Design and Development of License Plate Recognition System Using Neural Network

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***Abstract*— this paper begins with a detection of license plates using various strategies. The system has many practical applications such as: parking accounting systems, traffic monitoring and security systems of many kinds. The results of this technique are given and then reviewed. Finally, possible extensions to make the algorithm more robust are discussed.**

***Keywords*—O.C.R, Normalization, Extraction, Segmentation, Dilation, Crop, Neural Network etc.**

I. INTRODUCTION

The purpose of "Vehicle License Plate Recognition System" project is to build a real time application which recognizes license plates from cars at a gate, for example at the entrance of a parking area.

The system, based on regular PC with video camera, catches video frames which include a visible car license plate and processes them. Once a license plate is detected, its digits are recognized, displayed on the User Interface or checked against a database.

This project will focus on the design of algorithms used for extracting the license plate from a single image, isolating the characters of the plate and identifying the individual characters.

II . DESIGN

A set of rules have been placed on our system, they are as follows:

1. License plates are rectangular white regions containing 4 alphabets and 6 digits as most Indian license plates do.

2. There is no motion blur in the captured image, namely, the vehicle's speed is very low.

3. The license plate is located at the bottom level of the vehicle.

4. The plates have a rectangular shape with two rows and character

5. The plate has dark characters on a bright with background.

The license plate recognition system can be broken down into the following steps:

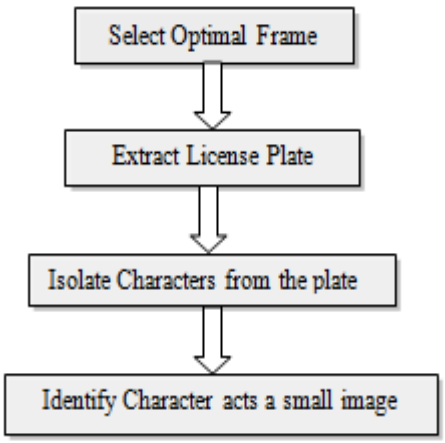


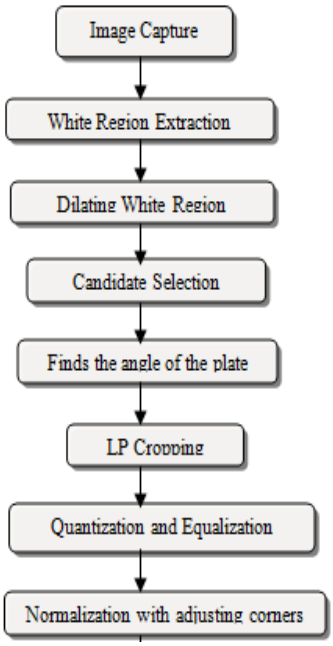
Figure 1 : Block Diagram of the system

Thus we are dividing the steps of our algorithm in three parts

1. Extraction of License Plate
2. Segmenting Characters
3. Character Recognition using OCR engine

1. Extraction of License Plate

The purpose of this part is to extract the License Plate from a captured image. The output of this module is the



RGB picture of the LP precisely cropped from the captured image, and a binary image which contains the normalized LP.

Figure 2 : License Plate Extraction

The most important principle in this part is to use conservative algorithms which as we get further becomes less conservative in order to, step by step, get closer to the license plate, and avoid loosing information in it, i.e. cutting digits and so on.

1. White Region Extraction:

The frame containing a license plate, which returns the binary image in which only white pixels are used. For this purpose, we used CIE (Commission International de Eclairage) color system is used, because it appeared to be more accurate for white pixels identification than the RGB(Red Green and Blue) and HSV(Hue Saturation and Value) systems.

Figure 3: Example of a captured frame

Figure 4: Captured frame with white regions filtered

2. Dilating White Regions

Dilation is a type of transformation that changes the size of an image. The method dilates the white regions appearing on

This method generally allows identifying white regions. It ignores the holes inside the plate, then grouping white regions in separate filled components and highlight the separation between them which is very useful for the next step.

3. Fixing the License Plate Region Candidate Selection:

The method first separates the picture into connected components. Then, it processes the candidate selection algorithm, in which the deepest white regions satisfying the following conditions are selected:

- Area > LP_MIN_AREA
- LP_MIN_RATIO <= height/width <= LP_MAX_RATIO
- Area >= max(areas of the candidates)/3.5

LP_MIN_AREA, LP_MIN_RATIO, LP_MAX_RATIO, 3.5 are parameters which are selected after testing multiple images, and should be refined to get even more accurate results. If no candidates are found, then the method chooses the region with maximum area to be the LP region; otherwise, it chooses the candidate with maximum area. The method returns a rectangular area with safety spacing from the found area.

Figure 5: Fixing the License Plate Region

Generally, the license plate appears as a separate component. Moreover, license plates have characteristics like height, width, area etc which are common to all license plates. It permits to select the proper region in the frame of the plate.

4. Determining the Angle of the Plate Using the Random Transform

The method determines the angle of the supplied picture relatively to the horizontal. It uses the Random transform in order to find lines on the picture, and returns the angle of the most visible one.

Generally, the license plate region contains parallel lines, with the same angle as the license plate one. Determining the angle of the plate permits to rotate it in order to avoid part of digits lost when cropping the plate.

5. **Improved License Plate Region**:

The method improves the license plate region as compared to the previous picture.

