Automatic License Plate Detection and Character Recognition

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Abstract- **Automatic License Plate Detection and Character Recognition (ALPD) is a surveillance system that captures the image of vehicle and recognizes the license plate characters. This system can be useful in several applications such as the detection of stolen vehicles, tracking of the vehicles which overrides the traffic rules, access control, motorway road tolling, and journey time measurement. In this system, different approaches are already proposed for the detection and recognition of the License plate. One of the methods of ALPD system implemented by using windowed method for detection and OCR technique for recognition of license plate. This process is complex even though it yields good results. In another method, it uses edge detection technique for detection of license plate and OCR with neural network for recognition of characters in the license plate. This method also had complex algorithm for character recognition as we have to train the characters each time. The main motivation of our project is to propose an efficient detection and character recognition algorithm for ALPD system. The algorithm should be robust against distortions caused by variations in illuminations, rotations and colours in the license plate. Our algorithm is framed into the following steps license plate extraction, character segmentation and character recognition. Input of the system is the image of a vehicle captured by a camera. The captured image is processed through the license plate extractor which gives the extracted license plate area as output. Now the extracted license plate is segmented into individual characters in the segmentation part and finally recognition part recognizes the characters and displays the license plate. In this context, the number plate area is localized using a "novel morphological-based number plate localization" method. In the above method height by width ratio of connected components is calculated and by this approach license plate region is detected and segmentation of license plate characters can be done by labelling the connected components and recognition of characters are done by template matching technique. Characters are detected based on the template matching technique and this process is repeated for all the characters in the license plate.**

Keywords – connected components, template matching, morphological operations, segmentation

I. INTRODUCTION

In literature, many license plate detection algorithms have been proposed. Although license plate detection has been studied for many years, it is still a challenging task to detect license plates with different poses, partial occlusion or multiple instances. License plate detection investigates an input image to identify some local patches containing license plates. Since a plate can exist anywhere in an image with various sizes, it is infeasible to check every pixel to locate it. Generally, it is preferable to extract some features from images and focus only on those pixels characterized by license plate. Based on the involved features, traditional license plate detection methods can be classified into three categories: color-based, edge-based and texture-based. In the following, we will review the related works of each category. Color-based approaches are based on the observation that some countries have specific colors in their license plates. It is intuitive to extract license plate by locating their colors in the images. In [8][9], a test image is checked with a classifier of color model. Then, candidate regions from the classification results are verified with some post-processing to locate the plates. In [10][11], a color interval is determined from a mapping function to label potential regions of license plate. In [12], the collocation of license plate color and character color is used to generate an edge image. Then, it checks neighbors of pixels with value within the license plate color range to find candidate license plate regions. In [13], the color of each pixel in the image is identified using characteristic function. Then a series of morphological operations are used to merge the same plate color pixels into separate candidate areas. The license plate is then extracted from candidates using the prior knowledge of its position in the image. In [14]color images are segmented by the Mean Shift algorithm into candidate regions, which are subsequently classified as with or without plate. Then, a feature combination of rectangularity, aspect ratio, and edge density is exploited to determine the candidate regions. To address the effect of illumination variation, By above different methods we concluded that each method has its merits and demerits.

II. METHODOLGY

The Automatic License Plate recognition work is generally framed into the steps: License Plate extraction, character segmentation and character recognition. The algorithm proposed in this paper is designed to recognize License Plates of vehicles automatically. Input of the system is the image of a vehicle captured by a camera. The captured image taken from 4-5 meters away is processed through the License Plate extractor with giving its output to segmentation part. Segmentation part separates the characters individually and finally recognition part recognizes the characters giving the result as the plate number .

