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A Robust Method of License Plate Recognition using ANN

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***Abstract*— The purpose of this paper is to design a system that can recognize vehicle license plate under poor environmental conditions by using neural network. Adverse environmental condition may refer to the image has been blurred by poor lighting, rain, poor image resolution and haze which make the image not clear. Recognition of a vehicle license plate is usually important for many security and control system. This paper presents a robust method of license plate location, segmentation and reorganization of the characters present in the located plate. The images of various vehicles have been acquired manually and then by cropping the license plate, number plate is extracted then segmentation of gray scale image generated by finding edges using Sobel filter for smoothing image is used to reduce the number of connected component and then bwlabel is used to calculate the connected component and finally, single character is detected. The results show that the proposed method achieved accuracy of 98% by optimizing various parameters with higher recognition rate than the traditional methods.**

***Keywords*— license plate, recognition, segmentation, neural network, noise, and filter.**

I. INTRODUCTION

Vehicle license plate was first introduced in France in 1983 [1]. The plate usually made of plastic or metal material is attached at the front and rear of automobiles. On the vehicle license plate, it will consist of alphanumeric and numeric codes that will represent the vehicle belong to which region of the country. With the wide use of computing technology, Intelligent Transportation System becomes more and more important in Traffic management [2]. License plate localization is an important phase in vehicle license plate recognition of intelligent transport systems. It can be used in many applications such as entrance check, security, and parking control, airport or harbor cargo control, road traffic control, and speed control and so on. A number of commercial software is developed in this area. However, sets of blurry and skewed snapshots give worse recognition rates than a set of snapshots, which has been captured clearly [3]. Due to the rapidly increase in number of vehicles across the world's big cities, vehicle number plate recognition system has become one of the most important digital image processing systems to be used.

II. RELATED WORK

A lot of research works in the field of Vehicle Number Plate (VNP) recognition are being carried out since mid 90's. License Plate Localization (LPL) methods are broadly classified into Morphology based LPL methods, Edge statistics, and neural networks and fuzzy based, template based and so on. The aspect ratio, color, variance, edge density are some of the license plate features used by the above methods. High contrast between characters and background in a license plate is a strong feature which is considered in edge analysis [4]. Character segmentation is an important step in license plate recognition (LPR) system. There are many factors that cause the character segmentation task difficult, such as image noise, plate frame, rivet, space mark, plate's rotation and illumination variance. Various methods such as Laplacian Transformation, Region marking method and the large interval- based character locating algorithm, mean shift segmentation along with the Mahalanobis classifier, a method calculating same distance between characters as well as the inter-characters, compensation-based binarization technique are available for the segmentation of characters from License Plates to be recognized [5]. The neural networks (time-delay neural networks) are also used in the process of segmenting characters from the License Plate. In the recognition process of characters in the License Plates, the neural network may be considered to be a very successful approach for license plate recognition. Back propagation neural network, feed-forward neural network, discrete-time cellular neural networks (DTCNN's) etc. are used in the process of recognition of characters of the License Plates. The probabilistic neural network (PNN) is trained to identify alphanumeric characters from car license plates based on data obtained from algorithmic image processing. Another approach is considered to identify vehicle through recognizing of its license plate using two different types of neural networks: Hopfield and the multi layer perceptron (MLP). A comparative result has shown the ability to recognize the license plate successfully [6-7].Another approach is to describe the smart vehicle screening system, which can be installed into a tollbooth for automated recognition of vehicle license plate. An automated system could then be implemented to control the payment of fees, parking areas, highways, bridges or tunnels, etc. They are considered an approach to identify vehicle through recognizing of it license plate using image fusion, neural networks and threshold techniques [8-9]. All of the systems discussed above have some kind of limitations for example they are plate size dependent, color dependent, work only in certain conditions or environment like indoor images etc. The method that we are proposing is independent of color, size, location and angle of the number plate of the vehicle.

III. PRPOSED METHODOLOGY

The objective of this paper is to build an image processing system whereby it is used to recognize the vehicle license plate under poor environment condition. It is basically designed for the usage at car park barrier systems, traffic control and security recognition system. Part of the objective is to study and investigate the different feature extraction and recognition algorithm development. When the license plate had been detected by the system, each letters and figures of the vehicle

license plate will be verified against a secure database. MATLAB is used as the platform to perform the mathematical computation of Neural Network. The computation on the MATLAB programmed is based on the Theory of Neuronal Approximation using feed forward neural network with back propagation algorithm [10]. The back propagation algorithm is an iterative gradient algorithm designed to minimize the mean square error between the actual output and the desired output. Inside MATLAB, there are various types of toolbox such as Image processing toolbox, Signal processing toolbox, Fuzzy logic toolbox, Neural Network toolbox and many more. Basically, the system overview can be achieved through general algorithm involving the following methods shown in Fig1.

