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RECOGNITION OF NUMBER PLATE BY USING HOUGH TRANSFORM

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Abstract—
Number Plate Recognition plays important role in traffic management system. It is very important in our daily life because of unlimited number of cars and transportation system. This paper presents novel approach for recognition of characters using Hough transform. The proposed system can be used to provide controlled access to restricted areas such as companies, military zones, Supreme Court. This system contains three main parts namely number plate detection, plate character segmentation and character recognition. Feature extraction is the important step of any recognition system. It is necessary to select and extract relevant features for improving the performance of the system. Images captured from the camera involve ample of features. It is necessary to analyze the features which are extracted from images for recognition purposes. The proposed system will use Hough Transform for extracting features of images and edge detection technique for detection of number plate.

Index Terms— Feature Extraction, Hough Transform, Image Processing, Vehicle Identification, Pattern Recognition.

I. INTRODUCTION

Number plate recognition plays important role in intelligent transportation system (ITS) [1]. A vehicle number plate is attached to vehicles for official identification purposes. The identifier can be used for uniquely identifying a vehicle. There are numerous reasons why it is necessary for individuals or organizations to identify a vehicle and thus its owner. This can be done by a human agent or by a special intelligent equipment which is be able to recognize vehicles by their number plates in a real environment. Examples are law/police enforcement, traffic control, and access to restricted areas, electronic toll collection or checking parking permissions purposes [2]. In some of the applications like traffic law enforcement, road monitoring and expressway toll system, where number plate recognition is used, it is necessary to process a large number of vehicles in a short time. In daily life there is huge traffic on roads, in this scenario application has to do very fast processing. Otherwise, violators and criminals can escape.

The detection of a single number plate and the recognition of its characters in a reliable way is an expensive task, since it relies on special license plate recognition cameras. Dedicated systems have been developed for this purpose using special ANPR (Automatic Number Plate Recognition) cameras [3].
There are certain areas where these systems are not practical, too heavy or too expensive to use. There are many challenges
involved in number plate recognition. The number plates may differ in size, shape, text format and color. Also the environmental factors such as light, illumination, dirt affects the result.
Three main steps of number plate recognition are number plate detection, character segmentation and character recognition. Input to the number plate detection is the car image captured by the camera and output is the portion of the image containing the number plate. In character segmentation step the characters are divided into separate images. After character segmentation, feature extraction is used to extract the relevant features of the characters for recognition purpose.
Feature extraction is the important step of pattern recognition. The result of whole system depends upon feature extraction step [1]. Therefore it is necessary to select and extract relevant features for improving the performance of the whole system. The main motivation of this work is to analyze the features which are extracted from characters for the recognition purpose. In image there are number of features which needs to be carefully selected for accuracy purpose. These features are then provided to classifier for classification purpose. The paper is organized as follows. Section II discusses the related work, section III describes proposed work for vehicle identification, and section IV describes the number plate detection with result. The paper concludes in section V.

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II. RELATED WORK

In the literature many number plate recognition algorithms have been proposed. Although number plate recognition has been studied for years it is still a challenging task to locate the number plate from different angle, partial occlusion and environmental conditions. In the entire procedure of number plate recognition most important and difficult step is reliable detection and isolation of the number plate from complex scene. The detailed survey of the number plate recognition is given in [1].

Rob G. J. Wijnhoven et al., presented a novel system for automatic identification of vehicles for garage door opening. Here recognition of both car and character is done using shape descriptor and linear classifier. Features are extracted from images using Histogram of oriented Gradients and provided to classifier for classification purpose. The accuracy of 90% is achieved using this approach [2].

Kumar Parasuraman et al., proposed the number plate recognition algorithm for Malaysian number plates. Here morphological operations are used for detection of number plate. For segmentation purpose they used filtering, thinning and horizontal and vertical projection [3].

S.Kranthi et al., proposed the feature based number plate localization system to recognize the vehicle number plates. Their study focuses on two main algorithms they are edge finding method and window filtering method for the better development of the number plate detection system [4].

