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Detection and Recognition of Bangladeshi License Plate

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ABSTRACT

Recognition of license plate is become an important research in computer vision. LPR is a part of surveillance system. Applications of LPR are like- traffic surveillance and monitoring, tracking of stolen car, maintaining parking lot and so on. This paper presents a new model to detect and recognize license plate of Bangladesh. The proposed model uses YCbCr color model for segmenting the input image. After taking an RGB image as an input, noises are removed through median filter. For suitable segmentation, the image is converted to YCbCr model. Based on the components of Y, Cb and Cr, the image is segmented. For Bangladeshi license plate, YCbCr model is fitted well for segmentation. A morphological opening operation is functioned on the segmented image. Using information of region properties, the image is filtered. Initially area and then aspect ratio parameters are used for filtering. Through this desired region is extracted. The proposed system does not require tilt correction. Using the proposed algorithm it is possible to extract characters easily from rotated plates also. Later characters are extracted separately followed by some morphological technique and region properties information. SVM classifier recognizes characters based on CNN features.

Key words : License Plate Recognition (LPR),YCbCr, Segmentation, Character Segmentation, Convolution Neural Network (CNN), Support Vector Machine.

1. INTRODUCTION

With the fast growing world and technology, research in LPR achieves much attention recently. License Plate Recognition is now a significant matter in surveillance system day by day. Smart parking areas, speed detection of vehicle, tracking of vehicle, collection of toll tax etc. are some application of LPR. It is demonstrated that vision based application are perform well with better efficiency. To provide strong security, authentication especially on vehicles are extremely noteworthy. Managing traffic in busy highway can be easier by vision based application such as LPR. But for Bangladesh perspective, research works related to LPR are very rare. Recently road accidents are occurring frequently in Bangladesh. It becomes a common news to read every day. Due to lack of well-developed surveillance system drivers are easily escaping. A universal system is not possible to develop in this case. License plates are varies from country to country and also sometimes vehicle to vehicle. This proposed system considers those license plates having a background of white and black printed characters. Moreover, the plates are bounded by black color. Some sample of Bangladeshi license plates are shown in figure 1. Figure 2 describes Bangladeshi license plate.

For security issue, LPR is important. As crimes using vehicle are happening anywhere, it is a need to have a well-developed LPR system. Romen developed a model using adaptive thresholding locally for segmentation [4]. Anagnostopoulos uses information of color features for localizing the license plate [9]. Duan employed edge detection and hough transformation for detecting plate [1]. But the calculation process is lengthy as well as consume much time. Kim and Chien created a method which uses symmetric regions for localizing license plate [7]. The method does not works properly for distorted license plates and need longer time. Ghaili with others offered a technique that involves use of vertical edge to detect LP (License Plate) [11]. It is a dual-stage algorithm with image processing. The system is designed for license plate covering a background of black and consists of white characters. A different method suggested by Deb uses HSI color form for detection purpose. But it works

Figure 1: Example of Bangladeshi license plate (black characters and white background)

for same color of vehicle body and LP [2]. To overcome from tilt problem arises in vertical and horizontal directions, the

LSFPO and applying inverse affine transformation on reorientation is used accordingly. The matching of template is applied to recognize the characters. Many recommended window approach to locate license plate [5, 3, 6].

Wafy recommended an algorithm with the basis of information that license plates have corner points of semi-symmetric distribution; it helps to explore morphological feature for learning [8]. The algorithm is much robust

Figure 2: Description of Bangladeshi license plate

in real-time. It also can make decision that whether a license plate is exit or not in a candidate region. Color features are proved as useful information by many researchers in various LP detection system and others also. The proposed system in this paper uses color information of license plate. Amir suggested color feature to detect license plate of Iran [10]. The method detects region of license plate by shape and hue recognition. Many other methods are also used gray-scale image or binary images to detect license plate. Feature informations are also useful to localize license plate or the regions of interest like corner points. Hough transformation is one of the common methods to detect the area of interest by extracting horizontal and vertical lines in an image. Lines are then combined to look for rectangles that associated to the aspect ratio i.e width and height of license plate [12], [1]. Morphological functions provide simple method for detecting objects. It is also effective in detecting various objects [30]. It is supportive to get white areas having few block objects . Candidates region can be detected by following white areas and with the help of thresholding [13], [14].It is supported in vehicle with white background with block characters. To locate the license plate, neural networks as a artificial intelligence model are also used particularly.

