



Automatic Bangladeshi Vehicle Number Plate Recognition System using Neural Network

Mohammad Badrul Alam Miah, Sharmin Akter and Chitra Bonik

Department of Information and Communication Technology (ICT)

Mawlana Bhashani Science and Technology University (MBSTU), Santosh, Tangail-1902, Bangladesh

Abstract: Now-a-days the necessity of traffic control is increasing day by day, because the number of vehicles in traffic system is increasing. To overcome this problem, computer based automatic traffic control systems are being developed. One of these systems is automatic vehicle number plate recognition system. This paper describes the Smart Vehicle Number Plate Recognition System from a photograph of Bangladeshi vehicle. This system defines image analytics as computer-vision-based surveillance algorithms and systems to extract contextual information from image. Here full-featured automatic system for Bangladeshi vehicle detection, tracking and license plate recognition is presented. This system has many applications in pattern recognition and machine vision and they ranges from complex security systems to common areas. This system has complex characteristics due to diverse effects as fog, rain, shadows, uneven illumination conditions, occlusion, number of vehicles in the scene and others. The main objective of this work is to show a system that solves the practical problem of car identification for real scenes. All steps of the process, from image acquisition to optical character recognition are considered to achieve an automatic identification of plates.

Keywords: Number plate recognition; Artificial intelligence; Neural network; Image Processing; Automatic recognition System

I. Introduction

An automatic vehicle number plate recognition system plays an important role in a modern traffic system. It can be used in Bangladesh for many applications for example, traffic security, road traffic control, parking control, airport or harbor cargo control, speed control and so on.

License Plate Recognition consists of three main phases:

1. License Plate Detection/Extraction
2. Character Segmentation and
3. Character Recognition.

In this paper, still photo of vehicles are used as input. In the first step image enhancement is performed using Contrast stretching. Then the next step Sobel Operator is used for edge detection [2]. After edge detection series of morphological operations are performed in order to detect the license plate. The character segmentation is done using line scanning technique, scanning is done from left to right of the plate [3]. After Character Segmentation, feature extraction is performed to obtain the unique features of every character. Neural network techniques used for character recognition.

II. Related Work

In this system we recognize the number plate of a car using neural network. [1] Proposed "Vehicle License Plate Character Segmentation – A Study" here projection based method and binarization is used for character segmentation. [2] Proposed "Towards License Plate Recognition: Comparing Moving Objects Detection Approaches" that used Background Subtraction for objects [3] proposed "A hybrid method for robust car plate character recognition". [4] Proposed "Automatic Vehicle Detection, Tracking and Recognition of License Plate in Real Time Videos" that used Sobel edge detection. [5] Proposed "Real-Time License Plate Recognition and Speed Estimation from Video Sequences" that used for recognize license plate. [6] Proposed "Design and Implementation of Car Plate Recognition System for Ethiopian Car Plates," cut image of the pre- treatment.

III. Design and Implementation

A Number Plate Recognition process consists of two main stages: 1) locating number plates and 2) identifying license numbers. In the first stage, license plate candidates are determined based on the features of license plates. Features commonly employed have been derived from the license plate format and the alphanumeric characters constituting license numbers.

A. System Architecture

In this paper, we proposed an automatic vehicle license plate recognition system which based on artificial neural networks. This system consists of three main topics. These are localizing the plate region from the car

image, segmenting the characters from the license plate image and recognizing the segmented characters. The block scheme of the proposed automatic vehicle license plate recognition system is shown in Fig. 1.

B. Plate Detection

The most difficult task is to identify the license plate, which could be at anywhere in the input image. This task becomes more challenging if the illumination of the image varies from one plate to another. The plate region consists of white background and black characters normally. In this region the black and whites color is very intensive. The captured image is converted into digital form using an image collection card. This image is then converted into a gray scale image the next step is image pre-processing. Finding the region that includes most transition points would be adequate for localizing the plate region. For identification plate region Sobel edge detection operator is applied to the vehicle images to get the transition points [1]. The Sobel edge detector uses a filter based on the first derivative of a Gaussian smoothing. After smoothing the image and eliminating the noise, the next step is to find the edge strength by taking the gradient of the image.

Let us assume the image of a vehicle is represented by a function $f(x, y)$, where $x_0 \leq x \leq x_1$ and $y_0 \leq y \leq y_1$. The upper left and the lower left corner of the image is represented by $[x_0, y_0]$ and $[x_1, y_1]$ respectively. If w and h are dimensions of the image, then $x_0=0$, $y_0=0$, $x_1=w-1$ and $y_1=h-1$.