Proposed solution

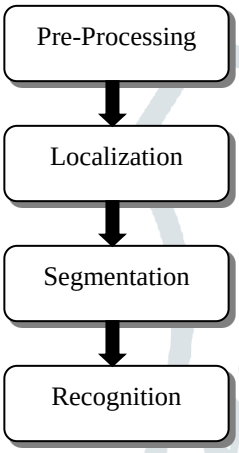

Fig.1 Algorithm of the proposed solution

In this process the extracted vehicle image is converted into black and white image then by using 8-connectivity procedure the white components are connected then for connected components the height by width ratio is to be calculated in the real time vehicles License Plates the height by width ratio is in between 0.2 to 0.3 for such components are extracted. In the above process we can extract the License Plate. Connected components labelling scans an image and groups its pixels into components based on pixel connectivity, i.e. all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labelled with a Gray level or a colour (colour labelling) according to the component it was assigned to. After the Localization of the License Plate of the vehicle involved, we need to recognize the License Plate into a standard form [2]. The vehicular License Plates maybe of Non-standard forms and may vary in their fonts. By using template matching technique we have to recognize the characters in the License Plate. In this process we have to correlate the templates with the characters and numbers in the License Plate. If the correlation coefficient is maximum the label is selected as the corresponding characters as the recognized character in the License Plate this process continues for all the segmented characters in the License Plate. By above process we can successfully recognize the characters in the License Plate.

Pre-processing

Image acquisition is the process of obtaining an image from the camera. This is the first step of any vision based systems. In our current research we acquire the images using a digital camera placed by the road side facing towards the incoming vehicles .Here our aim is to get the frontal image of vehicles which contains License Plate. The remaining stages of the system works in offline mode .
The operations performed in this step are

- RGB to gray
- Converting gray image to binary

After acquiring the image, the very next step is to derive the gray scale image. The images obtained from the cameras are color images there are several color standards like NTSC, PAL and CMYK. Each standard contain different color schemes. If we want to do operations on color images we need different algorithms for different color schemes. To avoid this complexity we convert the color image into gray image so only one algorithm is enough. Threshold is a quick way to convert gray scale image into binary image (pixels containing black and white pixels). I.e. binary image can obtained from gray-level or color image. Here in this paper we considered the gray level image. The binary image pixel values are obtained using the characteristic function as shown below.

$$b(x, y) = 1 \text{ if } g(x, y) < T \quad \ldots\ldots\ldots\ldots(1)$$
$$= 0 \text{ if } g(x, y) \geq T$$

From this binary image using connected components we will find out the coordinates of the license plate region and using these coordinates we will segment the original color image that is input image to extract the license plate region.

Plate localization

Localizing (identifying a License Plate) is an algorithmic function that determines what aspect of the vehicle's image is the License Plate. This variance can further compound the complexity for an algorithm to ascertain what area of a vehicle constitutes a License Plate and what area is not. The algorithm searches for a similar background color of unified proportion and contrast as a means to differentiate objects on a vehicle. The captured image is initially converted into gray scale and threshold is applied on it to convert it into a binary image Possible License Plate areas in the image are identified by observing sudden changes in contrast. Remaining areas are filtered out. The best possible License Plate location is found out by comparing width by height factor of actual Indian License Plates to the same factor of plate like areas found by this method. This system showed maximum efficiency when the width by height factor was set between 3 and 7. This step contains following operations they are

- Connected components
- Rotation
- Dilation
- Cropping
- Normalization

Connected components scans an image and groups its pixels into components based on pixel connectivity, i.e. all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labeled with a gray level or a color (color labeling) according to the component it was assigned. If the number pixels connected in the extracted license plate are less than 5000 pixels that object is eliminated. By above process noise or unwanted connected components can be removed

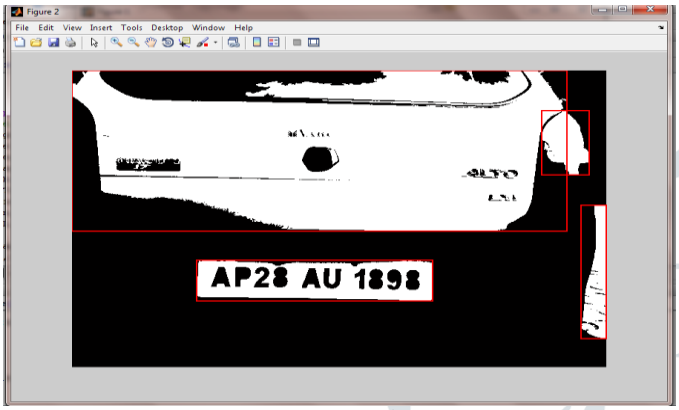

Fig.2 Connected components of the vehicle image

By calculating the height and width ratio of connected components the License Plate region has been detected the detected License Plate has shown below.