Neural network is employed for detecting the region of the license plate. It blurs and sweeps image surface through dynamic window [15], [16]. A method based on wavelet transform is used to extract important features as it works as a guide to find desired license plate [17]. The main advantage of using the technique is that it is possible to locate multiple license plates having diverse oriented position in an image. But in case of much close or too far space between the vehicle and the camera, it performs very weakly.

The key motive of this research is to develop a Bangladeshi LPR system followed by segmentation, character extraction and classification of characters by Support Vector Machine (SVM).

2. SYSTEM OVERVIEW

This paper represents a License Plate Recognition System (LPR) for Bangladeshi LPs which are designed as white in background and black characters in foreground. The procedure of the proposed system is drawn in Figure3. License plate is segmented using color information of YCbCr. The system comprises three main modules: segmentation of the plate, extraction of character and recognition of character. Input image is filtered to eliminate noise and enrichment of image which makes it much suitable for further processing. Morphological task is implemented to improve the binary image. It makes the image finer to go ahead towards desired region. Then image is filtered by area and aspect ratio respectively. Through this license plate is detected. Now comes character extraction. Detected LP is segmented and characters are extracted with a new way. After binarizing the ROI, morphological opening is performed. Then it is filtered by area. Resultant image is horizontally divided which results in upper and lower part of license plate. Then character are extracted. Horizontally division is a means to extract characters successively. At last the recognition of the characters is done by SVM and CNN features.

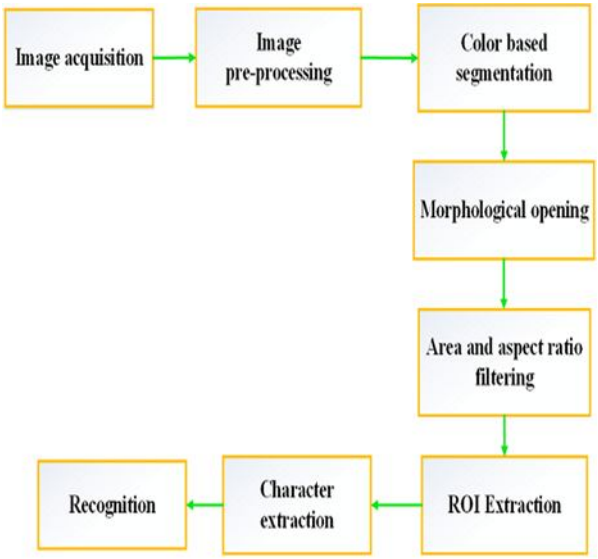

Figure 3 Steps of proposed system

3. DETECTION

In detection, segmentation of image is a key part. To get the desired region segmentation is the initial step here. The proposed system segments the image using color information of YCbCr. The input image is enhanced first like- noise removing. Then it is converted to YCbCr. Processing the image in YCbCr model provides good result especially in

segmentation. By collecting information of Y, Cb and Cr the image is segmented. Equation 1 is used to segment the image. Value of Y, Cb and Cr is set by analyzing large number of images. Figure 4(a) is the input image and figure4(b) is YCbCr image. Figure 4(c) shows result after applying (1).

$$Img(x,y)= \begin{cases} 1 & \text{if } Y>130 \text{ and } Cb>110 \text{ and } Cr>110 \\ 0 & \text{Otherwise} \end{cases}$$

Opening operation is applied on the segmented image. Opening is one of the morphological technique. Figure 4(d) shows result after applying morphological opening. Labeling the connected component is done to get region properties. Region parameters are most useful in extracting desired interested region. Area value and also aspect ratio values are computed to to get exact ROI. The image is filtered using area and aspect ratio parameters. Parameters of filtering and their values are drawn in Table 1. Region which is under the condition of Table 1 is selected as desired ROI. Figure 4(g) shows extracted roi. Detection statistics is shown in Table 2.. Figure 4(e) is the result of area filtering and Figure 4(f) showing aspect ratio filtered image. The extraction of ROI is made by using information of bounding box parameter of the desired ROI. Figure 5 also shows steps of detection.

