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Automatic Number Plate Recognition System: A Histogram Based Approach

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Abstract: *In past few decades number of vehicles has increased drastically. So it has become a challenging job to tract them. Even it has become seemingly impossible to identify the car owner in case of violation of any traffic rule or too fast driving. With the explosion in number of vehicles flying on the roads, proper tracking is impossible to be fully managed and monitored by humans; examples are so many like traffic monitoring, tracking stolen cars, managing parking toll, red-light violation enforcement, border and customs checkpoints.*

Therefore, there is a need to develop Automatic Number Plate Recognition (ANPR) system as a one of the solutions to this problem. Yet it's a very challenging problem, due to the diversity of plate formats, different scales, rotations and non-uniform illumination conditions during image acquisition. The proposed method suggests a histogram based approach which is easily implementable using MATLAB and can duly be verified for it's functionality. This approach has a basic advantage of being simple and hence faster. This paper makes use of various algorithms in each category from distinct edge detection to region of interest extraction. This enhances the performance of the system up to the maximum extent possible with less efforts and use of computational resources.

Keywords: *Artificial Neural Network, Automatic Number Plate Recognition (ANPR), Dilation, Image Processing, Region of Interest (ROI), Segmentation.*

I. Introduction

The Automatic Number Plate Recognition (ANPR) system is one of the most used techniques in Intelligent Transportation System (ITS). In today's world it's used in several purposes. Like automatic toll tax collection [1], automatic vehicle parking systems [2][3], law enforcement, borders and high security zones, like Parliament, Assembly etc.

In this proposed method the algorithm is generally divided into four parts. (1) Image Acquisition, (2)Pre-processing, (3) Segmentation, (4) Region of interest finding. As shown in Figure 1, the first step, i.e. image acquisition seems to be very easy and straightforward but it's quite exigent task. Especially for fast moving vehicles. It should be captured in real time in such a way that it's a single component should not be missed. Mostly with today's technological advancements, this entire image accusation and processing time has been contracted within 50ms [4].

The deep concern of this paper happens to be lesser time and computational complexity. In this approach, once the image is captured and pre-processing algorithms, like dilation, vertical and horizontal edge processing are implemented on the image to get horizon and vertical histograms. These histograms represent the sum of differences of gray values between neighboring pixels of an image, column-wise and row-wise. To prevent the loss of information in the upcoming steps, histograms are passed through a low-pass digital filter. Now by applying a filter unwanted areas, rows and columns with lower histogram values, are removed. The next step is to find all the regions in an image that has high probability of containing a license plate. Out of those regions got by segmentation process, one with maximum histogram value is considered as the region of interest. This is the region having highest probability of containing a license plate [5][6].

Locating region of interest largely reduces computational expense and algorithm complexity. For example a common 1024x768 resolution image contains a total of 786,432 pixels, whereas region of interest may be accountable for hardly 10% of the original image area. This enhances the simplification of algorithm design and abridged time [7].

II. Literature Survey

In [8], a technique called sliding concentric window (SCW) is developed for faster detection of Region of Interest (ROI). This two step method contains two concentric windows moving from upper left corner of the image. Then based on segmentation rule statistical measurements are calculated. This rule says if the mean exceeds a threshold value, derived by trial and error method, then the central pixel of the window is the considered as the ROI. Once the whole image is scanned, two windows stop moving.

In [9], another SCW has been proposed for Korean number plates. After applying SCW method hue-intensity-saturation (HIS) color model is used for color verification. By using least square fitting with perpendicular offsets (LSFPO) the tilts have been corrected.

In [10], to extract vehicle number plate by using salient features like shape, texture and color, a feature salient method is used. The authors used Hough transform (HT) to detect vertical and horizontal lines from rectangular vehicle number plate and then processed it by converting red, green, blue (RGB) to hue-intensity-saturation(HIS).

In [11], a method is proposed to find horizontal and vertical difference for finding exact rectangle with vehicle number, especially for Chinese number plates. On conversion of vehicle image into gray scale image the authors have used automatic binarization using MATLAB. Though no further details on algorithm have been disclosed but the authors claim to have an average recognition rate of 0.8second.

In [12], a novel approach has been presented for Indian number plates based on texture characteristics and wavelets [13]. The authors also used morphological operation [14] for better performance in complicated background. Sobel mask is used to detect vertical edges. The algorithm was implemented in MATLAB.

