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Vehicle License Plate Recognition System

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Abstract

The vehicle license plate recognition system has greater efficiency for vehicle monitoring in automatic zone access control. This Plate recognition system will avoid special tags, since all vehicles possess a unique registration number plate. A number of techniques have been used for car plate characters recognition. This system uses neural network character recognition and pattern matching of characters as two character recognition techniques. In this approach multilayer feed-forward back-propagation algorithm is used. The performance of the proposed algorithm has been tested on several car plates and provides very satisfactory results.

Keywords

Back error propagation, image segmentation, character recognition, license plate recognition

1. Introduction

Vehicle license plate recognition (VLPR) is an image processing system whereby it is used to recognize the vehicles by identifying the license plate. It is basically used for traffic and security purposes. The cycle will start when the vehicle steps over the detector. It will activate a signal to the vehicle license plate system of the presence of the vehicle. The illumination will be activated and images of the front picture of the vehicle will be taken. The system will read the information pixels of the vehicle and run the recognition process and system will apply error back-propagation algorithm to analyze the vehicle image. Besides analyzing, the images will be enhanced, locating the vehicle plate position and extract the characters from the vehicle plate. The characters will be recognized by using neural network. Then system will try to match the recognized vehicle plate number with the car plate database. If access granted, the gantry will open and allowed the vehicle. Previously different neural models were designed to filter the noisy sign. So, many researches of car identification have been approached by car license plate extracting and recognition, some of the related work is as follows. Lotufo et. al [2] proposed automatic number-plate recognition using optical character recognition techniques. Johnson and Bird [3] proposed knowledge-guided boundary following and template matching for automatic vehicle identification. Fahmy [4] proposed bidirectional associative memories (BAM) neural network for number plate reading. It's appropriate for small numbers of patterns. Nijhuis et. al [5] proposed fuzzy logic and neural networks for car LPR. This method used fuzzy logic for segmentation and discrete-time cellular neural networks (DTCNN'S) for feature extraction. Choi [6] and Kim [7] proposed the method based on vertical edge using Hough transform (HT) for extracting the license plate. E.R.Lee et. al [8] used neural network for color extraction and a template matching to recognize characters. S.K. Kim [9] used a genetic algorithm based segmentation to extract the plate region. Tavsanoglu et. al [10] proposed an approach to form orientation map as recognition feature using a Gabor filter for recognizing characters. Yoshimura et. al [11] used Gabor jets projection to form a feature vector for recognizing low resolution gray-scale character. Hontani et. al. [12] proposed a method for extracting characters without prior knowledge of their position and size in the image. Park et. al. [13] devised a method to extract Korean license plate depending on the color of the plate. H.J. Kim et. al [14] proposed a method of extracting plate region based on colour image segmentation. In this study, the proposed approach is based on extraction of plate region, segmentation of plate characters and recognition of characters.

2. Proposed Scheme

Camera can also focus on the face of the driver and save it for security reason. There are difficulties for vehicle license plate recognition in which it will affect the efficiency and accuracy of the system. It is essential and important to determine the facts which will be able to influence the operations and recognition proficiency. Next, we also need to look into other facts of variables that are not constant. Below are the non-constant variables which will affect the accuracy of recognition: speed of the vehicle,

weather condition, type of vehicle, distance between vehicle license plate and the camera, type of plate (rectangular, bent type), vehicle license plate orientation and type of vehicle font character. The proposed method is outline below in Fig. 1:

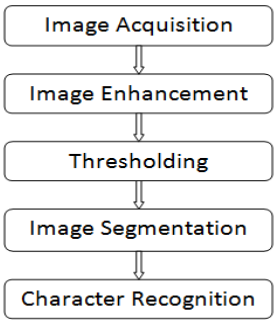

Figure 1: Steps used in vehicle license plate recognition system.

2.1 Image Acquisition

The initial phase of VLPR is to obtain images of vehicles. Electronic devices such as optical (digital/video) camera, webcam etc can be used to capture the acquired images. The images will be stored as color JPEG format on the camera. Image cropping is a recognition process whereby it will extract the smallest rectangle which contains the edge of the license plate and license plate itself.