Table 1: Properties Used For Filtering

Parameter	Minimum
Area	5000
Width	170
Height	90

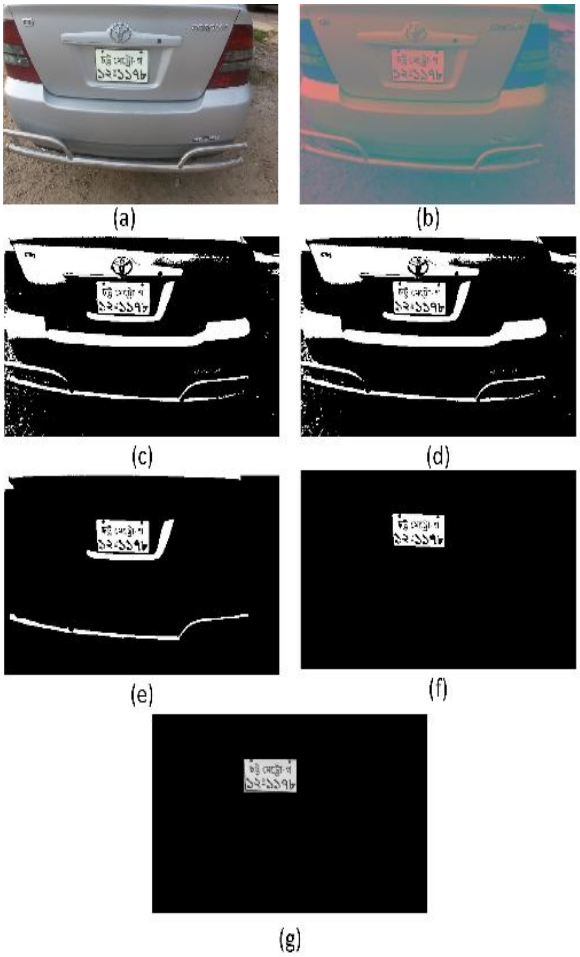

Figure 4: Stages of license plate detection (a) input image (b) YCbCr image(c) segmented (d)) after morphological opening (e) after area filtering (f) after filtering with aspect ratio (g) extracted ROI

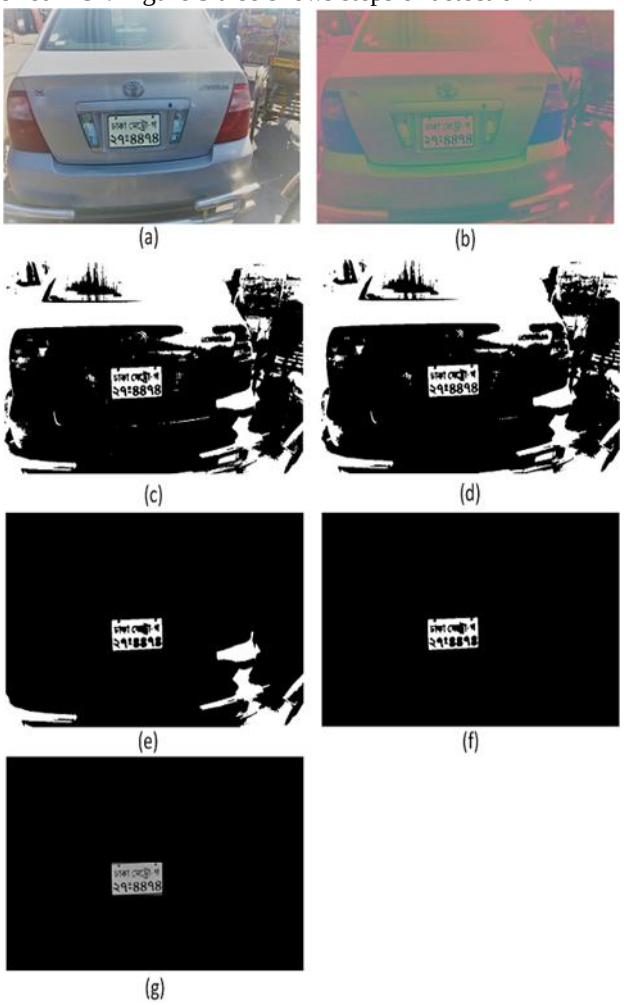

Figure 5: Phases in license plate detection (a) input image (b) YCbCr image(c) segmented (d)) after morphological opening (e) after area filtering (f) after filtering with aspect ratio (g) extracted ROI

Table 2: Detection statistics

Type	Number of tested images	Detected LP
Images with LP	198	193
Images without LP	63	1

4. CHHARACTER SEGMENTATION

Character segmentation is a vital step in LPR system. Extracted ROI is then process to get characters. Figure 6 shows steps for extracting characters. ROI is pre-processed first. Guided filter is applied and also makes the ROI more sharpen. Guided filter makes the edges smooth. Figure 6 shows the complete visualization.

