AN INTELLIGENT DESIGN FOR OPTIMIZED VEHICLE IDENTIFICATION IN TRANSPORT SYSTEMS

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Abstract: *Recognizing a vehicle's identity using the number plate is a widely used method due to the patterned method of number plate across the world. While recognizing data from a vehicle's number plate, there are many factors to be considered such as environmental circumstances, lighting conditions and camera positions. The existing approaches towards vehicle identification using number plate work only under restricted conditions, such as fixed illumination, limited vehicle speed, designated routes and stationary backgrounds. This proposed design considers all the constraints initially mentioned and it is tested with over 520 images. It provides 98% accurately detects the data in the number plate. Automatic number plate recognition is an important component in the future of Intelligent Transportation Systems (ITS) applications.*

Key words: *Detection of vehicle; ITS; Access control; Random Sampling Consensus; Connected Component Analysis.*

1. Introduction.

In recent years, there is a demand for information systems for processing the data in respect of vehicles with the pile integration of information technology. These systems require data to be archived or fed by a human or fed by a special team which is able to recognize vehicles by their license plates in a real-time environment reflect the original facts of vehicle in the information system. In most cases, vehicles are identified by their license plate number, which is easily readable by humans but not machines. For machines, a registration number plate is just a dark spot that exists within a region of an image with a certain intensity and luminosity. Because of this, it is necessary to design a robust system that able to perceive and extract the data from the captured image. Automatic Number Plate Recognition (ANPR) is an essential step in recognizing a vehicle. ANPR has gained much attention during the last decade along with the recent development of digital cameras and gain in computational complexity. For a vehicle, number plate data is the unique identification by which anyone can recognize the vehicle easily. Image processing is the best approach for this problem.

The proposed design consists of five stages. It starts with image acquisition, noise removal, image segmentation, data extraction and data recognition. The proposed design methodology uses some advanced image processing techniques for various stages in the solution.

Various methods are used in previous attempts at tackling the problem. Block thresholding method which is a memory intensive process and a correlation method is used for making a difference between the recognized and unrecognized images. It makes the system resistant to low noise [1]. Morphological operations like erosion and dilation are used.

In [2], Contour validation which is useful in accurate detection of number plate data and also it uses Hybrid discriminative Boltzmann machine constant recognize the characters easily by the constant found by Boltzmann machine but this method have many restriction while capturing the image and finding the Boltzmann constant is a time consuming process. If the captured image is blurred due to many reason then the system need to change the blurred image into deblurred condition. For this process a robust blur kernel estimation method is used. This estimation of blur kernel is based on the distance and angle of the character present in the image. In some methods Deconvolution [3] is used which gives the deblurred image from the blurred image but it also lost the information which is need to be identified. Non blind image deblurring method also has some artefact in the deblurred image. Line density Filter [4] is used to minimize the region where the character is located since if the area of number plate is larger in the captured image then the recognition becomes more difficult. In [5], to extract the number plate data anew morphology gradient method is introduced which extracts the number plate data with 96.6% accuracy.

However, this method takes much time and it is difficult to identify the data in the number plate if the captured image has complex background. In [6], Clustering with the edges are used for locating the number plate data from the captured image. In [7-9] the NBID algorithm which extracts the exact key point with kernel to calculate the final data from the image. To identify the number plate area from the captured image various qualities such as statistical quality, consistency quality, color quality of the

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captured image are used separately or jointly [10]. Only [11-12] utilized enhancing the contrast of the captured image and it is not efficient for very low contrast that is blurred number plate region. In [13] neural network is utilized in order to classify the colors present in the captured image. It classifies the colors into green, white, red and others.

2. System design

The proposed design starts with acquiring the image, it is converted to a grayscale image. At this stage noise removal process is done to remove noise from the image. Then the license plate area is located and Random Sampling Consensus (RANSAC) is applied. Features are extracted from the detected area in the image using Connected Component Analysis (CCA).

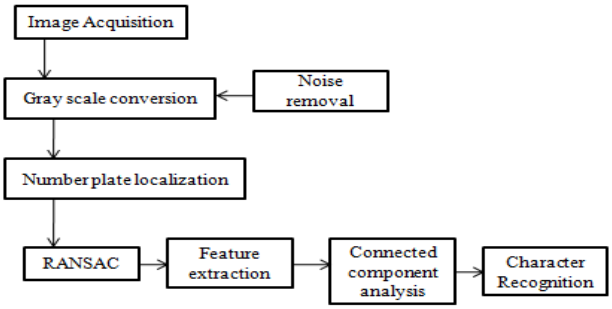


Fig.1. System design of ANPR.

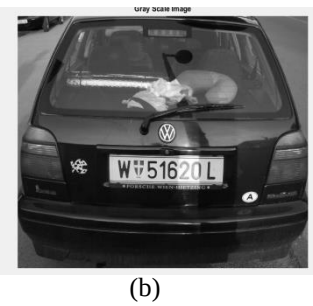
3. Proposed Deign Flow

3.1 Image Acquisition

Image acquisition is the process of getting input image for the ANPR process. Proposed design methodology takes input image from various environmental circumstances and various contrast conditions. Horizontally tilted images are also taken into consideration. After getting the captured image it needs to be converted into a grayscale image. For this conversion process, basic color to grayscale conversion method is used. Adaptive thresholding is used to isolate the centre image from the backdrop with non-uniform illumination conditions. This proposed method was extensively tested with various images taken in rain, foggy, other weather conditions, low contrast, high contrast, daytime, nighttime and horizontally rotated image while capturing. Fig.2 (a) shows an example of an input image.