Fig.3 Detected License Plate region from vehicle image

Rotation If the image is having any angle deviation it should be rotate to corresponding angle and fix the license plate horizontally so that the license plate can be ready to do any further morphological operations.By using the radon transform deviation of an angle with respect to horizontal axis can be calculated.

Fig. 4 License plate region rotated

Dilation By using the dilation operation if any connectivity lost between the components that can be connected. The dilation operation occurs by below process. The opening off set X by structuring element B Is denoted an $X \oplus B$, is defined .

$$X \oplus B = X + b = \{x + b : x \in X \,\&\, b \in B\} \ldots\ldots\ldots\ldots (2)$$

If X is any gray scale shape and B is symmetric structuring element. The output of dilation is the set of translated points such that translate of the reflected structuring element has a non-empty intersection with **X**. This equation is based on obtaining the reflection of B about its origin and shifting this reflection by b. This dilation of X by B then is the set of all displacements, b, such that x and b overlap by at least one element. One of the simplest applications of dilation is for bridging gaps. The structuring element has used for repairing the gaps. The gap shave been bridged.

Fig.5 Dilated image of License Plate region

Improved license plate After dilation process the improved license plate region is shown in below Fig..

Fig.6 Improved License plate

Cropping the detected license plate In order to eliminate the unwanted region which is extracted in the above steps we are going to remove it by cropping the License Plate. In this operation the height and width are predefined to certain values.

Fig.7 Cropped image of License Plate region

Grayscale image of the extracted License Plate In this the cropped License Plate image is converted into gray-scale image. In the gray-scale image all the shades of a color image is arranged between 0 to 1. If the image is 8-bit image it is having 255 different grey levels.

Fig.8 Grayscale image of the cropped License Plate

Binary image of the extracted License Plate The above grey image is converted into binary image by changing the image intensity values into 0 and 1.0 represents black image 1 represents white. If the image pixel intensity less than threshold that is converted to black and the value is greater than threshold that pixels converted into white. By above process the image becomes in the below Fig..

Fig.9 Binary image of the License Plate

Normalization of extracted License Plate In this step the detected License Plate height and width are set to some pre-defined value. So that it is easy to segment the License Plate in the further process. In order to arrange the license plate height and width normalization method is used. By this height and width of license plate can be arranged according to the requirement to get better results.

Fig.10 Normalized License Plate

Segmentation

Segmentation is one of the most important processes in the automatic License Plate recognition, because all further steps rely on it. If the segmentation fails, a character can be improperly divided into two pieces, or two characters can be improperly merged together.

Horizontal contours adjustment of extracted license plate

By this process contours of an image can be adjusted of a license plate. The license plate image start where the characters or numbers of a license plate. By above process elimination of unwanted components or unwanted region can be done.

Fig.11 License Plate after adjustment of horizontal contours

Segmentation of extracted license plate

Connected components labelling scans an image and groups its pixels into components based on pixel connectivity, i.e. all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labelled with a gray level or a colour (colour labelling) according to the component it was assigned to. After the Localization of the number plate of the vehicle involved, we need to recognize the number plate into a standard form. The vehicular number plates maybe of Non-standard forms and may vary in their fonts. If the number pixels connected in the extracted license plate are less than 50 pixels that object is eliminated. By above process noise or unwanted connected components can be removed. In the connectivity of labelled components 8-connectivity is used. It is an effective connectivity technique compared to 4-connectivity analysis. After connecting the license plate character components label the each character components. The next we have to recognize the extracted character components by using simple template matching technique.

