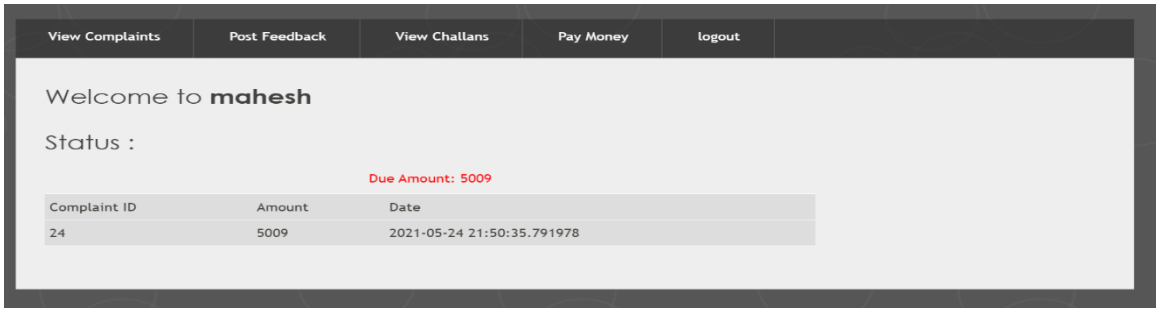

Figure 4.7: User Interface - Pending Vehicle Status

The user can check the complaints and fines that are imposed and can also post feedbacks. The user can then pay the fine using preferred payment methods.

4.3 Testing

Test Cases

Test case Id	Test case Description	Test Data	Expected Result	Actual Result	Pass/ Fail
1	Load Image	Testing Dataset	Dataset is loaded	Successfully loaded	Pass
2	Detect Possible Plates	Need to Find the Possible Number plates in Image	Detect Possible Number plates	Number plates detected	Pass
3	Detect Characters in Plates	Need to Find the Characters in Image	Detect possible Characters in plates	Possible Characters detected	Pass

Table 4.1: Test Cases and Result

4.4 Result Analysis Performance Analysis

System has been put to test for various measurements of performance and accuracy

Operation	Sample	Success	Fail	Success %
License Plate Localization	100	92	8	92%
Character Separation	92	88	4	95.7%
Character Recognition	88	83	5	94.3%

Table 4.2: Result Analysis

During the initial days, the system suffered severe performance faults. It took more than eighteen seconds for recognizing the license plate and extracting the number. Subsequent research on algorithm and code optimization drastically brought down the operation time to two seconds. One of the key factor that determined performance was the size of input image.

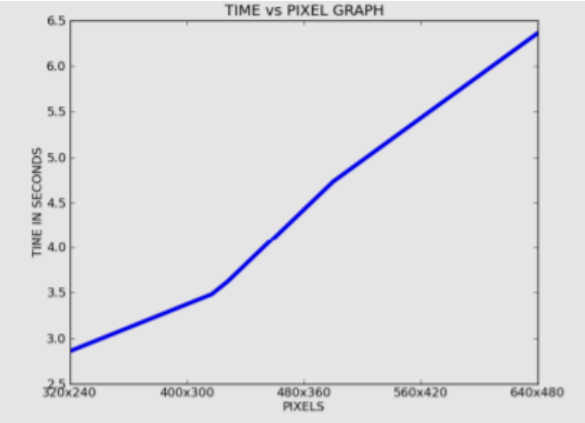

Figure 4.8: Performance Graph (Time vs Pixels)

Chapter 5

CONCLUSION

5.1 Conclusion

Scanning number plate sometimes goes unsuccessful by using the shape analysis method to detect exact area of the plate. Future extension of this work is to develop character recognition using template matching algorithm. Detecting number plate characters during night times work efficient but it gets inefficient in case of sunny time

The message of this research is to show that free and open source technologies are matured enough for scientific computing domains. Python and OpenCV are good points of start for researchers and students of computer vision

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 proprietary systems, even though there are known restrictions.

5.2 Future Scope

The automatic vehicle recognition system plays a major role in detecting threats to defense,also it can improve the security related to the women's as they can easily detect the number plate before using cab or other services. The system robustness can be increase if bright and sharp camera is used. Government should take some interest in developing this system as this system is money-saving and eco- friendly, if applied effectively in various areas.

Appendix

Workshop Certificates

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Approved by AICTE, New Delhi, Affiliated to JNTU Hyderabad
Programmes Accredited by NBA

Participation Certificate

Presented to

Miss. RAVOORI THARUNI

for successful participation in the workshop titled "*An innovative way of research article drafting on implementation of Machine Learning using python and LaTeX*" organized by Department of Computer Science and Engineering on 20th ,22nd and 23rd of May 2021 in ONLINE mode.

Mr. R. Praveen Kumar **Coordinator**

Mr. B. Srinu **Coordinator**

Dr. J.R.V. Jeny **HOD-CSE**

Dr. G. Durga Sukumar **Principal**

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