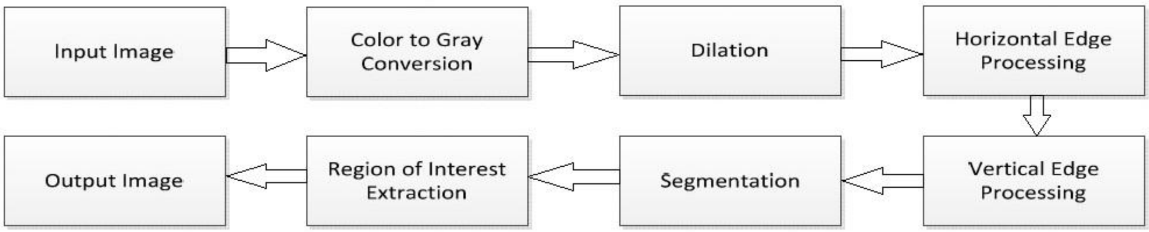
In [15], an approach has been proposed for image accusation using CCTV. It's a novel approach for efficient localization of license plates in video sequence and the use of a revised version of an existing technique for tracking and recognition. The authors proposed a novel solution for adjusting varying camera distance and diverse lighting conditions. License plate detection is a four step procedure including finding contours and connected components, selection of rectangle region based on size and aspect ratio, initial learning for adaptive camera distance/height, localization based on histogram, gradient processing, and nearest mean classifier. After processing these steps final detection result is forwarded for tracking.

In [16], for number plate recognition a fuzzy discipline based approach is proposed. In this proposed method, the edge detector algorithm is sensitive to only black-white, red-white and green-white edges.

III. Methodology

This section deals with the description of the algorithm development proposed by this paper. It also discusses the necessity and output of every step in detail. This is just a simple procedure to detect the number plate and display it. This procedure is valid for tilted image as well.

3.1 Proposed methodology:



3.1.1 Image Acquisition and Pre-processing:

The required image for pre-processing is taken by using a camera in RGB format. In case of an RGB image each component, i.e. R, G, B. requires at least 8 bit for their storage. The representation of a single pixel in RGB format is shown below.

R	G	B	R	G	B

Figure 3.1 Representation of Pixel in RGB Format

Then pre-processing algorithms are implemented as the proposed algorithm is sensitive towards backdrop illuminations, color components. The proposed algorithm is truly independent of color components and solely depends on grey scale for extraction and segmentation of image. So, a standard color frame changing algorithm is used to convert the 3 Dimensional RGB image is converted to its 2 Dimensional Gray counter-part.

Figure 3.2 Original image taken as input

Figure 3.3 RGB to Gray Conversion of Inputted Image

3.1.2 Dilation

Dilation is a process of structural improvement of an image by filling holes, adding pixels and joining broken lines for sharpening the boundary of an image as well as for increasing brightness. In the pre-processing stage RGB to Gray conversion results in the loss of some details of the original image. Even noise can also corrupt the image. So, dilation is necessary to enhance the converted image and make it suitable for edge processing, by removing noise and sharpening edges. By making the edge sharper the difference of grey value in the neighboring pixels of an object increases. It further enhances Edge Processing. Due to pre-processing some key features of an image, like brightness, light edge, color difference may get lost. By dilation such losses can be overcome and the pre-processed image is sharpened and the brightness is increased.

Figure 3.4 Dilated image

3.1.3 Horizontal and Vertical Edge Processing

An image histogram is a graphical representation of the tonal distribution of a digital image. For ANPR algorithm horizontal and vertical histograms are used, which represents column wise and row wise histograms respectively. In the first step, horizontal histogram is calculated. To calculate horizontal histogram, the algorithm goes to every single column of the image. In each column, the second pixel from the top is taken as the starting point and then the difference between the second and first pixel is calculated. Now, if the difference exceeds certain threshold value then it is added to the total sum of differences. As the algorithm further traverses down the column to calculate the difference between the second and third pixel and so goes on until the column ends and total sum of differences between the neighboring pixels is calculated. An array containing the column-wise sum is created after the process. Same procedure is followed for obtaining the vertical histogram, this time considering the row. In a similar manner an array with row wise difference sum is calculated.

3.1.4 Filtering

In Figure 3.5(a) and Figure 3.5(b) shown below, it can be clearly understood that the histogram value between the neighboring pixels changes drastically. Hence to prevent loss of further information, the changes in values are averaged out by passing the histograms through a low-pass digital filter. This step is performed considering the right and left hand side values. In the figures below histograms before and after passing through the filter are shown.