C. Nelson Kennady Babu et al., proposed a method for vehicle license plate identification on the basis of a novel adaptive image segmentation technique. Here a novel method for license plate localization based on texture and edge information is proposed [5].

V. Swetha et al., proposed the system to provide security to the restricted areas. The algorithm consists of vehicle detection, extraction of number plate, classification of vehicle and recognition of character. Here for extracting the plate region smearing algorithm is used [6].

P.Vijayalakshmi et al., proposed the number plate recognition algorithm which uses the Genetic algorithm at two levels for vehicle detection and for number recognition. Here detection is based on contour and shape information. Finally, a feature based matching is adopted for character recognition [7].

Shuang Wang et al. proposed a system using video cameras to perform vehicle identification. They reconstruct an input by using multiple linear regression models and compressed sensing, which provide new ways to deal with feature extraction and robustness to occlusions and misalignment [8].

C.N. Anagnostopoulos et al., proposed algorithm for vehicle license plate identification on the basis of a novel adaptive image segmentation technique i.e. Sliding Concentric Windows and connected component analysis in conjunction with a character recognition. The probabilistic neural network is trained to identify alphanumeric characters from car license plates based on data obtained from algorithmic image processing. Here overall accuracy of 86% is achieved [9].

Anish Lazrus et al., proposed the system for number plate recognition of Indian number plates. Here the images of various vehicles have been acquired manually and converted in to gray-scale images. Here the system achieves the accuracy of up to 98% [10].

Dhiraj Ahuja et al., proposed number plate recognition using wavelets and neural network. Here different wavelets are used for license plate detection and feature extraction of license plate characters. Using different wavelets shape features of license plate characters are extracted and analysis of wavelets is done on the basis of recognition rate and time [11].

Fatih Kahraman et al., proposed license plate character recognition based on the Gabor transform and vector quantization. Gabor filter gives the plate boundary location. Then binary split tree is used in order to extract the exact boundary of number plate. After segmentation is done so that characters become ready for the optical character recognition [12].

Subhradeep Kayal et al., proposed automatic number plate detection using Gabor filter and cross cuts. Here the input image is first convolved with a 2-dimensional Gabor Filter with a vertical orientation so as to filter out the vertical edges. Then a method of 'cross-cuts' is adopted to effectively separate the actual plate region from any region with characters or letters [13].

III. PROPOSED SYSTEM

Feature extraction is the first step in many object detection algorithms. It is the process of generating features to be used in the selection and classification task [4]. Different feature extraction techniques are available for extracting features from images which are used to train the classifier for classification purpose. Different feature extraction methods have been developed in the context of vehicle identification. The proposed system will use feature extraction technique such as Hough Transform for extracting features for vehicle number plate recognition. Number plate recognition system is generally divided into three main steps: Number plate detection, character segmentation and character recognition. After character segmentation step the features of character are extracted for recognition purpose. Figure 1 shows the block diagram of the proposed system.

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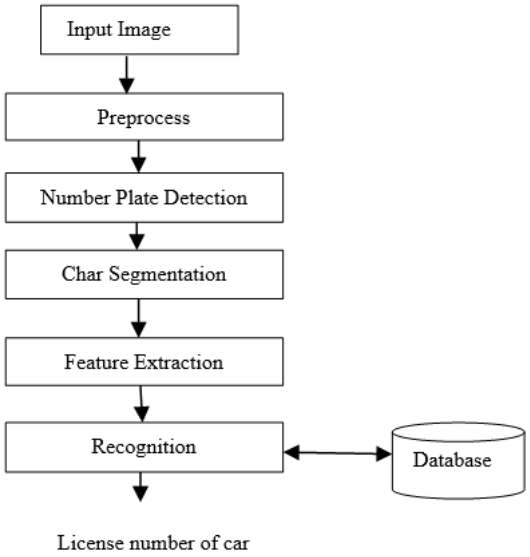

Fig.1 Block diagram of Proposed System

Input to the system is the images captured from camera. System should be able to detect number plate in given image. Images are captured with different angles with varying distance from the car. System should able to detect and recognize number plate besides used color, font and format of plate. After that preprocessing of the image is done to remove the noise from image and to enhance number plate area. After preprocessing, number plate detection is done using different algorithms explained in section IV. Next step is to segment the characters of number plate. After character segmentation, features extraction is done using Hough Transform. Hough Transform is the most suitable method for identification of plate characters, as the plate characters are composed of connected edge lines and Hough Transform is able to analyze line features.