Band: The band b in the snapshot f is an arbitrary rectangle $b = (x_{b0}, y_{b0}, x_{b1}, y_{b1})$ such as $(x_{b0}=x_{\min}) \wedge (x_{b1}=x_{\max}) \wedge (y_{\min} \leq y_{b0} \leq y_{b1} \leq y_{\max})$

Plate: The plate p in the band b is an arbitrary rectangle such as $p = (x_{p0}, y_{p0}, x_{p1}, y_{p1})$, $(x_{b0} \leq x_{p0} \leq x_{p1} \leq x_{b1}) \wedge (y_{p0} = y_{b0}) \wedge (x_{p1} = y_{b1})$.

C. Character Segmentation

The characters of the detected number plate can be segmented by detecting spaces in its horizontal projection. We often apply the adaptive thresholding filter to enhance an area of the plate before segmentation. The adaptive thresholding is used to separate dark foreground from light background with non-uniform illumination. After the thresholding, we compute a horizontal projection $p_x(x)$ of the plate $f(x, y)$ [4]. We use this projection to determine horizontal boundaries between segmented characters.

The principle of the algorithm can be illustrated by the following steps:

Determine the index of the maximum value of horizontal projection:

$$x_m = \arg \max_{0 \leq x \leq w} \{p_x(x)\}$$

Detect the left and right foot of the peak as:

$$x_l = \max_{0 \leq x \leq x_m} \{x | p_x(x) \leq c_x \cdot p_x(x_m)\};$$

$$x_r = \min_{x_m \leq x \leq w} \{x | p_x(x) \leq c_x \cdot p_x(x_m)\}$$

Zeroize the horizontal projection $p_x(x)$ on interval (x_l, x_r)

If $p_x(x_m) < c_w \cdot v_w$, go to step 7.

Divide the plate horizontally in the point x_m

Go to step 1.

End

D. Feature Extraction

The description of an image region is based on its *internal* and *external* representation. The internal representation of an image is based on its regional properties, such as color or texture. The external representation is chosen when the primary focus is on shape characteristics. The description of normalized characters is based on its external characteristics because we deal only with properties such as character shape. The simplest way to extract descriptors from a bitmap image is to assign a brightness of each pixel with a corresponding value in the vector of descriptors. Then, the length of such vector is equal to a square ($w \cdot h$) of the transformed bitmap:

$$x_i = f\left(\left\lfloor \frac{i}{w} \right\rfloor, \text{mod}_w(i)\right) \quad \text{Where, } i = 0 \dots w \cdot h - 1$$

Figure 1: The block diagram of automatic vehicle license plate recognition system.

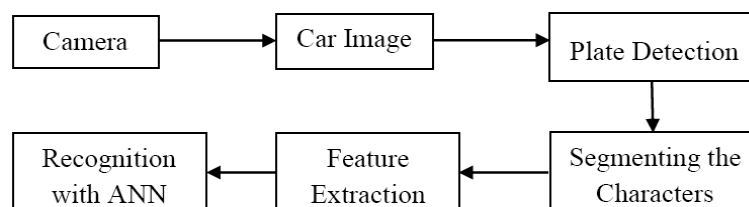
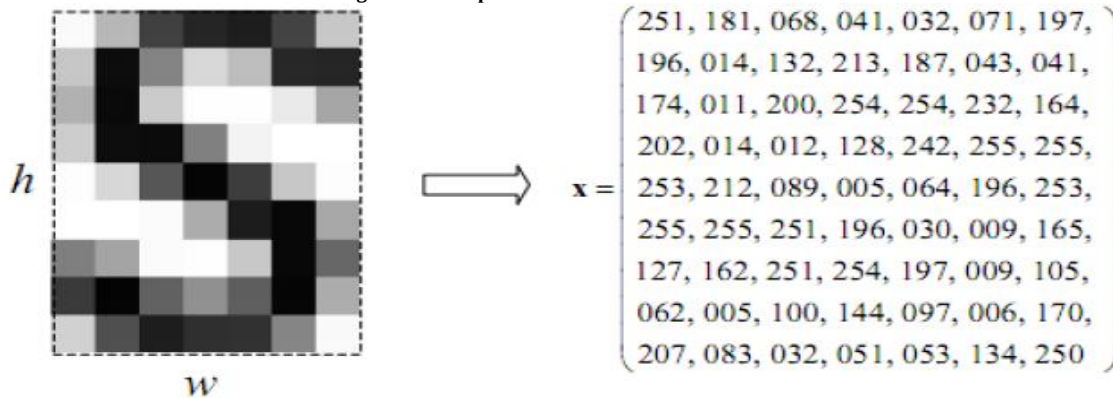