(a)



(b)



(c)

Fig. 2. (a) Input image, (b) Grayscale image, (c) Adaptive threshold image.

Fig.2 (b) shows the image after grayscale conversion. If there is any noise present in the image then that would be removed before starting the extraction of number plate data from the processed image. If the image has periodic noise then Fourier transform is applied to that image. That consists of converting the image into a Fourier series image from which periodic noises are removed. After which an inverse Fourier transform is applied so the image can undergo adaptive thresholding. If the image has small noises like an effect of foggy or rain then Weiner filter is used for removing these noises. Adaptive thresholding is applied to the gray converted image based on the window size. The window size is calculated based on the local mean value.

$$Output\ B = \begin{cases} 255\ A & < \dfrac{\sum_{a-\frac{m}{2}}^{a+\frac{m}{2}} \sum_{b-\frac{n}{2}}^{b+\frac{n}{2}} A(i.j)}{m * n} \\ 0\ A & \leq \dfrac{\sum_{a-m/2}^{a+m/2} \sum_{b-n/2}^{b+n/2} A(i.j)}{m * n} \end{cases} \quad (1)$$

Here m, n represents the row and column present in the local mean value of the pixel intensity. A represents the input image taken for the process. B represents the output adaptive thresholded image.

3.2 Number plate localization

Number plate localization is the next step in the ANPR process. RANSAC is used to accomplish the task. It is a repeat mode algorithm used in image processing to locate a particular object. If a dataset contains outliers then it needs a tool to calculate the model for further evaluation. In this proposed design, a revised version of RANSAC is used which consists of the following four steps.

i. Arbitrarily choose a subset of data from the given dataset.
ii. Defining a subset of data model which fits with the selected subset.
iii. The total number of outliers is calculated with the model which fits the subset of data selected.
iv. Step i to iii is repeated for (2N-1) iterations.

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Here N represents the total number of outliers present in the captured image. The mutual originality between two different types of a dataset is found by RANSAC method. This localization of number plate area from the whole image can do at day and night time. After finding the total number of outliers from the process a sliding window is calculated which is moved over the image regions. This process selects the best outlying line from the total outliers. It indicates the number plate area through a line which is drawn over the captured image. After finding the component region total area contains only the height and width of the number plate characters are chosen. Other than the region in the image is discarded.

Fig.3 (a) shows the outliers present in the given input image. With the help of these outliers, RANSAC is applied and the number plate area is located and it is segmented with the help of image segmentation process. Here the input image is not having the clear background and with the help of noise removal process then the outliers present in the image is calculated with RANSAC and number plate data region is located. Height and width of the plate area are chosen for further process and the remaining regions are neglected.



(a)



(b)

Fig.3. (a) Outliers, (b) Number plate localization using RANSAC.

3.3 Image segmentation

Image segmentation is the process of dividing the image into several parts. This is used for object detection. Here with the help of the located image only the region containing the number plate is segmented. For this segmentation, adaptive thresholding is used. This thresholding method is based on the local mean intensity value of the pixel we have chosen from an m*n image. After this segmentation process character in the image will be identified with the outliers calculated from the RANSAC process.

3.4 Connected Component Analysis (CCA)

Connected Component Analysis is a feature extraction process. Feature extraction mainly focuses on extracting the exact information from the captured image. This exact information is useful for further process. To extract any information from the image initially the total size of the image must be reduced. This reduction of size is done by the segmentation process. CCA is an extraction process which exactly identifies the characters in the image. This method initially scans the total segmented image and collects all its pixels into a connected component. In the connected component, all the pixels share the same pixel intensity value. These connected components are connected in some way with each other pixels. If all the components are detected then it is labelled with a color according to the pixel intensity.

3.5 Character recognition

After extracting the characters it is necessary to classify them as alphabet s or integers. Template matching method is used with the aid of the connected component to accomplish this task. Template matching technique compares the particular area of the image with template images. This provides a final output that is the number plate data from the input image.



(a)



(b)

Fig. 4. (a) Segmented image, (b) Extracted characters with CCA.

4. Results and Discussion

This proposed design is implemented in MATLAB R2014b. The dataset contains 520 number plate images taken under various conditions (low light, high contrast situation, rainy season, foggy season and fast moving vehicles). The plate sizes in the data sets vary from 16 × 80 to 25 × 150. This method detects the number plate data from the image with 98% accuracy. Compared with the previous methods this proposed method is effective in detecting characters with very low processing time. Fig.5 shows the final detected characters by this proposed methodology.

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Fig.5. Detected characters in the number plate.

Table 1 describes the comparison of accuracy got from various methods of number plate detection.

Table 1
Comparison of ANPR methods

Method	Number of plates	Processing time	Overall accuracy
Edge features	320	Not given	96.6%
Salient features	1176	223 ms	93.1%
Revised RANSAC and CCA (Proposed Design)	520	156ms	98%

5. Conclusion

Proposed design uses revised RANSAC and Connected Component Analysis (CCA) with template matching techniques to deliver an optimal solution to reading the number plate data of the vehicles. This method provides 98% accuracy and it identifies number plate data under a variety of environmental conditions that were a challenge for previous approaches. This proposed design can be used by any transportation system administration for identifying vehicles, enforcing traffic law, keep monitor the overall activity of vehicles in the transportation system.

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