IV. NUMBER PLATE DETECTION

Number plate detection is the most important step of vehicle identification system. It affects the result of whole system. The goal of this phase, given a image is to produce the region with high probability of containing the number plate area. We have developed the project using Java platform and Eclipse is used as IDE. Locating the number plate helps in dramatically reducing both computational expenses and algorithm complexity. For example currently common 1028*768 image contains a total of 786432 pixels while the region of interest (in this case number plate area) may account for only 10% of the image area. Also, the input to the following segmentation and recognition stages is simplified, resulting in easier algorithm design and shorter computation times.

This is done using two steps. In first step image preprocessing is done for detecting edges of number plate. In second step exact number plate area is detected using horizontal and vertical image projection.

A. Edge Detection

Number plate can be defined as a rectangular area with increased occurrences of horizontal and vertical edges. The high density of horizontal and vertical edges on a small area is caused by contrast characters of a number plate. To detect horizontal and vertical edges we use Sobel edge detector. The first is dedicated for evaluation of vertical edges, and the second for evaluation of horizontal edges. Figure 2 shows original input image and figure3 shows the result after applying vertical sobel filter.

Fig.2. Input Image

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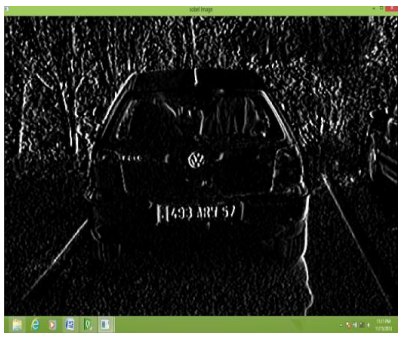

Fig.3. Sobel Vertical edge detection

B. Horizontal and Vertical Projection of Image

The vertical projection of the image is a graph which represents an overall magnitude of image along with Y axis. If we compute vertical projection of the image after application of vertical edge detection filter, the magnitude of certain points represents the occurrences of vertical edges at that point. The horizontal projection represents overall magnitude of image according to X axis. Figure 4 shows vertical projection of image.

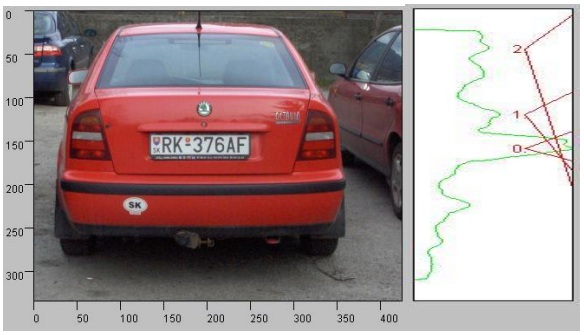

Fig 4. Vertical projection of image

Let an input image be defined by a discrete function f(x,y) . Then, a vertical projection p_y of function f at a point y is a summary of all pixel magnitudes in the y throw of the input
image. Similarly, a horizontal projection at a point x of that function is a summary of all magnitudes in the x th column. We can mathematically define the horizontal and vertical projection as:

$$p(x) = \sum_{j=0}^{h-1} f(x, j)$$

$$p(y) = \sum_{i=0}^{W-1} f(i, y)$$

Where w and h are dimensions of image.

Detection of the number plate area consists of band clipping and plate clipping. The band clipping is an operation, which is used to detect and clip the vertical area of the number plate (so-called band) by analysis of the vertical projection of the snapshot. The plate clipping is a consequent operation, which is used to detect and clip the plate from the band (not from the whole image) by a horizontal analysis of such band.
The band can be also defined as a vertical selection of the image, and the plate as a horizontal selection of the band.

I. Vertical Detection(Band Clipping):

The band clipping is a vertical selection of the snapshot according to the analysis of a graph of vertical projection. 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. This row will be called as band.
We 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. Figure5 shows band detected after analysis of vertical projection.

