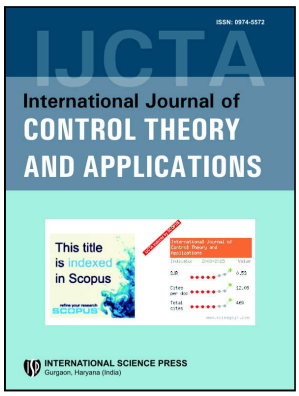

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Automatic OCR based control and analysis of vehicle license plates

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Abstract: This paper deals with the broad areas in image processing, neural networks, machine vision, etc. in designing the automatic number plate recognition system. The proposed system is real time and based on Python APIs. It recognizes the number plate which is standard, under the normal conditions. This system can be installed at a tollbooth for recognizing vehicle license plate and controlling the gate at tollbooth. It then can be implemented in parking areas, highways, bridges or tunnels, etc. This system involves software stack which is based on Python language, as it is growing field in image processing area. I have combined image processing tool stack in Python with embedded device (here I have chosen Raspberry Pi).

Keywords: Character-Recognition, Neural-networks, Feature-extraction

1. INTRODUCTION

The Automatic Number/License Plate Recognition (ANPR/ALPR) was invented in 1976 in the UK. It has gained much interest during the last few years. It automatically extracts and recognizes a vehicle number plate's characters from an image. It consists of a camera to capture an image, find the area of the number in the image and then extract the characters for character recognition to convert the pixels into numerically readable character. This system can be used in many areas like parking management system. It can also be used to detect and prevent a wide range of criminal activities and for security control of a highly restricted areas like military zones or area around top government offices. Apart from the robustness, the earlier methods use feature based approach or requires large training data or use transform which are computationally costly. The presented ANPR system is proposed to run real time and recognizes standard number plate under normal conditions. This ANPR system works in three stages, the first is the detection and capturing an image of vehicle, the second stage is detecting and extracting the area belonging to the number plate in an image. The third stage uses image segmentation technique to get individual character segment and optical character recognition (OCR) to recognize the each character with the help of database which is already stored. Some of the work that has been done in the field of ANPR systems involves use of deep learning and convolutional neural networks for the same. While it is a general observation that convolutional neural networks take significantly more time to train, they are more

accurate than the simpler image processing methodology used. Most of the systems that were used focused on ANPR used bulkier hardware. Very less research has been involved in making an entire ANPR system function on an embedded device.

2. PROPOSED ALGORITHM

2.1. Proposed Methodology

Seeing this from a bird's eye, the system involves following hardware components. A pocket sized computer, a web camera and a servo motor (for indicating output and to drive application). The web camera is the first point from where the image of vehicle is captured. The captured the image is used by the software to produce text output of the license plate number. It involves preprocessing of image and then various image processing techniques like segmentation, feature extraction, classification, etc. Image processing using Matlab is traditional method; but now image processing using Python s growing trade. It is getting wider scope because of beneficial features of Python - inbuilt libraries, readability of code, ease of programming, more efficiency, etc. Hence, all the software aspects here are implemented using libraries which make use of Python language. The text output of the license plate number could be compared with a database if needed. According to the need of your application, the triggered output can be used. E.g., based on the comparison with database, we can drive a servo motor that does motion, based on the output and with this, you can control the gate at tool both.

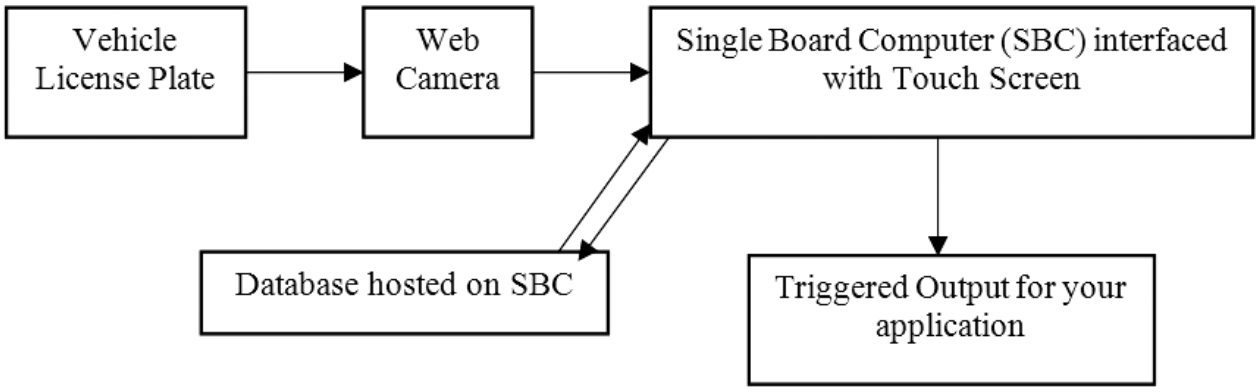

Figure 1: Block Diagram of proposed System

2.2. Proposed Algorithm

Detection of the license plate area involves detection. Once detection is completed, we proceed to segmentation. Segmentation uses binarization, character analysis, and plate edge detection, de-skewing and character segmentation. Feature extraction and classification both the processes happen during OCR phase.