Figure 6: Improved LP Region

Some white components outside the license plate still appear and we need to get closer to the LP region in order to start the cropping process with the best conditions.

6. LP Crop:

The method computes the sum of the lines and of the columns in the picture obtaining one vector for each direction. For these two directions, it computes the first point respectively at the left and the right side of the vector which is superior or equal to the average of this vector, thus obtaining a rectangle to be used for cropping the LP. This function is used to crop the License Plate and returns the smaller image from the bigger image.

Figure 7 : Cropping of an image

The image obtained at the precedent step is very close to the LP real contours. This step permits to eliminate local noises at the border of the plate, thus obtaining a precise LP contour.

7. LP Quantization and Equalization:

This is a very important step for a successful decryption of the LP. In order to perform the character recognition, we should be able to make the difference between digits and background inside the plate.

Figure 8: Quantized and equalized LP

Equalization and Quantization permit to obtain a gray scale image with improved contrast between digits and backgrounds, thus obtaining better performance for the binarization process which uses adaptive threshold. This is essential for the character recognition process.

8. Normalized LP:

Transform the previous step of image into a rectangular matrix (by turning and stretching) whose normalized size is 50x150. The method also transforms the binary mage into its complement.

As said before, there are Indian LPs of different sizes and we need to get a LP with standard size in order to recognize the LP digits in front of the digits which are in the neural network dataset.

9. Adjusting Normalized LP Horizontal Contours:

The method determines the LP horizontal contours and removes vertical small noise from the picture. It first computes the sum of the lines in the supplied image; the graph is searched for a signal whose bandwidth is between MIN_HEIGHT = 26 and MAX_HEIGHT = 48, parameters which was previously statistically chosen.

Figure 9 : Normalized LP region

It is clear that we should obtain a better LP contour, for example the black line which is around the plate should be removed, for the next steps to be more successful. Here, the vertical contours are not adjusted in order not to cut digits; this will be done transparently by the segmentation machine.

B. SEGMENTATION

In order to segment the characters in the binary license plate image the method named peak-to-valley is used. The methods first segments the picture in digit images getting the

two bounds of the each digit segment according to the statistical parameter For that purpose, it uses a recursive function which uses the graph of the sums of the columns in the LP binary image. This function passes over the graph from left to right, bottom-up, incrementing at each recursive step.

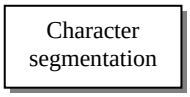


Figure 10: Character Segmentation

This function uses the segment function which keeps the result with largest area and finds the separation of the segment.

C.THE OCR ENGINE

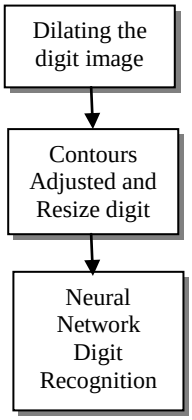


Figure11: steps of OCR Engine

1. Dilated Digit:

The method dilates the digit image obtained as the precedent step. By Dilating image, it permits to reduce noises due to poor image quality. It also exaggerates the digit width making a clear separation between the digit and the background which make the work easier for the OCR machine.

Figure12 : The Dilated Digit

2. Contours adjusted and resized digit:

The method adjusts the LP contours for both in the horizontal and vertical directions. Then the digit is resized to standard dimensions, according to the neural network dataset (20x10).

The OCR engine was designed as an inter-changeable plug-in module. This allows the user to choose an OCR engine which is suited to their particular application and to upgrade it easily in the future. At present, there are several versions of this OCR engine. One of them is based on a fully connected feedforward artificial neural network with sigmoidal activation functions. This network can be trained off-line with different training algorithms such as error back propagation.

It is clear that we should obtain a better digit contour for the OCR machine to be more successful. Moreover, the standard size of the digit image corresponds to the size of the pictures in the neural network dataset.

3. The Neural Network and the digit recognition algorithm:

Given the digit image obtained at the precedent step, this digit is compared to digits images in a dataset, and using the well-known Neural Network method, after interpolations, approximations and decisions algorithm, the OCR machine outputs the closest digit in the dataset to the digit image.

As known, neural network is a function from vector to vector, and consists of an interpolation to a desired function

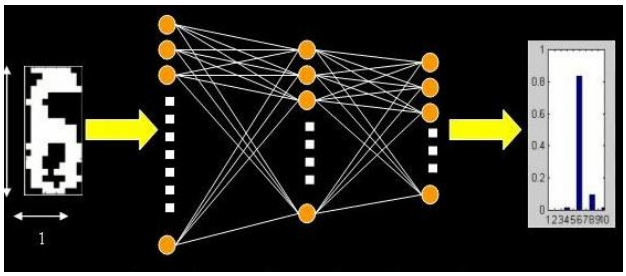


Figure 13: Neural Network Architecture

We use a trainable recognition engine based on a neural network. During the recognition phase, the system does not access this database but uses the information conveniently stored in a compact form in the weight state of the neural network.

Optical Character Recognition is extensively implemented using neural networks, which generally solves problems using different tools for Neural Networks which permits to concentrate on the digit images dataset only and this is very convenient.

Conclusions

In this paper, the process of license plate was discussed, and three typical approaches were overviewed. An algorithm based on text detection was introduced and discussed in detail.

We have developed a new method for detecting and recognizing car license plates. Characters template can be created and added to the system, if different plates are taken into account. Future work is intended to be done in improving and testing the system on a larger number of images.

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