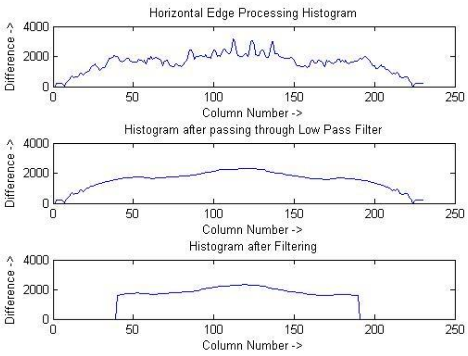


Figure 3.5(a)

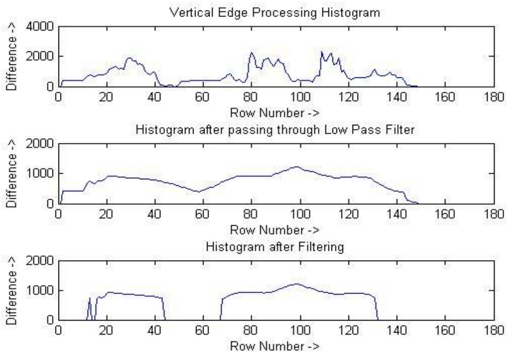


Figure 3.5(b)

After passing the histograms through low pass filter, the unwanted regions are removed from the image using another filter. The rows and columns with low histogram values are considered as unwanted regions. Since the lower histogram values indicate very lesser variations among neighboring pixels. Since the region with a license plate contains a plain background with alphanumeric characters in it. So the difference in the neighboring pixels, especially at the edges of characters and number plate, will be very high. Therefore, horizontal and vertical histograms of lower values aren't required anymore. So, they are filtered out by using dynamic threshold, applied on both horizontal and vertical histograms. The filtered histogram consists of the regions having the highest probability of containing the number plate.

3.1.5 Segmentation

The regions having the highest probability of containing the license plate are segmented out and the co-ordinates of such regions are stored in an array. The figure below is showing below the regions having most possibility of license plate.

Figure 3.6 Segmented Image

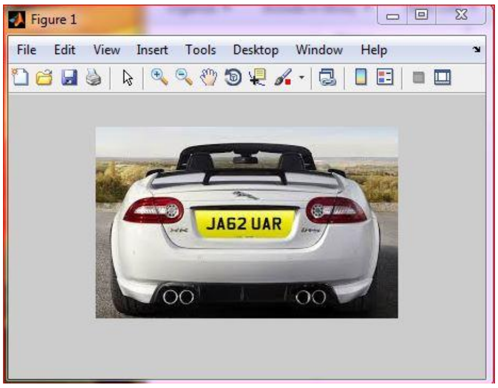
3.1.6 Region of Interest Extraction

Out of all the segmented regions only one with maximum histogram value is to be considered as the most probable candidate. All the regions segmented out by the segmentation process are processed row and column wise for finding a common region having maximum horizontal and vertical value. The common region having the maximum horizontal and vertical histogram value is extracted out. This region contains the number plate and can be outputted. The output image of the license plate detection is shown below.

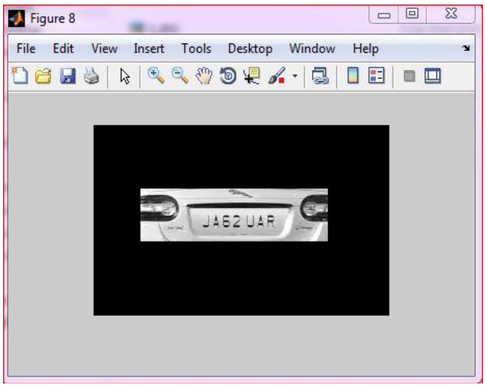
Figure 3.7 Final output showing the number plate

IV. Result And Analysis

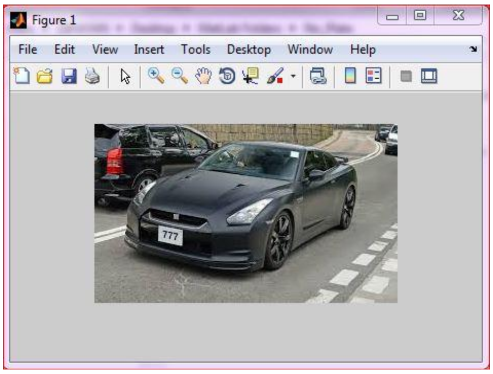
The algorithm is tested with different lighting conditions, tilts and background colors. The result of which is shown below.