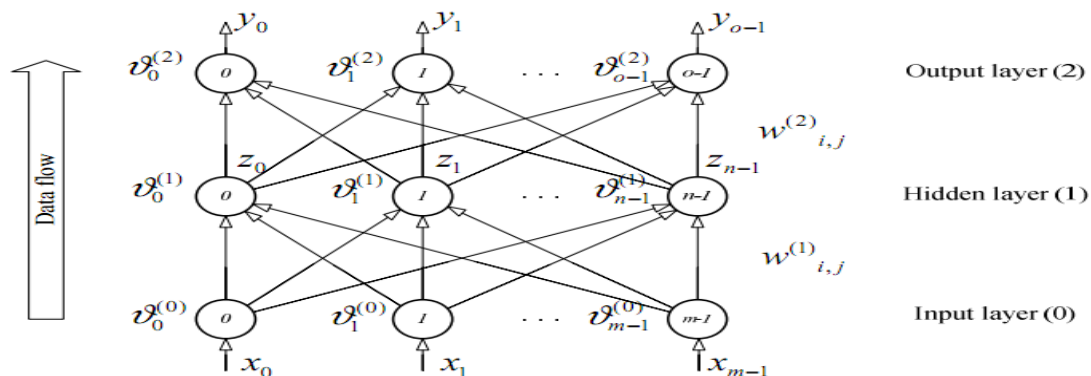
Figure 2: The “pixel matrix” feature extraction method



E. Character Recognition

The neural network is defined as an oriented graph $G = (N, E)$, where N is a non-empty set of neurons and E is a set of oriented connections between neurons. The connection $e(n, n') \in E$ is a binary relation between two neurons n and n' . The set of all neurons N is composed as: $N = N_0 \cup N_1 \cup N_2$. The number of neurons in the input layer (m) is equal to a length of an input pattern x in order that each value of the pattern is dedicated to one neuron. Neurons in the input layer do not perform any computation function, but they only distribute values of an input pattern to neurons in the hidden layer. The number of neurons in the hidden layer (n) is scalable, but it affects the recognition abilities of a neural network at a whole. Too few neurons in the hidden layer causes that the neural network would not be able to learn new patterns. Too many neurons cause network to be over learned, so it will not be able to generalize unknown patterns as well.

Figure 3: Architecture of the three layer feed-forward neural network.



IV. Experimental Results

Two groups of images have been collected for our experiments. The first contains 238 images (640 by 480 pixels) taken from 71 cars of different classes. For each car, nine images were acquired from fixed viewpoints. The experimental results with the first group of images are summarized in Table I. In this table columns correspond to viewpoints, rows to the classes of vehicle (or the types of license plate), and the entries are the number of correctly located license plates. The percent of correctly located license plates (the success rate) is given in the bottom row of the table. The success rates for viewpoint (i.e. straight on) are 100%, independent of the type of license plate and viewing distance. In the worst case, viewpoints the success rates are 94.2%, 92.6%, and 91.8%, respectively.

A. Learning and Training Procedure

This system has been learned by several sets of learning images of digits from “0” to “9” and alphabets from “A” to “Z” of various fonts and formats to make the system more reliable. The following images show such a set of learning images:

Figure 4 Learning images.



While learning, these images are converted into normalized images. These normalized images are used for testing purpose.

B. Testing Procedure

In this system, the learning images generate an .xml file which is used to recognize the characters of a number plate from a car image. How the system recognizes characters from an image that is shown in Fig. 5 followed by the original foreign-language citation [8].

Sometimes a problem occurs in the identification module because of the fact that the module recognizes characters based on their contours and that contours preserve only partial information about object shapes.

C. Performance Analysis

The automatic Bangladeshi vehicle number plate recognition system results in an accuracy rate of 91.47% on an average for images captured from different viewpoints. The performance decreases for unclear, blur and very distant vehicle images. Due to weather, the performance also fluctuates. In rainy and foggy weather the system cannot detect and recognize the characters correctly. It works best with images from sunny weather. Due to identification module problem sometimes the system makes misidentification between characters “I” and “1”, “O” and “0” etc.

Figure 5 (a) 2-layer number plate clipping (b) Recognized characters from the plates.