2.3. Understanding image processing methods involved

2.3.1. Area Detection

First step is the area detection of license plate area. This is an important step and a difficult step as many more rectangles also get detected. The algorithm that is used here is Local Binary Pattern Algorithm. First step is to specify all the details of the license plate areas.

To preserve the intensity of an image, each pixel has to be replaced with average pixel intensity in the area which is covered by the rank filter matrix. The convolution matrix should satisfy the following equation-

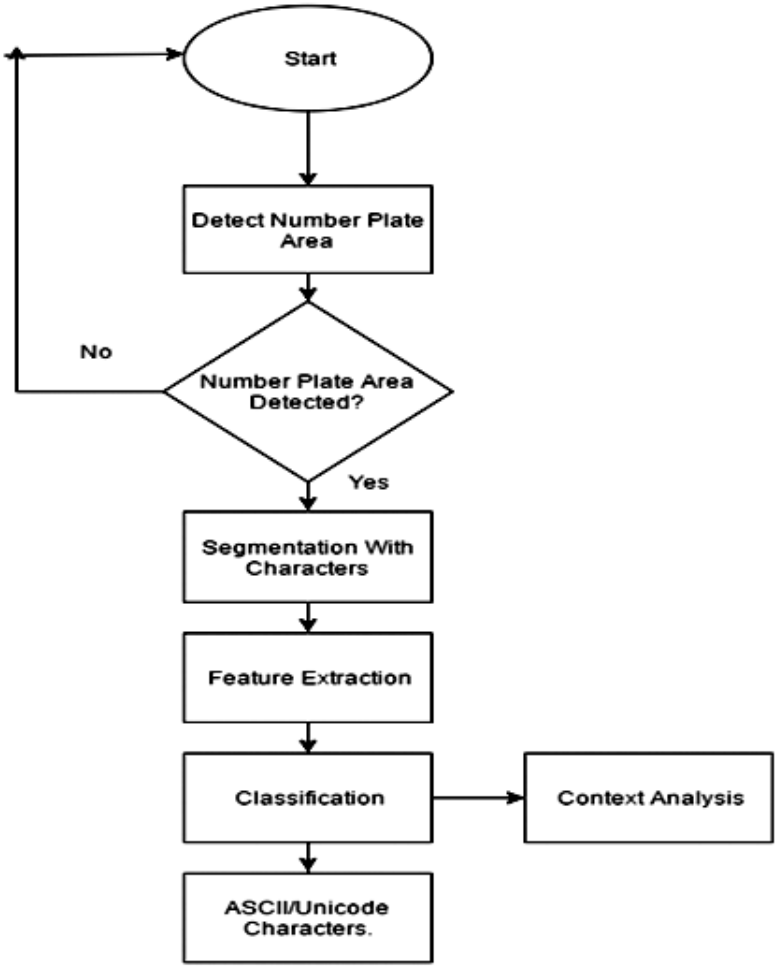

Figure 2: Flowchart of proposed System

$$\sum_{i=0}^{w-1}\sum_{j=0}^{h-1} m_{hr}[i,j] = 1.0$$

where, w and h are dimensions of the matrix

We can define the horizontal and vertical projection mathematically as:

$$p_x(x) = \sum_{j=0}^{h-1} f(x,j); \quad p_y(y) = \sum_{i=0}^{w-1} f(i,y)$$

where *w* and *h* are dimensions of the image.

2.3.2. Binarization

Second step is the Binarization of the selected image area. In this step the image is converted into black and white. Binarization process involves Wolf-Jolien method.

The process involves converting every pixel to grayscale using OpenCV in the backend.

2.3.3. Character Analysis

Third step is the Character Analysis. It attempts to find character sized blobs. This is the part of image segmentation. Image segmentation is done by finding character sized blobs.

In the plate region, it tries to find character-sized regions. It first finds all connected blocks in the license plate region. Then it looks for blocks that roughly match the width and height of a license plate character and have tops or bottoms that are in a straight line with other blocks of similar width/height.

The analysis is done multiple times for the region of interest. It first looks for small characters, and then gradually looks for larger characters.

If nothing data of interest is found in the region, then the region is out of processing; otherwise, the character region is saved and on that further processing takes place.

This algorithm disturbs statistical properties of brightness and contrast.

Figure 3(a): Before applying character analysis algorithm

Figure 3(b): After applying character analysis algorithm

2.3.4. Edge Detection

In the fourth phase the plate edges are detected. It finds all the horizontal and vertical lines that exist in the system and then it detects the most sensible horizontal and vertical lines using analysis from previous step and other parameters.