Fig.12 Connected components of the license plate

Fig.13 Segmented characters of the license plate

Character recognition

Here we use optical character recognition(OCR). OCR is the mechanical or electronic translation of images of handwritten or typewritten text (usually captured by a scanner) into machine-editable text. The procedure consists of two important steps, training and recognition. Training**:** The program is first trained with a set of sample images (Templates) for each of the characters to extract the important features based on which the recognition operation would be performed. Templates of characters and numbers are taken and these are used to correlate with the numbers and characters of license plate.

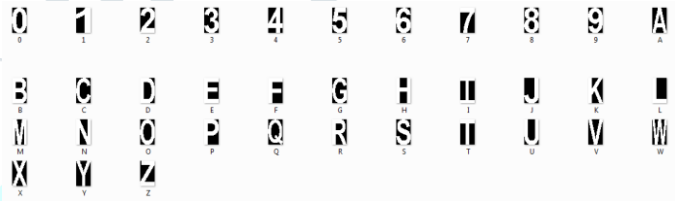

Fig.14 Template images of the characters and numbers

Template matching technique

In this we will compare segmented Characters with the templates by using statistical method correlation. And the template where we get maximum correlation is recognized as that character. The image obtained after segmentation is Grayscale which Follows the preprocessing steps used for the training of the characters. Before preparing the template for each of the characters for further use, we need to do some processing on the images. The following are the operations that are performed: Binarization, Inversion of intensity of the characters. Finding the connected component that represents the character. Finding the smallest rectangle enclosing this connected components. Normalization of the image to size 15 X 15. Storing the intensity values using the below mentioned algorithm for each of the characters. Calculate the score for each of the characters**:** We calculate the matching score of the segmented character from the templates of the character stored by the following algorithm. We compare the pixel values of the matrix of segmented character and the template matrix, and for every match we add 1 to the matching score and for every mis-match we decrement 1. This is done for all 225 pixels. The match score is generated for every template and the one which gives the highest score is taken to be the recognized character.

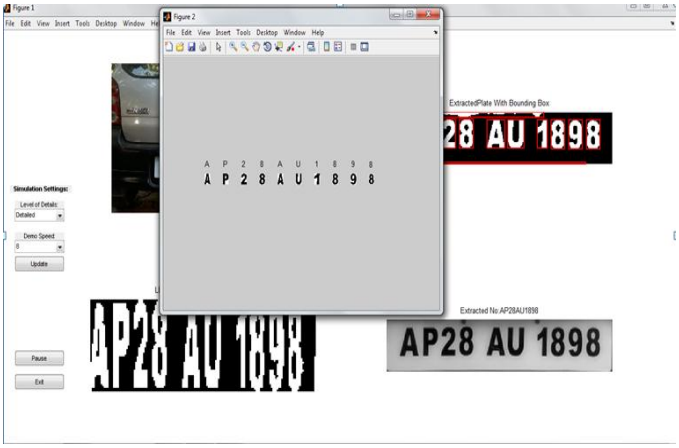

Fig.15 License plate detected and characters recognized license plate

III. CONCLUSION

After successful detection and recognition of characters from License Plate of a vehicle by using Connected Components for detection of License Plate and template matching technique for recognition of characters in the License Plate, We proposed a new algorithm for detection of License Plate by using morphological operations and recognition of characters using template matching technique. We achieved good results by using this approach. It is an easy and simple method for detection and recognition of characters in the License Plate. In order to decrease the complexity in detecting and recognizing the characters in the License Plate we proposed a new algorithm in the detection stage of License Plate that is Morphological operations with 8-connectivityin the segmentation phase [We have drawn the bounding boxes for connected components using 8-connectivity] and in the recognition phase we used template matching technique to correlate the License Plate characters with templates.

Future scope

In this paper we have checked and evaluated the accuracy of the proposed technique. The Template matching affects the accuracy of License Plate recognition. We have found that there are some factors which affect the effectiveness of template matching based on OCR technique i.e. font type, noise in image, tilting etc. In future the work can be done on these factors and efficiency may be increased further for better results.

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