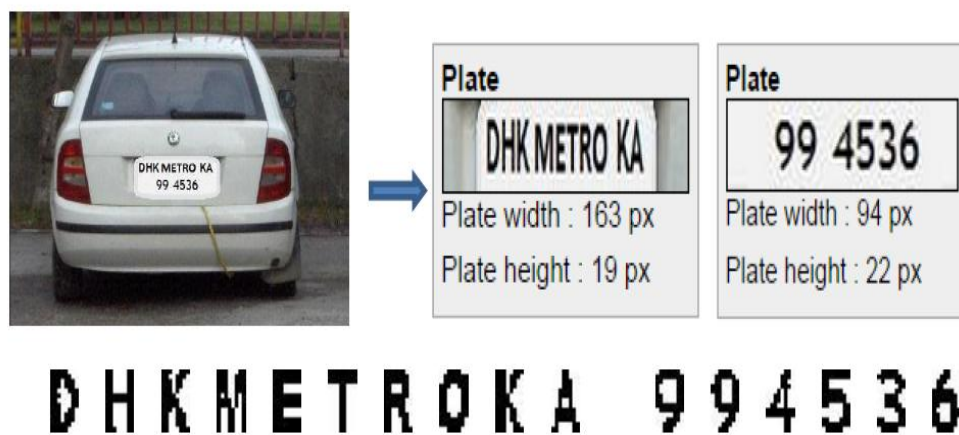


Table I Experimental results.

viewpoint	A1	A2	A3	B1	B2	B3	C1	C2	C3
Vehicle class									
Private automobile	10	13	15	18	10	10	17	14	15
Bus	17	7	5	8	14	17	15	5	7
Truck	10	14	12	6	18	7	8	8	16
Vans	13	10	16	14	18	5	8	10	9
Success rate (%)	85.2	87.4	82.7	93.1	97.8	83.5	97.2	96.9	95.8
Average success rate (%): 91.47%									

V. Limiations and Future Work

In this study, there are some limitations. At first those should be removed. Adding the normalization step can improve the performance of license number identification. The aim of this study is to focus on night surveillance and to improve the existing algorithms reported in literature. However, the other segments of this system should be improved, focusing on the occlusion handling, vehicle matching procedure and also focus on improving the accuracy measure for character recognition by using the concept of neural network for recognizing all font type of a character by using back propagation algorithm. The ultimate target of this study is to work for Bengali characters.

VI. Conclusions

In this paper, Automatic Bangladeshi vehicle number plate recognition system is developed. Here used problematic of machine vision, pattern recognition, OCR and neural networks for plate recognition system. We can improve quality of the vehicle image using Java, then extract the license plate and isolate characters contained on the plate, and finally identify the characters on the license plate using artificial neural network. This work also contains demonstration AVNPR software, which comparatively demonstrates all described algorithms. Even though there is a strong succession of algorithms applied during the recognition process.

VI. References

- [1] V. Karthikeyan, R. Sindhu, K. Anusha and D. S. Vijith, "Vehicle License Plate Character Segmentation – A Study", International Journal of Computer and Electronics Research, vol. 2, Issue 1, February 2013.
- [2] V. J. Oliveira-Neto and G. Cámara-Chávez and D. Menotti, "Towards License Plate Recognition: Comparing Moving Objects Detection Approaches", Computing Department, Federal University of Ouro Preto, Minas Gerais, Brazil, 2013.
- [3] X. Pan, X. Ye, and S. Zhang, "A hybrid method for robust car plate character recognition", Engineering Applications of Artificial Intelligence, vol. 18, no.8, 2005, pp. 963–972.
- [4] Lucky Kodwani, "Automatic Vehicle Detection, Tracking and Recognition of License Plate in Real Time Videos", Communication and Signal Processing, 2012-2013.
- [5] Mayank Garg and Sahil Goel, "Real-Time License Plate Recognition and Speed Estimation from Video Sequences", ITSI Transactions on Electrical and Electronics Engineering (ITSI-TEEE), vol. 1, Issue 5, 2013.
- [6] Huda Zuber Ahmed, "Design and Implementation of Car Plate Recognition System for Ethiopian Car Plates", Addis Ababa Ethiopia, November, 2011.
- [7] H. Erdinc Kocer, "Artificial neural networks based vehicle license plate recognition", Procedia Computer Science, vol. 3, 2011, pp. 1033–1037.
- [8] Anuja P. Nagare, "License Plate Character Recognition System using Neural Network", International Journal of Computer Applications, vol. 25, No.10, July 2011.
- [9] Ondrej Martinsky, "Algorithmic and mathematical principles of automatic number plate recognition systems", Brno university of technology, 2007.

VII. Acknowledgments

The authors are grateful who participated in this research.