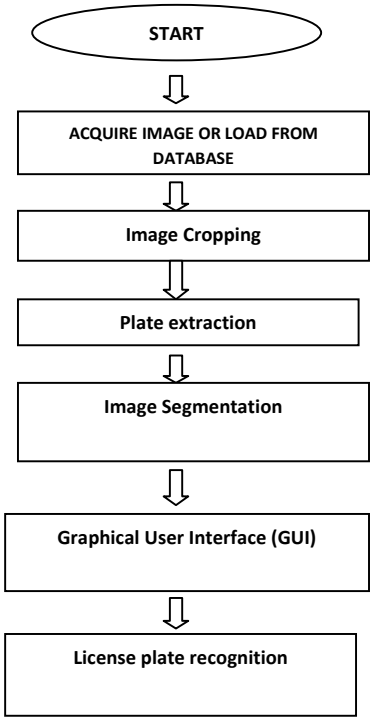


Figure 1. The flow diagram for proposed system.

The system will identify the vehicle license plate and convert the images to grayscale images following by converting the grayscale images to binary images which consist of only '0' and '1'. Then, the process continues to image segmentation which will segment out each individual character and number. The system uses the sequence of image processing techniques such as edge detection, histogram equalization and also image threshold. Last but not least, each character and number is been recognize using neural network.

A threshold image g(x,y) is defined as:

$$g(x,y) = \begin{cases} 0, & f(x,y) < T \\ 1, & f(x,y) > T \end{cases} \quad (1)$$

0" denote black and "1" denotes white.

The value of the gray level varies from the darkest (0) to the brightest (255) and Local thresholding an image is divided into sub images and a threshold is determined independently for each sub image and last Optimal thresholding a method that selects a threshold value that is statistically optimal based on the contents of the images. For the vehicle license plate extraction, the writer had decided to use Otsu Thresholding method [11]. The Otsu method chooses the threshold that minimizes the intra class variance of black and white pixels. It operates directly on the gray level histogram in term of 256 numbers. Level is a normalized intensity value that lies in the range [0,1].

The weighted within –class variance is:

$$\sigma^2 W(t) = q_1(t)\,\sigma_1^2(t) + q_2(t)\sigma_2^2(t) \quad (2)$$

where the class probabilities are estimated as:

$$q_1(t) = \sum_{i=1}^{t} P(i) \quad (3)$$

$$q_2(t) = \sum_{i=t+1}^{I} P(i) \quad (4)$$

and the class means are given by:

$$\mu_1(t) = \sum_{i=1}^{t} iP(i)/q_1(t) \quad (5)$$

$$\mu_2(t) = \sum_{i=t+1}^{I} iP(i)/q_2(t) \quad (6)$$

The total variance as:

$$\sigma^2 = \sigma_W^2(t) + q_1(t)\,[1-q_1(t)]\,[\mu_1(t)-\mu_2(t)]^2 \quad (7)$$

The approaches to Image segmentation are categorized into 3 classes of techniques: edge-based, region based and global approaches. The edge-based represents a large group of methods based on information about edges in the image. The approach for region-based techniques can be carried out by convolving the image with kernel mask like the sobel filter mask and the third method is global approaches techniques means that all the pixels in an image are used in the calculation of the threshold value.

IV. ARTIFICIAL NEURAL NETWORKS

Neural network is a mathematical model for information processing base on biological neural networks. Its architectures usually consist of multiple layers of cells. A common architecture consists of three layers (input, hidden, and output). The network architecture consists of two parts that is feed forward network and feedback network. The second is the method of setting the value for the weights enables the process of training or learning. Training a network refers to the process of modifying the weights in the connections between network layers. And the internal process when a network is been trained, is known as learning.

