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Automatic License Plate Recognition (ALPR) for Bangladeshi Vehicles

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Automatic License Plate Recognition (ALPR) for Bangladeshi Vehicles

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Abstract - This paper presents Automatic License Plate extraction, character segmentation and recognition method for license plate of Bangladeshi vehicles with chain code and neural network. In Bangladesh, license plate models are not followed strictly. Characters on plate are in Bangla and English languages and also are in one or two lines. Due to dissimilarity in the model of license plates, vehicle license plate extraction, character segmentation and recognition are key issue. Different types of algorithm already applied and the performance is examined for English license plate. We describe the license plate extraction, character segmentation and recognition work, with Bangla characters. License plate extraction is performed using Sobel filter, connected component analysis and morphological operations. Character segmentation is performed in different levels by using scanning the binary image horizontally and vertically and connected component analysis. Character recognition is carried out using chain code generation and stored knowledge of the network.

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I. Introduction

Automatic License Plate Recognition (ALPR) is an important area of research due to its applications. It is a machine vision technique used to identify vehicles by their license plates without direct human involvement. The Intelligent Transportation System provides the data of vehicle information which can be used in follow up, analysis and monitoring. The complexity of automatic license plate recognition work varies throughout the world. For the standard license plate, ALPR system is easier to read and recognize. In Bangladesh this task becomes much difficult due to variation in plate model and specialties of Bangla scripts.

Bangla text can be partitioned into three zones. The upper zone indicate the portion above the headline called 'Marta', the middle zone indicate the portion of basic characters and compound characters under the head-line and lower zone is the portion where some of the modifiers can exist in .The ALPR algorithm consists of three steps: license plate locating as well as true license plate extraction, character segmentation and character recognition. From the input image, the license plate detection, noise removal, invert and skew detection is performed from license plate in license plate extraction phase. In character segmentation phase each and every character is isolated and segmented accordingly followings step line segmentation, word segmentation and character segmentation, based on the selection of good features of characters, each character is recognized using neural network, in the character recognition phase. Extraction of license plate is difficult job; mainly due to license plate occupy a small part of whole image, difference in license plate models and cause of environmental factors. This step affects the accuracy of character segmentation and recognition work.

The rest of this paper is prepared as follows segment II shortly illustrates the applications of the ALPR system in different areas, Segment III described related works, Segment IV described true license plate extraction process, Segment V includes steps of the character segmentation and Segment VI includes steps character recognition process. Segment VII discusses its experimental results and lastly Segment VIII concludes the paper.

II. Application

ALPR system is mostly used in Intelligent Transportation System. ALPR is important in the area of highway toll collection, traffic problems, borders and custom security, premises where high security is needed, like national assembly, V.I.P houses and so on.

III. Related Work

Different techniques are developed for license plate extraction. Hao Chen [1] et al planned the method, several candidates based on texture information similar

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to license plate are extracted and auto-correlation based binary image and projection algorithm are used to verify the true candidate plate. Gisu Heo [2] developed license plate detection technique using group of lines forming rectangle at the plate boundary, followed by this step is the vertical edge density technique to find out the plate area. Ozbay et al [3] developed smearing algorithm to locate the license plate. Mei Yu et al [4] proposed vertical edge detection followed by size, shape filter for edge area and edge matching technique based on plate model. Farhad Faradji et al [5] first used Sobel edge detection on the image. Next, vertical projection analysis was used to locate plate area. False candidates were removed using compact factor, which estimated the densest vertical edge area declaring true license plate. Every character on detected license plates is segmented in character segmentation step. Segmentation techniques based on projection analysis, Hough transform, region growing are proposed in the text. Xinagjian He et al [6] used horizontal and vertical projection analysis for character segmentation. Yuangang Zhang et al [7] developed character segmentation using Hough Transform. In this, horizontal edges of the plate area were decided initially, using Hough Transform, which helped to segment the characters with the large rotation. Characters were segmented using vertical projection analysis based on the prior knowledge of the plate model. Feng Yang et al [8] developed region growing algorithm for character segmentation. Shen Zheng Wang et al [9] used connected component analysis for character segmentation.

In this paper ALPR work for Bangladeshi car is presented. Images are taken out with different lighting conditions, different background and direction. Histogram equalization, median filter are used which take care of lighting and contrast problem. Sobel vertical edge detection and morphology is employed to locate the license plate. Horizontal and vertical scanning is used to segment the line, word and characters. For character recognition work chain code and neural network is used.

