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Vehicle License Plate Recognition Using Edge Detection and Neural Network

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Abstract: ***Vehicle License Plate Identification and Recognition (VLPIR) uses image processing and character recognition technology in order to identify the license plate number automatically. VLPIR system are used for the purpose of effective traffic control, security applications such as access control to restricted areas and tracking of car, tracing of stolen cars, identification of dangerous and reckless drivers on the road. The objective of this work is to develop an algorithm for Vehicle License Plate identification and Recognition (VLPIR) of Nigeria License Plates. Standard Nigeria plate numbers consists of different colors such as the background colour (white), background image (Nigerian Map in green colour) and the number colour (red or blue). The system are divided into three, vehicle license plate extraction, character segmentation and character recognition, since the rows that contain the number plates are expected to exhibit many sharp variations. Hence, edge detection technique is used to find the location of the plate, vertical and horizontal projection is exploited to perform the character segmentation to ease and improve recognition rate. Median filter is used to remove noise, enhancement of the image to increase readability of the plate number. Neural network is used to recognize the vehicle license plate character.***

Keywords: Image processing, License plate localization and recognition, Plate numbers, neural network

1. Introduction

It is clear that all over the nation it is forbidden and is an offence for two vehicles to have the same license plate number, vehicle are identified by their license plate. Vehicle license plate identification is an image processing technique to identify vehicles by their unique license plates. Vehicle license plate identification and recognition (VLPIR) system are used for the purpose of effective traffic control, security applications such as access control to restricted areas and tracking of cars, tracing of stolen cars, identification of dangerous and reckless drivers on the road [2].Vehicle License Plate Identification and Recognition systems are very popular and studied all over the world. It has been categorized in three main steps; first step is License Plate identification: Using vertical edge detection technique and extraction method, scans possible regions detected by edge information, and obtains license plate region. Second step is character segmentation which will be achieved by vertical and horizontal projection. Third step is Character Recognition: the numbers and the letters will be classified by using two separate ANN for increasing the success rate of the recognition step. The character recognition will be done by Neural Network [3].Low quality camera, motion blur, poor lighting and low contrast due to over exposure, reflection or shadows, dirt on the plate, poor image resolution are some problem affecting vehicle license plate recognition. Image enhancement technique is very crucial based on filters to remove noise and unwanted effects of the light in order to obtain clear and readable images.

Generally, a license plate Identification and recognition (LPIR) system is made up of five parts; Image acquisition, pre-processing of image, plate extraction, character segmentationandcharacterrecognitionFig.1

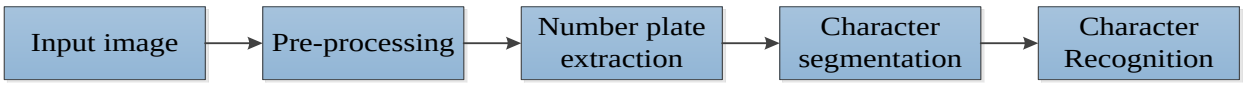

Figure 1: License plate recognition system

In Nigeria the attributes of the vehicle license plates are strictly maintained. For example, the size of the plate, color of the plate, font face/ size/ color of each character, spacing between subsequent characters, the number of lines in the license plate, script etc. are maintained very specifically. Some of the images of standard vehicle license plates, used in Nigeria, are shown in Fig2.

Figure 2: Standard vehicle plate used in Nigeria.

2. Related Work

Several works have been done concerning vehicle license plate identification and recognition system. For example, Daramola *et. al.*, [1] developed an Automatic Vehicle Identification System (AVIS). The proposed system was divided into three major modules; they are vehicle image preprocessing, license plate feature extraction and classification algorithm based on Hidden Markov Model (HMM). Experiment was conducted to demonstrate the effectiveness of the proposed system. The proposed system was tested using English vehicle license plates. On the other hand, Sarfraz, M. et al [5] utilized vertical edge detection and filtering which is then followed by vertical edge matching in the localization of Saudi Arabian license plates. As it is horizontal lines than vertical lines, this approach reduces computation time by detecting only vertical lines. In the case of support vector machines (SVM) based approaches, Kumar, P. [4] has improved SVM based approaches by modifying the conventional approach to yield a recognition rate result on complex images by applying Multi-class SVMs. Hasen et. al. [7] discusses a statistical pattern recognition approach for recognition but their technique found to be inefficient. This approach is based on the probabilistic model and uses statistical pattern recognition approach.

Sekan et. al., [6] studied Automatic Vehicle Identification (AVI) by plate recognition and submitted that Automatic Vehicle Identification (AVI) has many applications in traffic systems (highway electronic toll collection, red light violation enforcement, border and customs checkpoints, etc.). License Plate Recognition is an effective and efficient form of AVI systems. Simple algorithm was presented for vehicle's license plate recognition system. The author proposed algorithm consists of three major parts: first part is Extraction of plate region, second part is segmentation of characters and third part is recognition of plate characters. For extracting the plate region, edge detection algorithms and smearing algorithms were used. In segmentation part, smearing algorithms, filtering and some morphological algorithms were used. And finally statistical based template matching was used for recognition of plate characters.