The image is binarized and then complemented. Result is depicted in Figure 6 (c) and Figure 6 (d) correspondingly. Figure 6 (a) is the extracted roi and Figure 6 (b) is enhanced image Complement of the binary image is necessary because characters are black and background is white in the binary image as well as in ROI also. Result of complemented images is displayed in Figure 6 (d). Complemented image is then dilated. Dilation is one of the morphological operations. It expands the pixel of white areas (foreground). Figure 6 (e) is the result of dilation. Region properties are helpful in filtering image. Area information is used to eliminate some possible unwanted information. Result of area filtering is shown in Figure 6 (f). Resulted image is then needs to divide horizontally to extract characters sequentially. Using centroid information, the image is divided into upper part and lower part. Dividing license plate using centroid allows to avoid tilt correction. Figure 6 (g) shows result of dividing license plate.

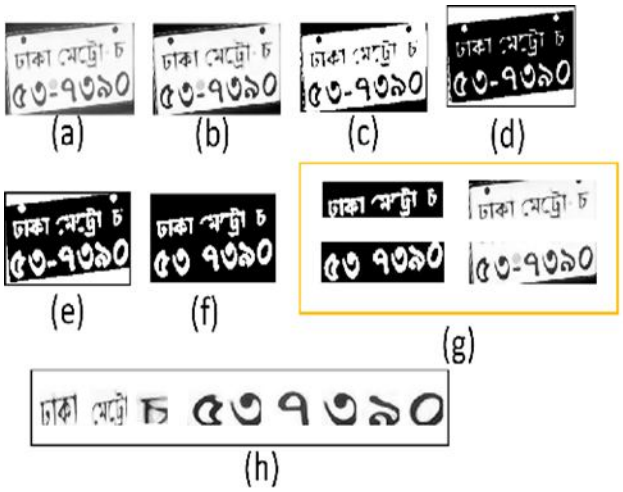

Figure 6 :Character extraction processes (a) extracted ROI (b) adjusted image (c) binary image (d) complemented binary image (e) dilated image (f) area filtered image (g) divided portion of plate (h) extracted characters

At last extraction of characters are made by the information of bounding box parameters. Resultant characters are displayed in Figure 6 (h).

5. RECOGNITION

5.1 Dataset

Image Dataset is vital for simulation and to evaluate the performance of system. It is a fact that, any dataset is not available for Bangladesh in this case. Hence, still images are captured from specific vehicles in Bangladesh for dataset. Images are considered under various environment like illuminations, complexities etc. some n images also created syntactically from collected images by adjusting different parameters of image such as- brightness, contrast etc. Finally the dataset consists of 1400 images for 14 classes. It means 100 images for each class. Figure 7 displays some sample of characters extracted from the LP

Figure 7: Some example of dataset

5.2 Convolution Neural Network

Most special ability of Convolution Neural Network is that it extracts features itself. Feature descriptors are not needed in CNN. CNN is composed of multiple layer. Among those layers convolution layer is most important in image recognition or classification. CNN permits networks to have lesser weights.

First layer is known as the Input Layer where image size is determined. In this system the size is 30x30x1 which denotes to height, width and size of channel. This layer also supports data transformation. The convolutional layer follows a activation function which is nonlinear. Here RELU Layer specifies it. Max-Pooling Layer is generally involved in down-sampling operation to limit the parameters. This layer also helps to avoid over fitting. It creates the features much nourished against alteration and noise. All the features are combined by Fully connected layer. Fully connected layer uses softmax activation for classification purpose. the softmax activation function returns probabilities. It is then used by classification layer.