Figure 2: cropping of number plate from captured image

Color Image Processing

The RGB image is made of color pixels of an M x N x 3 array. The color space is normally graphically shown as RGB color cube. The cube vertex consists of the primary color (red, green and blue) and the secondary color (cyan, magenta and yellow).

Conversion of RGB images to binary images

The image obtain is converted to binary image. Binary image is an image which quantized into two values representing 0 and 1 or in pixel values of 0 and 255 representing the color black and white. It is useful as the information we need, can be obtained from the silhouette of the object. The application is text interpreting and identifies the object orientations. Binary images are obtained by converting the input image into grayscale format, then by converting the grayscale image to binary image by thresholding. The image is made up of a matrix squares which is called pixel. Each pixel in the image has a brightness value which is known as gray level. The pixel of gray level above the threshold will be set to 1 (equal to 255; white) and the rest will be set to 0 (black). We will obtain white object with black background or vice versa.

2.2 Image Enhancement

The aim of this process is to increase and improve the visibility of the image. The process can fall into two categories: histogram processing and spatial domain.

Histogram Processing

The Histogram image equalization is the process whereby the preceding transformation will generate an image that will show a histogram at each intensity level. The net result of the process will yield an image with an increased sparse range of intensity and higher contrast compare to the original image. Histogram matching is very similar to histogram equalization but it need to specify the histogram shape in which it is able to highlight the given image gray level range.

Imcomplement

Imcomplement will compute the complement image (IM). IM can intensity, binary or true color image. For the complement binary image, black will becomes white and white will become black; zeros will become ones or ones will become zeros.

2.3 Thresholding

The gray-level simplest thresholding is used here. The regions of the images are classified by the reflectivity and absorption of light on its surface. The value of threshold (T) is being selected and compare with the pixel of the image. It also transforms the input image (K) into an output binary image (F) which is being segmented.

$$F(x,y) = 1 \; if \; K(x,y) >= T;$$
$$= 0 \; if \; K(x,y) < T$$

Representing $F(x,y) = 1$ for image object; $F(x,y) = 0$ for background of the object and T= threshold.

2.4 Image Segmentation

Image segmentation plays an important and critical step that lead to the analysis of the processed image data. In order to extract and analyzed the object characteristic, the process need to partition the image into different parts that will have a strong correlation with the objects. Segmentation process can be categorized into several parts. Firstly is the global knowledge of an image. The feature of the image is represented by a histogram. Secondly is the boundary-based segmentation. The process uses the edge detection to obtain the region contours and the objects will construct from the obtain contours. Lastly will be the edge-based segmentation.

Feature extraction from digital image

The digital image description is depends on the external and internal representation. The color or texture of the image is basically the internal representation whereas the external representation is based on the characteristic of the shapes. The descriptor vector includes the characteristics as the number of lines, vertical or diagonal edges etc. The process of the feature extraction is to transform the bitmap data into a form of descriptor in which more suitable for computer.

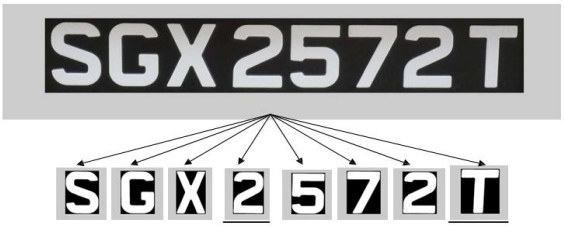

Figure 3: Image segmentation of number plate

2.5 Character Recognition

Normalization

In this phase, the extracted characters are resized to fit the characters into a window. For the project, each character is normalized to the size of (50x30) binary image and then followed by reshape to standard dimension before sending the data set to neural network for training. It is very important to expand the training database size for neural network. By increasing the database size, the efficiency and accuracy for the network will be improved. Multilayer perceptrons are used for character recognition.