IV. License Plate Extraction

License plate extraction is the key step in ALPR system, which maintains the accuracy of the system significantly. The goal of this phase, given an input image, is to produce a region that contains true license plate.

a) Image capturing and noise removing

In this system a high resolution digital camera is used to capture an image. Images are taken in different background, illumination conditions and at various distances from the camera to vehicle. Images are resized to (1024 X 768). All the processing steps are executed on gray scale image. Preprocessing is mainly used to enhance the processing speed, improve the contrast of the image and to reduce the noise in the image. Therefore, it is necessary to filter this noise before we process the image. Usually the low-pass filter approach is used to reduce the problem of low quality and low contrast in vehicle images. Original image that captured by digital camera and corresponding gray scale image are showed in Fig. 1(a) and (b).

Fig.1 : (a) Original image (b) Gray scale of image

b) Vertical Edge detection

The license plate region contains plentiful edges with respect to background. Sobel edge detection is used to find out the regions which have high pixel variance value. To extract candidate license plate area from the entire image, threshold is used to select rows which are having particular white pixel density. Fig. 2 shows the result of effect of using, Sobel edge detection and threshold [10].

Fig.2 : (a) Sobel vertical edge detection (b) Effect of threshold

c) Candidate Plate Area Detection

Morphological operations aim to remove unrelated objects in the image. Dilation and erosion are used to extract candidate plate areas from the entire image. Sometimes background areas may also get declared as candidate plate. Hence to remove the fake candidates, plate validation is done using the aspect ratio of the plate and horizontal cuts in the license plate [11]. Invert and threshold operation is performed for true license plate extraction.

Fig.3 : (a) Extracted Candidate plate (b) After Inverting and threshold

d) Skew Detection and Correction

The captured image may be skewed, so skew detection and correction necessary to make text lines

horizontal. Skew angle makes the text lines of the document image with the horizontal direction. Skew correction can be accomplished in two steps. Firstly, we will estimate the skew angle and secondly, we will rotate the image by skew angle.

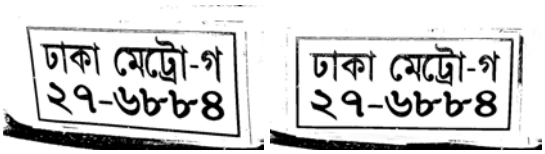

Fig.4 : (a) Skewed image (b) After skew correction

e) True license Plate Extraction

After the detection of candidate license plate area, Bounding Box analysis is used to extract plate area from the image. From the Bounding Box analysis, respective row and column indices of plate area are found out. The result is as shown in Fig. 5.

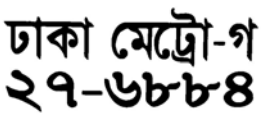

Fig.5 : Extracted true license plate

V. Character Segmentation

Character isolation from the license plate region is very important and crucial step in ALPR system, which influences the accuracy of character recognition significantly. The goal of this phase, given the license plate image, is to segment all the characters, without loosing features of the characters. This phase consists of the sequence of operations as, line segmentation, word segmentation, character segment and connected component analysis.

a) Line segmentation

Line segmentation has been executed by scanning the input image horizontally. Frequency of black pixels in each row is counted in order to construct the row histogram. The position between two consecutive lines, where the number of pixels in a row is zero denotes a boundary between the lines. Line segmentation process shown in figure.

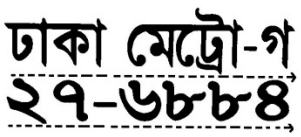

Fig.6 : Line segmentation

b) Word Segmentation

Each line is scanned vertically for word segmentation. Number of black pixels in each column is calculated to construct column histogram. The portion of the line with continuous black pixels is considered to be a word in that line. If no black pixel is found in some vertical scan that is considered as the spacing between words. Thus different words in different lines are separated. So the image file can now be considered as a collection of words. Fig. 7 shows the word segmentation process.

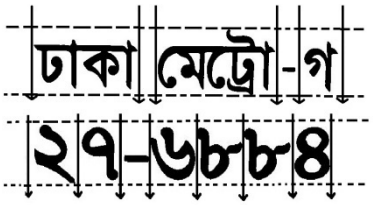

Fig.7 : Word Segmentation

c) Zones of Bangla script

From fig. 8 we see that Bangla text may be partitioned into three zones. The upper zone denotes the portion above the headline, the middle zone covers the portion of basic characters below the head-line and lower zone is the portion where some of the modifiers can reside. The imaginary line separating middle and lower zone is called base line.

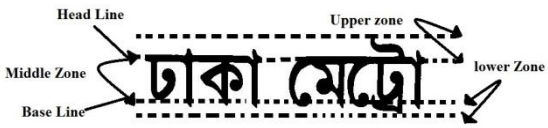

Fig.8 : The zones of bangle script

d) Detection and Deletion of Matra

To segment the character separately from the segmented word, Firstly we find out the headline of the word which is called 'Matra'. From the word, a row histogram is constructed by counting frequency of each row in the word. The row with highest frequency value indicates the headline.