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Fig.5 Band detected by analysis of vertical projection

II. Horizontal Detection (Plate Clipping)

Plate clipping is based on horizontal projection of band. First band must be processed by vertical edge detection. If w is the width of the band, then corresponding horizontal projection p(x) contains w values. 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 plate aligned with x and y axis. Here we apply Sobel vertical edge detection and then vertical projection. The strongest peak in this projection will correspond to number plate. Thus we get exact number plate from this step as shown in figure

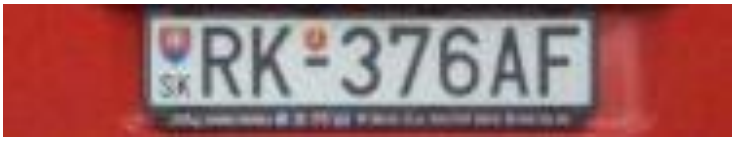

Fig.6 Detected number plate

V. CHARACTER SEGMENTATION

The next step after the detection of the number plate area is a segmentation of the plate. The segmentation is one of the most important processes in the automatic number 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. The output of this stage is a set of monochrome images for each character in plate. There are two phases. In first phase characters are segmented using horizontal projection. Second phase involves enhancement of segments. The segment contains besides the characters also undesirable elements such as dots and stretches. There is need to eliminate these elements and extract only the character.

A. Segmentation of plate using Horizontal projection:

We can segment the plate by detecting spaces in its horizontal projection. First we apply adaptive threshold filter to enhance area of number plate before segmentation. After the thresholding, we compute a horizontal projection p_x of the plate f(x,y) . We use this projection to determine horizontal boundaries between segmented characters. These boundaries correspond to peaks in the graph of the horizontal projection.

Figure7 show number plate after application of horizontal projection.

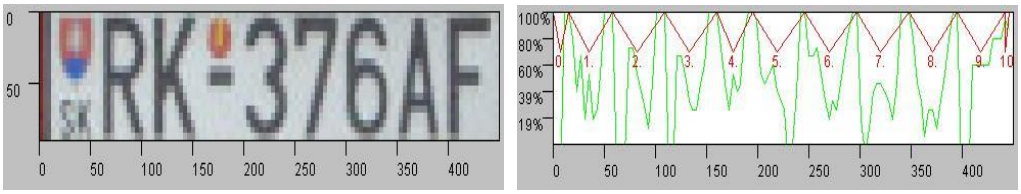

Fig.7 Number plate after application of horizontal projection

The goal of the segmentation algorithm is to find peaks, which correspond to the spaces between characters. There are several important values in a graph of the horizontal projection

V_m - The maximum value contained in the horizontal projection.

V_a - The average value of horizontal projection.

V_b - This value is used as a base for evaluation of peak height. The base value is always calculated as $V_b = 2V_a - V_m$.

The algorithm of segmentation iteratively finds the maximum peak in the graph of vertical projection. The peak is treated as a space between characters, if it meets some additional conditions, such as height of peak. The algorithm then zeroizes the peak and iteratively repeats this process until no further space is found.

B. Extraction of Character from horizontal segment

The segment of plate contains besides the character also redundant space and other undesirable elements. Since the segment has been processed by an adaptive thresholding filter, it contains only black and white pixels. The neighboring pixels are grouped together into larger pieces, and one of them is a character. Our goal is to divide the segment into the several pieces, and keeps only one piece representing the regular character. This algorithm is based on similar principle commonly known as Seedfill algorithm.

Figure 2.2 shows result of character segmentation

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Fig.8 Result of character segmentation

VI. CHARACTER RECOGNITION

To recognize the character from bitmap representation, there is need to extract feature descriptors from such bitmap. As an extraction method significantly affects the quality of whole system, it is very important to extract features, which will be invariant towards the various light conditions, used font type and deformations of characters caused by a skew of the image.