Training Modes

The learning results from the multiple presentation of the training set to the network. "Epoch" is the complete training set during the whole process of learning. The learning process will still be in progress unless an error signal hit the predestined minimum value. Thus, we need to shuffle the order of the presentation of the training examples between epochs. There are two type of back propagation learning for the given training set and these are the "sequential mode" referred as online, pattern mode and the weights will be updated after the training example and the "batch mode" referred to weights will update after the training is presented to the network.

Pattern Recognition

It is the process whereby the input data is assigned to a prescribed number of classes. The neural network will perform the pattern recognition by going through a training session. The neural network will present the input data with the category in which the patterns belong to. Later, a new set of patterns will be present to network which has not seen before but still belong to the same population of pattern which is used to train the network. With the information which has been extracted from the training data, the neural network is still able to classify the class of the particular pattern.

3. Results

Database used is shown in fig. 4. It is a collection of information or data which it is being orderly organize, thus it can be accessed easily and updated. Database can be in the form of text, contents and images. Database is needed to make sure that the image space can contained enough characters which have been extracted and the vehicle license plated number stored in the excel sheet for the purpose of comparison.

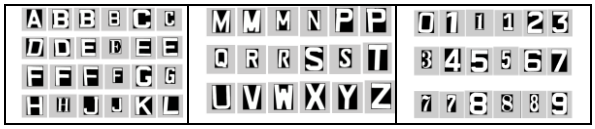

Figure 4: Character design of alphanumeric database

Experiments were performed on ten different samples of number plates having different numbers. Two different approaches were used, one with single hidden layer and another with two hidden layer. Rest of all the parameters is kept same. We obtained 96.53% average recognition rate using double hidden layer and 94% using single hidden layer. For both experiments with one and two hidden layers, it is evident that the error is reduced when two hidden layers are used in the network. In other words, we can say that with the increase in the number of hidden layers, there is an increase in probability of converging to the network before the number of training epochs reaches it maximum allowed count. The results of the learning process of the network in terms of the number of training iterations, small number of epochs are sufficient to train a network when we use one hidden layer. As the number of hidden layers is made two, the number of epochs required to train the network also increases. The individual digits are determine by the angle of the vehicle license plate as shown in fig. 5.

Figure 5: Recognition: SGX2572T

Obtaining the input digit at the precedent step, the input digit will be compared to the images stored in the database. After interpolation, approximation algorithm, the system will produced an output to the closest digit stored in the database in which it was entered. Neural network is a function from vector to vector. The success rate of the system is evaluated by the identification of the license plate and each of the individual characters. Graphical User Interface (GUI) is used for simplicity. By clicking on the "Load Image" icon vehicle image stored from the specific folder as shown in Fig. 6(a). The vehicle image will appear in the "Original image box" as shown in Fig. 6(b). Click on the "Select ROI" to perform the manual cropping of the vehicle license plate. The cropped image will be transfer to the car plate region as shown in Fig. 6(c). Click on the "recognition" icon, it will do a check with the database for this crop image and comparison will be done. The feedback of the result will be position under the "recognition". This is shown in Fig. 6(d).

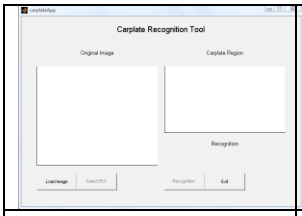

Fig. 6(a)

Fig. 6(b)

Fig. 6(c)

Fig. 6(d)

4. Conclusions

The proposed method for the vehicle number plate recognition using the back propagation approach, showed the remarkable enhancement in the performance when two hidden layers were used. The recognition accuracy is best in experiments where MLP with two hidden layers was used. Number of hidden layers is proportional to the number of epochs. This means that as the number of hidden layers is increased; the training process of the network slows down because of the increase in the number of epochs. If the accuracy of the results is a critical factor for an vehicle number plate recognition application, then the network having many hidden layers should be used but if training time is a critical factor then the network having single hidden layer should be used. The proposed approach could be used with conjunction with other ones for better security and increasing the area of the particular application.

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