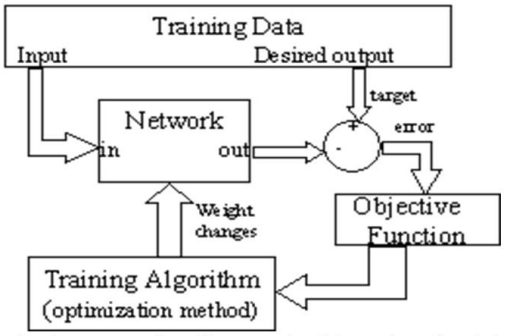


Fig 2: An example of supervised learning / training

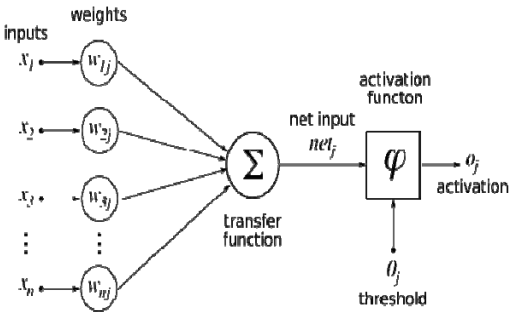


Fig 4: An example of activation function

The activation function is used to calculate the output of a neuron. MATLAB neural network toolbox provides a complete set of functions and a graphical user interface for the design, implementation and simulation of neural networks. Perceptron is a connected network base on an analogy to the human system, capable of learning by means of a feedback system which can distinguish between correct and wrong answers. It consists of an input layer and output layer of nodes, each of which are fully connected to the other [12]. There is also back propagation was created by generalizing the Widrow-Hoff learning rule to compute multiple-layer networks and nonlinear differentiable transfer functions [13]. It allows multi-layer perceptrons with non-linear differentiable transfer functions to be trained.

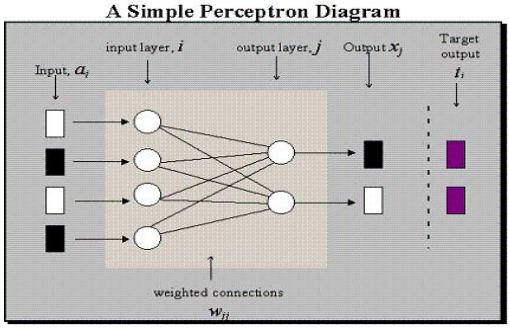


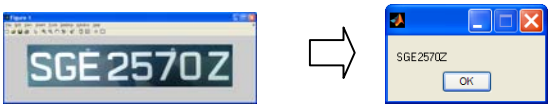
Fig 5: An example of a simple perceptron diagram

V. RESULTS AND ANALYSIS

There are two snerios under which the images were subjected for testing. They are explained as under:

Scenario 1

The vehicle license plate image is reflective due to over expose of light



. Fig 6: the vehicle license plate correctly recognized

The result shows at the text.txt; it reads the vehicle license plate SGE2570Z correctly with no error at all.

Scenario 2

The vehicle license plate image taken at a raining day, but the plate is at a slanted position.

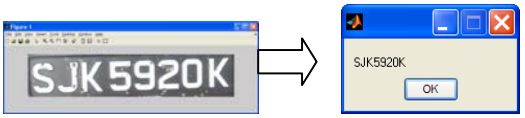


Fig 7: the vehicle license plate correctly recognized

The result had show at the text.txt; it had read the vehicle license plate SJK5920K correctly with no error at all

Scenario 3

The vehicle license plate image taken at night time with double wording at a raining day,

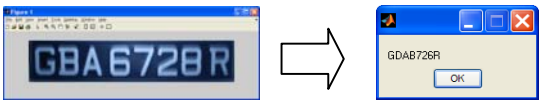


Fig 8: the vehicle license plate correctly recognized

Following table contains all the result conducted for other vehicle license plates and the percentage accuracy has been shown below:

Table I: Recognition Result

Vehicle License Plate	Recognition Output	Percentage Accuracy
SGE2570Z	SGE2570Z	100 %
SJQ1446H	SJ01446H	87.5 %
SJK5920K	SJK5920K	100 %
SGS7124Y	GGG7124Y	75 %
SJY2131S	SJY2131S	100 %
SGX2572T	SGX257ZT	87.5 %
SGX2402B	SGX2402B	100 %
SGV2927P	SS292P	62.5 %
SJP8246C	SJP8246C	100 %

From the recognition table, it can be observed that this Vehicle License Plate Registration Recognition System under adverse environmental conditions is still not 100% accurate. The result is based on each vehicle license plate been represented by an image size of 50 by 30 matrix of real values. The Percentage Accuracy is obtained from testing with different number of images of vehicle license plate. Total 150 images were tested in order to get the accuracy desired. If the characters and numeric databases are of big size, it might produce a recognition output that is 100% correct.

VI. CONCLUSIONS

For this paper, available image processing algorithm and classification methods are discussed. Most of the effort was spent on image processing methods like thresholding, segmentation and feature extraction which are crucial for the recognition system. Great amount of time were spent on training the correlation in two dimensions and building up the templates for the classification. Overall the vehicle license plate recognition software has been successfully designed and developed to recognize the 38 different characters using correlation in two dimensions. As results achieved are not 100% accurate, there are some methods that would enhance efficiency and reliability of the program for future work.

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