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Automatic Number Plate Recognition System

[1]Amulya Ashok Biradar, [2]Apeksha Shrinivas Deshpande , [3]Ayesha Banu M.S, [4] Srusti C Shetty

Student, Department of information science and Engineering, SDMCET,Dharwad,Karnataka,India
student,Department of information science and Engineering,SDMCET,Dharwad,Karnataka,India
student,Department of information science and Engineering,SDMCET,Dharwad,Karnataka,India
student,Department of information science and Engineering,SDMCET,Dharwad,Karnataka,India

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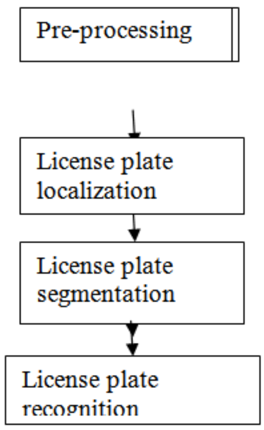
ABSTRACT:Nowadays, we hear a lot of news about accidents and also the vehicles being stolen. In order to keep track of these issues we have to install the CCTV camera on every area around the cities. Also, we need detect the vehicles and its details. Therefore, there is a need to develop Automatic Number Plate Recognition (ANPR) system which can be a solution to this issue. In number plate detection system the image processing includes basic operations preprocessing, image conversion from RGB to Gray, apply edge detection, apply morphological operators on same image then extract plate region from image and last process the plate region using OCR.Every algorithm in this category always follows this basic steps, each algorithm has some pros and cons, because same algorithm cannot be useful for different environmental condition.

KEYWORDS: Automatic Number Plate Recognition (ANPR), Optical Character Recognition (OCR), License Plate (LP)

I. INTRODUCTION

The identification of license plate is a very good source of knowledge for record detection and recognition. But the conventional license plate recognition process is a boring one. The manual way of identifying the vehicle and its owner is not that applicable in detecting license plates to retrieve the hidden treasures of information. Automatic recognition of license plate is an important stage in the intelligent traffic network, and several ways for the construction of ANPR architecture have been developed. Although the proportion of the license plate in the image is greatly correlated with shooting distance, therefore the ANPR architecture is not easy to balance in. Vehicles in motion, however, are too tiny to capture in the huge open space and clear recognizable license plate images. Identifying a license plate from tiny and distorted pictures will reveal a lot of effort. The method for recognizing license plate includes the four main steps–



II. METHODOLOGY

In this section The process of automatic number plate recognition consists of four main stages: (1) Preprocessing (2) License plate localization (3) Character segmentation (4)Character recognition

3.1. Preprocessing. As mentioned before, the system of automatic number plate recognition faces many challenges. So, this step is essential to enhance the input image and making it more suitable for the next processing steps. The first step done in the preprocessing is to apply minimum filter to the image in order to enhance the dark values in the image by increasing their area. This is mainly done to make the characters and the plate edges bold, and to remove the effect of the light diagonal strips that appear in the characters and edges of the Egyptian license plates (see Fig 1).This process is followed by increasing saturation of the image to increase the separation between colors. Then the image is converted to grayscale (taking the luminance component of NTSC) [8]. Then increasing the image contrast to separate the background from highlights.

3.2. License Plate Localization. In this stage, the location of the license plate is identified and the output of this stage will be a sub-image that contains only the license plate. This is done in two main steps.

3.2.1. Locating a large bounding rectangle over the license plate. In this step a rectangle that contains the license plate is located (this rectangle may also has some extra parts from the four sides), and this rectangle is the input to the next step for further processing (removing the extra parts, character segmentation then recognition)

First, Sobel vertical edge detection is applied to the image. Then a threshold of 36 (This value is determined using trial and error) is applied, Such that every edge with magnitude less than 36 is considered false edge and is set to 0. Then a vertical projection (projecting on the Y-axis) of the edge detected image is taken and smoothed using an average filter with width equals 9. It's obvious that the characters of the plate along with the plate's vertical edges will have very strong vertical edges . Moreover, these edges will sum up horizontally in the vertical projection and a strong peak will appear in the rows of the plate (These row will be called band). So, the approach is to take some number of peaks in the vertical projection and processing each of them individually in the next steps and when a successful band is found, the processing of the following bands is canceled. The reason behind taking more than one peak is that the image may contain objects (logos, road advertisement, etc..) that produce many vertical edges also these "false" edges may be centered in the same area so they will form a peak that may be stronger than the peak of the plate itself [8].For each band, we take a sub-image referenced by this band and all subsequent processing will be applied on this sub-image. Now the problem is to cut the band image from the left and right to get a bounding rectangle over the license plate (Again, this rectangle doesn't have to be tight on the plate). For this sake, a vertical Sobel edge detection is applied again, but the height is larger than the width of the filter, this is to decrease the effect of false edges and noise, experimentally, the best size is 6x3 filter. Again a threshold of 30 is applied for the same reason as before. Now, a horizontal projection of the edge detected band image is taken (projection on the X-axis) and smoothed using an average filter of large size this time, since there are gaps between the letters and the projection will have many peaks at the x coordinates where letters exist but it will drop down in the x coordinates of the gaps. So, smoothing it with average filter of large width will resolve this problem and many number of peaks will be converted to one wide peak that represents the range of the X-axis where the plate is located in that specific band we are working with. The width of the average filter is taken to be the height of the band. Relating the height of the band with thewidth of the average filter is very important since over-smoothing of the projection will merge the plate peak with the other main peaks in the band like the peak got from vehicle lamps for example (and it already explained why the width shouldn't be very small). Now, a predefined number of peaks (It's already explained why we take more than one candidate peak not just the strongest one) will be selected from the smoothed projection For each peak, a sub-image is taken according to the range of current peak. So, the bounding rectangle of the license plate is located. This is will be the input to the next step.