Fig.9 : After Matra elimination

Detection of character between baseline and headline After removing the headline the characters in a word are isolated and can easily be separated. Vertical scan is initiated from the row that is just beneath the 'Matra' row to find the differentiation line between characters. If during scan, one can reach the base line without touching any black pixel then this scan successfully found a differentiation line between characters. Fig. 9 illustrates the character segmentation process.

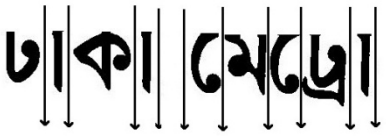

Fig.10 : Character segmentation

e) Detection below the baseline

A greedy search technique is initiated for the presence of black pixels below the baseline, the result will some connected components below the baseline. The components below the baseline contain lowest point called 'Base point'. Baseline is highest frequency row of base points. After determining the baseline, The Depth First Search (DFS) technique easily extracts the characters below the baseline.

Fig.11 : Below the base line detection

VI. Character Recognition

The character recognition phase consists of three steps:

1) Character normalization
2) Feature extraction
3) Character classification and recognition

a) Character Normalization

Segmented characters may have variation in size. In this step, all the characters are normalized to predefine valued in pixel. Characters may have variable width horizontally and vertically, each character image is normalized to a size.

b) Feature Extraction

The objective of feature vector is to define characteristic features of the characters. Selecting the most appropriate feature of each character can facilitate data visualization, data understanding and also reduce the measurement, storage requirements, training and utilization time. Initially, connected component extraction and the centroid of the character image is determined. Chain code was introduced by Freeman [12] as a way to represent lines or boundaries of shapes by a connected sequence of straight line segments of particular length and direction. A chain code has two components .They are: 1) The coordinates of the starting point; 2) A chain of codes; that represents the relative position of the starting pixel and its followers. The chain code is generated by using the changing direction of the connected pixels contained in a boundary. The character has been divided into connected components and boundaries of the connected components are recognized. Freeman chain code works on the observation that each pixel has eight neibourhood pixels is given in fig.12. Transitions are specified for axes with predetermined angles. By monitoring strokes of each character, 13 different angles are decided to count the transitions.

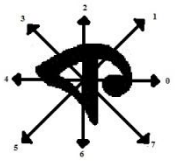

Fig.12 : Slope convention for Freeman chain code

For a closed boundary, its chain code obviously depends on the starting point of the boundary. To make it invariant to the starting point, the chain code can be normalized according to the following method [13]: A chain code can be treated as a circular sequence of direction numbers. Therefore, the starting point can be redefined so that the resulting sequence of numbers forms a minimum integer.

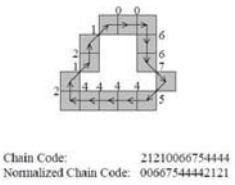

Fig.13 : Bidirectional chain code

c) Classification and Recognition

A neural network [14] is a extremely parallel distributed processor that has a natural propensity for storing experiential knowledge. First knowledge is acquired by the network through a learning process and then storing knowledge is for recognition of character. We use feed forward neural network for the classification and recognition Bangla characters. We trained the neural network by normalized feature vector obtained for each character in the training set. Our layer neural networks have been used with two hidden layers for improving the classification capability. For 32 dimensional feature vectors and 4 layers is used for each Character and recognized using stored knowledge of the network. Use of two hidden layers increases the recognition rate extensively.

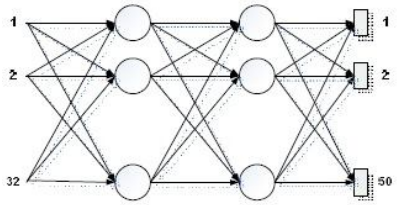

Fig.14 : A neural network with 4 layers

VII. Experimental Results and Performance Analysis

Different sized JPEG colored images are used in our experiment. Total 300 images are used to test the algorithm. The images are taken with different background as well as lighting conditions. Experiments show that the algorithm has good performance on license plate extraction, and character segmentation work. This work is implemented using MATLAB 7.0. Result found 84% for license plate extraction and 80% for character recognition. Deep shadows and reflections have an effect on license plate extraction work. Because of rough lighting, true license plates could not get correctly extracted. Failure in character segmentation phase when two characters are joined together. Good Performance of the ALPR system depends on good feature extraction of character.

VIII. Conclusions

An algorithm for vehicle License plate extraction, character segmentation and recognition is offered. Experiment consists of images with different size, lighting, background, camera angle and distance etc. The experimental results show that, license plates are extracted truly with higher success. Character recognition phase using connected component analysis, Freeman chain code, and Neural network that works well. We suggest to use multilayer feed forward neural network for classify and recognition of character. Recognition performance will be increased if the network trains with distorted character and with good shaped character.

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