3. Research Methodology

The proposed system is developed to recognize the vehicle license plate from the vehicle image. The input to the system is the image of the vehicle acquired by a digital camera and the output of the system is the identification and recognition of the extracted license plate. The implementation of the program is developed on MATLAB 7.11.

The following are the methods used during implementation of the system.

- Image acquisition
- Pre-processing
- Plate extraction
- Character segmentation
- Character recognition

3.1 Image Acquisition

A digital camera is used to capture vehicle plate numbers that will be used as input to the proposed recognition system. The image was captured during the day and in the night.

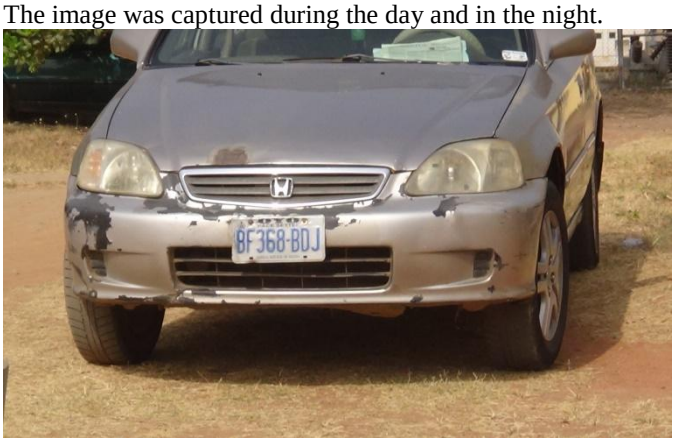

Figure 3: Original image

3.2 Pre- Processing

The captured image consists of many colors and the image is first processed to improve the quality and prepares it to next phases of the system. Since the vehicle image has different colors the system will convert the RGB images to grayscale images using NTSC standard method.
Gray=0.299*Red+0.587*Green+0.114*Blue

Subsequently, the gray image is filtered using median filter in order to remove the noise, while preserving the sharpness of the image. The filter used is a non-linear filter where it replaces each pixel with a value obtained by computing the median of values of pixels.

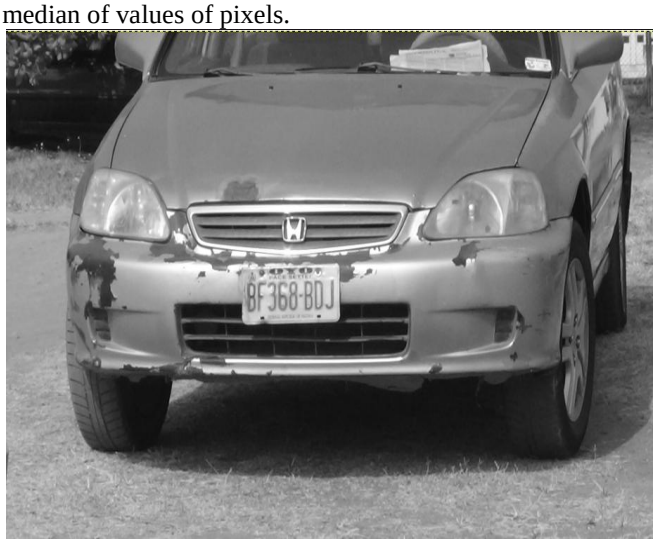

Figure 4: Gray scale image

2.3 Plate Extraction

The plate extraction phase is the third part and one of the most important phases of the recognition system. Each phase performs a process of localization on the gray scaled image to eliminate the pixels which does not belong to the license plate region. For illustration the horizontal localization phase is responsible for identifying the horizontal segments that contain the number plate. In the same way vertical localization phase is responsible for locating the vertical segments of the number plate. Let us consider that we are

taking into consideration of Nigeria number plates.

Three types of plates are available

- Blue characters on white background
- Red characters on white background
- Green character on white background

In this paper Sobel operators is used to find the edged image as shown in figure 5. The sobel command performs a 2 dimensional spatial gradient measurement on an image. Normally sobel operator is used to find the approximate absolute gradient magnitude at each point in an input image which is the gray scale image. The actual sobel masks are shown in fig 5. If we define A as the grayscale source image, and G*x* and G_y are two images which a teach point contain the horizontal and vertical derivative approximations, the computations are shown in equations (1) and (2) for horizontal and vertical gradient window, respectively.