5.3 Feature Extraction

Feature extraction is a process to represent key portion an image with lower dimension. Extraction of feature means gathering certain information of interest from an image

which is then forwarded for additional processing. Figure 8 and figure 9 visualizes the features of convolution and fully connected layers. Feature vectors are generally used as input to classification or pattern recognition task,

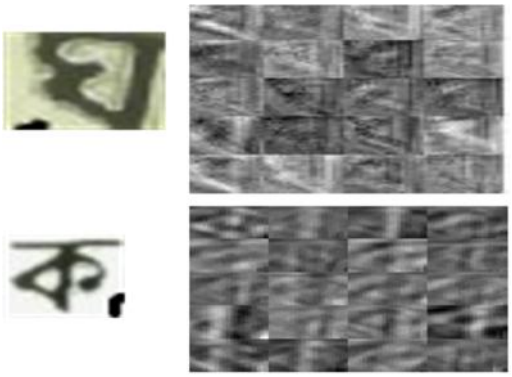

Figure 8 :Characters (left) and corresponding visualization of features in convolution layer (right)

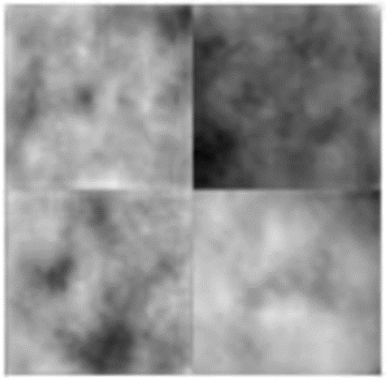

Figure 9: Visualization of features in fully connected layer

In this proposed system classification is done by SVM with features from CNN layers. This system uses activations on last fully connected layer. Then SVM classifies image with these features. The simulation is done by using MATLAB 2018a. 70% of dataset is used for training. The confusion matrix depicts 99.3% accuracy in recognition. The confusion matrix is projected in figure 10.

Table 3: Comparison with other method

Method	Detection rate	Recognition rate
Binary method/SVM [30]	97.16%	97.88%
Morphological [28]	97.5%	94%
Proposed system	97.7%	99.3%

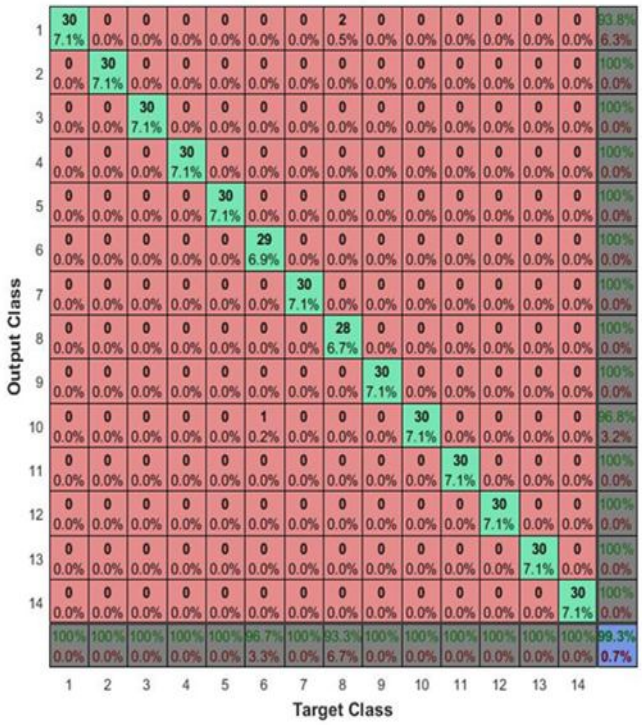

Figure 10: Confusion matrix

6. CONCLUSION

Most The paper presents a new system to detect and recognize license plate only for Bangladesh. The presented system is tested for license plate containing black printed characters with white background. Segment of license plate is followed by color information. This proposed system can extracts characters easily without correcting the tilt. Detection of the plate is followed by segmentation, opening operation and filtering. Color based segmentation proceeds the system ahead to get the plate. Convolution Neural Network is employed to get features. Features extracted by CNN works very well. SVM is used to recognize characters. SVM is well known classifier for its speed and precision rate. The system results in 99.3% accuracy rate to recognize characters. A comparison is shown in Table 3. This system is simulated for 14 types of characters. So it may be possible to classify other characters also with good results. We will try it in future. Later, we will try to increase classes and take into account long distance images.

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