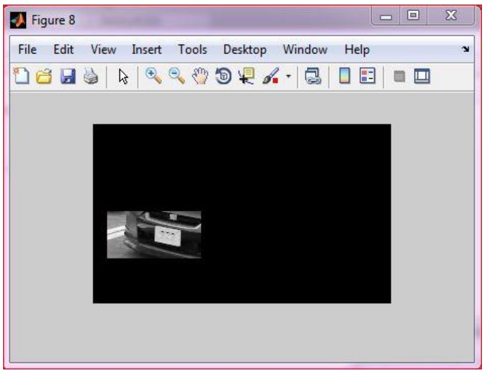
Inputted Image with Yellow Colored Plate



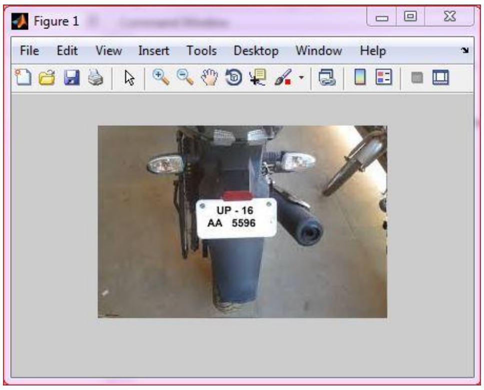
Outputted Image with Proper Recognition



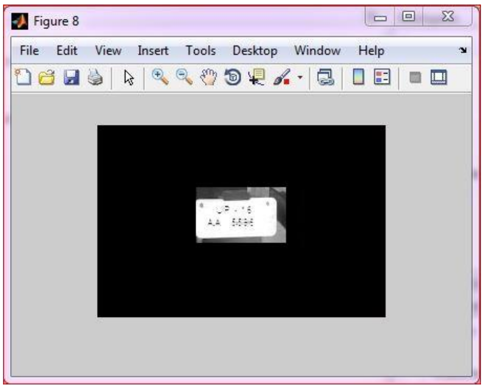
Inputted Image with Non-directed Plate



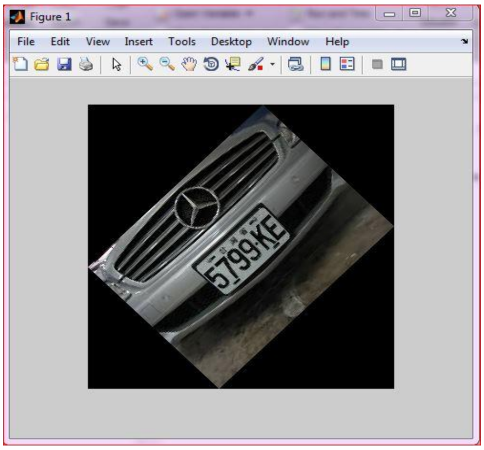
Outputted Image with Proper Recognition

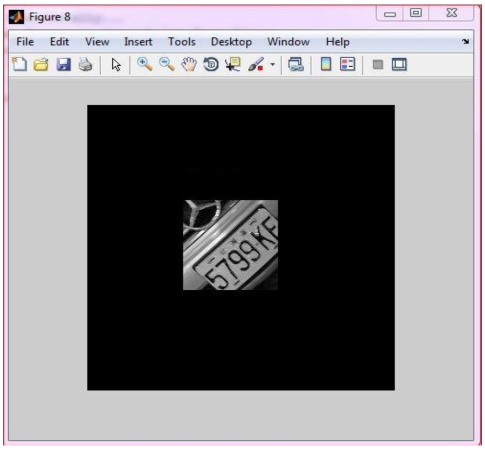


Inputted Image with White Colored Plate



Outputted Image with Proper Recognition





Inputted Image (with 45 deg rotation) Outputted Image with Proper Recognition

The summary of performance analysis is highly optimistic, as the algorithm fits for all possible sizes of number plates. But, the computation time solely depends on the size of the number plate. If size is bigger, computational time will be higher than that of smaller number plate.

V. Conclusion

The sole objective of this algorithm was to resolve the computational and mathematical complexities of ANPR. By addressing the logical sequences of the problem statement this paper has proposed an algorithm that easily bypasses the computational cost and complexities of machine learning and character recognition approach. By using pre-defined functions available for pre-processing in MATLAB computational cost has been reduced. The algorithm presented in this paper is successful for most images, acquired under different conditions. This algorithm overcomes the drawbacks of the previous proposed algorithms with lesser complex and easily maintainable approach.

VI. Future Works

In further we will have to find more accuracy. This algorithm fails to detect number plates under changing illuminations. Further research on this algorithm will be based on that. We further want to extend the ambit of this work in real time taking video input and directly connecting it to the database for better policing and surveillance.

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