3.2.2. Determining the exact location of the license plate. Using the sub-image from the last step which contains the license plate with some extra parts (if any), the following processing is applied to this sub-image. The license plate may be skewed because of the angle of the camera while image acquisition process. And it is very important to de-skew the plate to its original orientation, thus making the platealigned with the X and Y axes.So a Hough transform is applied to the horizontally edge detected image in order to find the shear parameters by which the image can be de-skewed to retrieve the standard orientation. After this operation we have a plate with its axes aligned with the X and Y axes. Then a Gaussian smoothing filter is applied to smooth the image and remove noise. Then a morphological operation consists of subtracting the bottom-hat of the image from the image itself is done using a structuring element of a horizontal line of length 150 . This operation makes the characters of the plate bold and increases the characters area along with the effect of increasing contrast, and subsequently this will ease the process of segmentation and recognition afterward. All the above is considered a preprocessing for this step. Next, we aim at finding the exact band of the plate. In other words, the goal of this step is to cut the top and bottom extra parts of the previously cut rectangle (but this time the cut will be accurate because we have limited the area we are working with and moreover we de-skewed the plate). This is doneusing the same idea we used previously to get the plate band. It consists of applying Sobel vertical edge detection, then applying a threshold, then doing a vertical projection (projecting on the Y-axis), Then getting the strongest peak in this projection and cut the image accordingly using the range of this peak, thus cutting the exact plate band from the image and leaving the top and bottom extra parts. This time just the strongest peak is taken since we already limited the possibility that false edges appear when we cut a rectangle around the plate and we are sure that the vertical edges produced by the plate's characters are summed up correctly in a limited number of rows due to the de-skew operation.

3.3. Character Segmentation. This stage is meant for segmentation of the characters from the plate. The output of this stage is a set of monochrome images for
each candidate character in plate. The first step in this stage is to convert the plate image to a binary image. This is done using adaptive threshold with a window of size 11 (This is selected using trial and error). Then a process of noise removal is applied. This is done by getting the connected components from the binary image based on the 8-neighbourhood using flood fill. For every component, we decide if it's a noise or not based on the aspect ratio of the component and based on the number of pixels in that component. This is based on the fact that the characters of the plate have a certain range of aspect ratio and a certain range of number of pixels. After removing the noise components a maximum filter is applied to make the effect of thinning the characters to make sure that no two components are merged. This is followed by a horizontal projection, to detect the boundaries between the characters to be able to cut them individually. The peaks in this projection correspond to the gaps between the characters. So, we get all of these peaks and a rejection process is applied also, since a true plate has a fixed range of gaps between characters. So, any plate that has number of peaks that do not fit in that range, will be rejected. Also, there is a powerful rejection measure; it is the variance of the characters width (the variance of the spaces between peaks). After this the characters are cut according to the peaks of the previous projection. Then another set of measures are computed to reject the false characters that may still exist after the noise removal operation. These measures are aspect ratio, deviation from average height test, deviation from average contrast, deviation from average brightness, deviation from hue, deviation from average saturation. After rejecting falsecharacters, if the number ofcharacters is not located in a predefined range, then the plate is rejected. Otherwise, the processing is continued and for every character a copy of its corresponding location in the grayscale is got. The gray level histogram is computed for the sub-image of each character, This gray level histogram will have a standard shape which is one peak at the dark values (this corresponds to the character's pixels) and another peak at the bright values (this corresponds to the background) and some small values between them. So, this gray level image is converted to binary using the following procedure. First, we find two peaks in the histogram then we find the minimum value in between, this will be the value of the threshold (thus, every pixel that has a gray level value less than the mentioned value, will be converted to black, every other value will be converted to white). This way for converting the grayscale image that contains only a character to binary one proved to be effective. At this point we have a set of binary images each contains one character and this is the output of this stage and the input to the next.

Also we used a feed forward artificial neural network trained with back propagation with sigmoid activation function and the ANN is trained on the chain code feature of the optimal characters images. The neural network has 4X4X8=128 input neuron, it also has 37 output neurons corresponds to the Arabic alpha-numeric set of characters except zero, it also ceil (37+128)/2)=83 hidden neurons. So, for every character we get the chain code feature and do a feed forward on the trained FFNN (Feed Forward Neural Network) then the class the corresponds to the neuron with the maximum value will the predicted class of that character. If the error exceeds a predefined value then the character is considered a false one and rejected. The plate is known to have a fixed range of characters that may appear in it, so if the total number of passed characters does not match this range, then the plate is rejected. Otherwise, the license plate number is found.

III. CONCLUSION

This survey is the brief study of algorithms used for ANR (Automatic Number Plate Recognition) and observed the performance of some algorithms. But all these algorithms are image dependent. As image changes the algorithm changes because one's algorithm is efficient for his input image, but inefficient for others input image. So, there may be the future work on the algorithm that will be image independent making the algorithms dynamic. During the survey it is observed that Pre-processing plays the major role and extracting the ROI from the image is the difficult and tricky task because the position of the number plate in the image is not fixed for every vehicle image.

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