In our system Hough Transform algorithm is used for feature extraction. It is a powerful global method for detecting edges. It transforms between the Cartesian space and a parameter space in which a straight line (or other boundary formulation) can be defined. So using Hough transformation all the strong edges vertically and horizontally in the image are identified. Hough Transform is used to find features of any shape in an image. The purpose of Hough transform is to find imperfect instance of objects within certain class of shape by a voting procedure.

Simplest form of hough transform is to detect straight lines. Equation of line can be written as

$$y = mx + b$$

Where m is slope and b is its intercept. For a point (x', y') in the xy plane of the image space, there are an infinite numbers of lines that can pass through this point with different values of m's and b's. But this equation has problem with vertical lines. Therefore following equation is used.

$$r = x\cos\theta + y\sin\theta$$

Where r = distance from the origin to closest point on the straight line and θ is the angle between x axis and the line connecting the origin with that closest point. By using Hough Transform different features are extracted from such as height, height width ratio, brightness and contrast of characters. These extracted feature vectors are provided to classifier for classification purpose. Neural network is used as classifier in our system. In this step single character images will be passed as a input to the classifier. Neural network uses feed forward that contains of connected neurons to help recognize individual characters. Figure9 shows architecture of neural network.

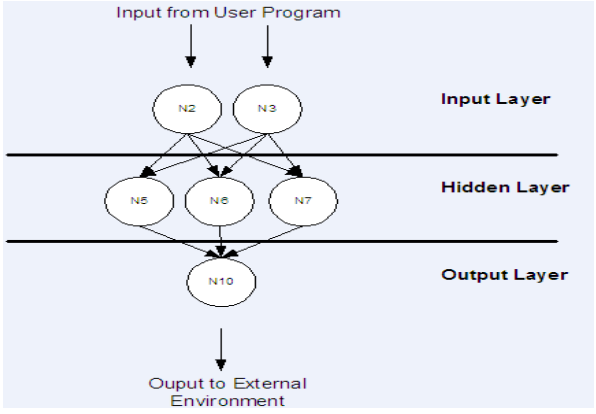

Fig.9 Architecture of Neural network

Input layer: The input layer to the neural network is the conduct through which the external environment presents a pattern to the neural network. Once a pattern is presented to the input layer of the neural network the output layer will produce another pattern. In essence this is all the neural network does. The input layer should represent the condition for which we are training the neural network for. Every input neuron should represent some independent variable that has an influence over the output of the neural network.

Output layer: The output layer of the neural network is what actually presents a pattern to the external environment. Whatever patter is presented by the output layer can be directly traced back to the input layer. The number of a output neurons should directly related to the type of work that the neural network is to perform.

In order for neural networks to confirm if they computed correctly they use back propagation method that will be used to recheck. It involves taking input, computing calculations and giving the output and in this case the output is the recognized character. Neural networks involve training the network with certain input and in this case will be trained

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with the input character images from the segmentation method. Since number plate contains only of numbers 0-9 and 26 letters A-Z and all in all is 36 characters so the network will be trained through 36 characters in checking the errors and recognizing the characters. It is typical for any neural network to learn in a supervised or unsupervised manner by adjusting its weights. In the current method of learning, each candidate character taught to the network possesses a corresponding weight matrix. For the kth character to be taught to the network, the weight matrix is denoted by Wk. As learning of the character progresses, it is this weight matrix that is updated. At the commencement of teaching (supervised training), this matrix is initialized to zero. Whenever a character is to be taught to the networks, an input pattern representing that character is submitted to the network. The network is then instructed to identify this pattern as, say, the k th character in a knowledge base of characters. That means that the pattern is assigned a label k. In accordance with this, the weight matrix Wk is updated. Recognized output by using neural network is shown below.
License number of car: RK 376AF

VII. CONCLUSION

The process of number plate recognition requires very high degree of accuracy when it is used for providing security. Feature extraction is the key point of any recognition system. A reliable feature extraction technique is required for improving the accuracy of recognition. The system performs number plate recognition system using different algorithms. It uses Hough transform algorithm for extraction of features. The number plate area detection and segmentation is done using same algorithm. Character recognition is done using neural network and number of car is recognized. In the future system can be modified to recognize number plates of different format.

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