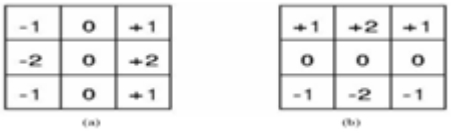

Figure 5: Sobel masks for edge detection (a) vertical (b) horizontal

$$G_x = \begin{pmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} * A \quad (1)$$

$$G_y = \begin{pmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{pmatrix} * A \quad (2)$$

Then the magnitude of the gradient is calculated using the equation (3) below.

$$|G| = \sqrt{Gx^2 + Gy^2} \quad (3)$$

An approximate magnitude can be calculated using equation (4)

$$|G| = |G_x| + |G_y| \quad (4)$$

If A is denoted as pixel values as in equation (3) then the gradient value is shown in equation (4)

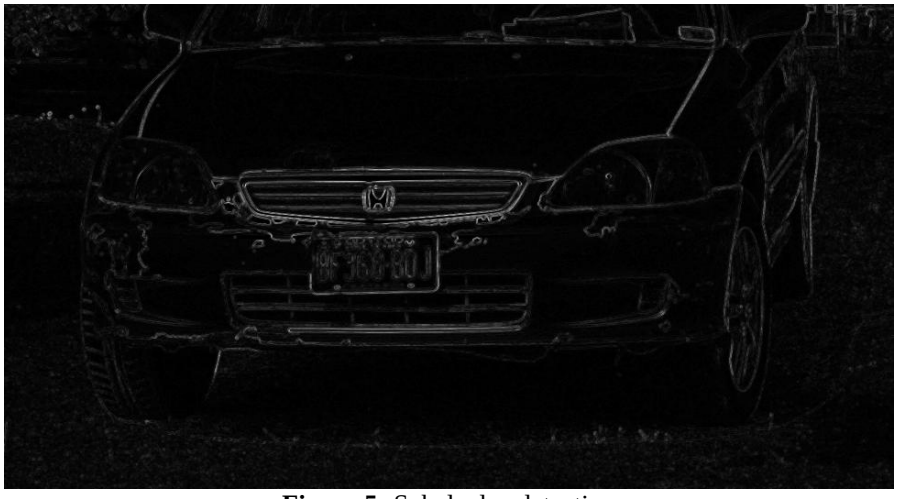

Figure 5: Sobel edge detection

2.4 Character Segmentation

This is one of the stages that need attention in VLPIR system. This stage is to recognize the isolated characters and dividing the extracted license plate into individual character images, the character in each Number Plate can be identified clearly. The license plate segmentation process consists of three phases such as, character region enhancement, and noise removal and projection analysis.

2.5 Character Recognition

This stage involves recognizing the character images that have been extracted from the license plate image. There are many methods involved in character recognition but Artificial Neural Network (ANN) was used to recognize the characters on the plate image. In this research work**,** the numbers and the letters will be classified by using two separate ANN for increasing the success rate of the recognition stage. Both of them will have same architecture but only the input numbers will be different. The reason for using two separate ANN for recognition is preventing the complexity of recognition of similar numbers and letters such as"0"–"O","2"–"Z"and"8"–"B". Letters in Nigeria license plates are usually in capital letters, this complexity will decrease the recognition success.

In the proposed approach, a Multi Layered Perceptron (MLP) ANN model is used for classification of the characters. The processing units in MLP are arranged in three layers. These are input layer, hidden layer and output layer. Each neuron in the input layer is fed directly to the hidden layer neurons via a series of weights. The sum of the products of the weights and the inputs is calculated in each node. The calculated values are fed directly to the output layer neurons via a series of weights. As in hidden layer, the sum of the products of the weights and the hidden layer neuron outputs is calculated in each node in the output layer. If the error between calculated output value and the desired value is more than the error ratio, then the training (changing the weights and calculating the new output by using the new weights) process begins. This training process will come to an end by obtaining the desired error rate for all input combinations.

Training

In training the ANN, feed-forward back-propagation algorithm was used. For measuring the training performance of the network, Mean Square Error (MSE) function is used. The value of the MSE is used to determine how well the network output fits the desired output. The stop criteria for supervised training are usually based on MSE. Most often the training will be set to terminate when the MSE drops to some threshold. Approaching the MSE value to the zero means that the calculated output value is becoming closer to the desired output value.

4. Experimental Results

Experiments have been performed to test the proposed system and to measure the accuracy of the system. The system is designed in Matlab.7.11 for recognition of Nigerian vehicle license plates. The images for the input to the system are captured colored images. The test images were taken under various illumination conditions. The results of the tests are given by Table I.

Table 1: Results of the Tests

Unit of VLPR SYSYEM	*Number of Accuracy*	*Percentage of Accuracy*
Extraction of VLP	194 / 200	97%
Segmentation	192 / 200	96%
Recognition of Character	197 / 200	98%

It is shown from Table I above that accuracy for the extraction of vehicle License Plate region is 97%, 96% for the character segmentation and 98% is the percentage of accuracy of the recognition stage. The overall system performance can be defined as the product of all units accuracy rates (Extraction of vehicle license plate region, segmentation of characters and recognition of characters). Recognition Rate of VLPR System =Π(Percentages of Accuracy)

5. Conclusions

This present work introduced an effective method for identification and recognition of VLP. The technique is tested with 200 image samples and gives satisfactory performance. The applied algorithm was tested with static images in MATLAB. For extraction of VLP from the entire image sobel edge detection technique is used on gray image, binarization and morphological operation is also applied to locate the VLP area. Connected component analysis is used to remove noise and projection analysis is exploited to segment the extracted VLP. Neural network approach is used for character recognition.

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References

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