For the first step, algorithm works on the plate image to compute a horizontal and vertical lines, which are Hough lines.

The corners of the plate use this list and the character height (which is computed in Character Analysis) to find the matching plate line edges. It uses various configurable weights to determine the edge.

2.3.5. De-Skew

In this fifth step the images are deskewed. Images are converted into standard size and orientation.

Given the plate edges, the de-skew stage remaps the plate region to a standardized size and orientation.

Figure 4(a): Before applying de-skew mechanism

Figure 4(b): After applying de-skew mechanism

2.3.6. Character Segmentation

The character segmentation phase isolates all the characters which take part in making up the plate image area. It uses a vertical histogram. This histogram is used to find the gaps in the plate characters. It also clears the character boxes by removing small, disconnected speckles. It tries to remove edge regions so that the edge of the license plate gets correctly classified (like a '1' or an 'I').

2.3.7. Optical Character Recognition (OCR)

It analyzes each character independently. For each character segment given, it computes all possible characters and their confidence levels, from which we can judge the most nearest output

2.3.8. Post Processing

With the all OCR characters and confidences, this post processing phase determines the best plate letter combinations. It disqualifies all characters below a particular threshold. It also has soft thresholds which means, the characters that are below this threshold will be added to the possible list, with possibly blank).

2.3.9. Python API

For using the underlying algorithms that are pipelined and written in C++, a python API has been developed.

Python API provides methods to access end to end of the C++ implemented algorithms.

2.4. Tool stack used in this system

The tool stack that uses tesseract along with leptonica and OpenALPR is the most stable tool stack along with tried and tested methodology. It uses OpenCV underlying in its architecture. It also exclusively uses Leptonica for the sake of binarization, skew corrections and other image manipulations. Tesseract builds on top of leptonica. It adds OCR features that can be trained for better accuracy or even for independent new form of OCR. OpenALPR allows us to go ahead with the license plate area detection and configuration of all of the other number plate features like expected size, fonts, etc. But its operability on embedded platform is yet to be tested.

3. EXPERIMENT AND RESULT

The test set for this evaluation experiment is taken from the vehicles available around my working area and the internet.

3.1. This image is an example of zoom up or close-up of what we can get from a normal camera. Clearly the system is able to recognize the license plate easily, the problem being more of detection of area than of OCR.

Figure 5: (a) Testing image sample-1

3.2 In this figure also we see that the characters in the plate are detected, but not completely.

Figure 5(b) Testing image sample-2

3.3 This proves the accuracy of this system is good in terms of the OCR recognition, but I face challenge in area detection.

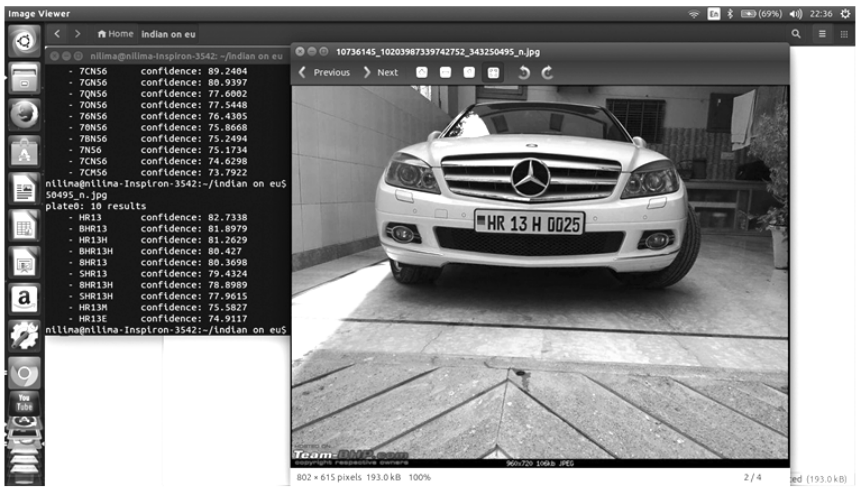

Figure 5(c) Testing image sample-3

4. CONCLUSIONS

Customizing an ANPR system for Indian condition has its own unique challenges. The standard setup which uses existing models are configured for European and North American standards. Although there are not much issues with font detection and identification, significant challenges are faced by us for the part of area detection and configuring it for Indian conditions. Currently we have simulated the entire model on a Virtual machine.

Choosing the right tool stack based on design requirements was also a major issue. There are many different tool stack and results can be obtained from all the tool stacks, but it was important to use stack based on computational feasibility as it will be deployed on an embedded device. Along with this it was also important that it provided some framework for building ANPR system as writing libraries for all the steps involved would not be feasible in terms of time constraints.

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