An Automatic Number Plate Recognition of Bangladeshi Vehicles

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ABSTRACT
Now-a-day, the importance of automatic traffic monitoring has drawn the attention to the intelligent transport systems. A number plate is the unique identification of a vehicle. Automatic Number Plate Recognition (ANPR) is designed to locate and recognize the number plate of a moving vehicle automatically. For Bangladeshi Vehicles there are no fixed rules for number plates like other countries. Because of the variety of conditions and patterns, the recognition process of number plates for Bangladeshi vehicles is so difficult. We develop a ANPR system which is divided into three part such as number plate Localization, Extraction and Recognition. After successfully complete localization and extraction of number plate we send that portion to a Bangla OCR to fetch the text of the number plate for further processing. In this paper we present a complete ANPR system for Bangladesh Vehicles using standard algorithms with some customization and with our own algorithm for Number Plate extraction which can detect Number Plate region and successfully extract detected region and then able to recognize that number plate text.

Keywords
ANPR, Sobel Operator; Otsu threshold; Hough transform; Bangladeshi vehicles number plate

1. INTRODUCTION
Number Plate [1] is a rectangular, usually metal plate that bears a sequence of numbers, letters, or both and is issued by a government to identify an officially registered vehicle. It is placed front and back side of any type of vehicles. ANPR system is an image-processing technology used to identify vehicles by their license plates or number plate. They can use existing closed-circuit television or road-rule enforcement cameras, or ones specifically designed for the task. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals.

ANPR system is well-known all over the world but it is comparatively very new for our country. Bangladesh is one of the most populated countries in the world and day by day the number of automobiles is increasing almost at an exponential rate. An increase in vehicles would clearly mean an increase in vehicles related crimes. Eventually, couples of 2-parallel lines were considered as a plate-designate [11] [12]. Another approach was based on the morphology of objects in an image [13] [14] [15]. This approach focuses on some salient properties of vehicle plate images such as their brightness, contrast, symmetry, angles, etc. Due to these features, this method could be used to detect the similar properties in a certain image and locate the position of number plate region. The third approach was based on statistical properties of text [16], [17]. In this approach, text regions were discovered using statistical properties of text like the variance of gray level, number of edges, edge characteristics of boundary lines. The input image being first processed to enrich and enhance boundary line-information by using such algorithms as the gradient filter, and resulting in an image formed of edges. The image thus processed was converted to its binary counterpart and then processed by certain algorithms, such as Hough transform, to detect lines. Eventually

2. RELATED WORK
The ANPR was invented in 1976 at the Police Scientific Development Branch in the UK [3]. Prototype systems were made in 1981. The first arrest through detection of a stolen car was made in 1981. There are many works done in ANPR all over the world. There have been various commercial ANPR products around the world, which include Safe-T-Cam [4], SeeCar in Israel [5], VECON in Hongkong [6], LPR in USA [7], the ANPR in UK [8], IMPS in Singapore [9], and the CARINA in Hungary[10]. Different approach can be used for developing an ANPR system. The First approaches were based on characteristics of boundary lines. The input image being first processed to enrich and enhance boundary line-information by using such algorithms as the gradient filter, and resulting in an image formed of edges. The image thus processed was converted to its binary counterpart and then processed by certain algorithms, such as Hough transform, to detect lines. Eventually, couple of 2-parallel lines were considered as a plate-designate [11] [12]. Another approach was based on the morphology of objects in an image [13] [14] [15]. This approach focuses on some salient properties of vehicle plate images such as their brightness, contrast, symmetry, angles, etc. Due to these features, this method could be used to detect the similar properties in a certain image and locate the position of number plate region. The third approach was based on statistical properties of text [16], [17]. In this approach, text regions were discovered using statistical properties of text like the variance of gray level, number of edges, edge densities in the region, etc. This approach was commonly used in finding text in images, and could well be used for discovering and designating candidate number plate areas as they include alphabets and numerals. In addition there are many approaches like artificial intelligence, genetic algorithms, mean-shift algorithm based [18] [19] [20].
3. PATTERNS OF BANGLADESHI NUMBER PLATES

In developed country there are standard rules for all the number plates for every specific country. For example in UK [21], In UK’s number plate follow White front plate (to British Standard BS AU 145d), Yellow rear plate (to British Standard BS AU 145d), The registration number of the bearer vehicle in the mandatory font (black ‘Charles Wright 2001’), Spacing of characters and character groups in accordance with the measurements specified in the regulations. Variations are not permitted. The plate has 7 characters in 3 parts, each with a different meaning. The first two letters show where the vehicle was registered, the local memory tag. The two numbers indicate the age of the vehicle, the age identifier. The last three letters give a unique identity to a vehicle, the random letters. But unfortunately in Bangladesh, there are no fixed rules and regulations for making number plate. For Bangladeshi vehicles it varies in number plate size, font, color etc. For this reason a complete successful ANPR is very difficult to build. Figures 1 shows different license plates of Bangladeshi vehicles and UK vehicles.

4. OUR DEVELOPED SYSTEM

Number plate rules are the core concept of ANPR system. In the world which countries are using this system they have strict rules of number plate. But in Bangladesh there are no such rules. Lacking of such rules we prevent us from just using all the standard algorithm and procedure available for developing any standard ANPR system. So here we proposed and developed an ANPR system for our country for detecting and recognizing number plate of Bangladeshi vehicles. For developing our system we used the following development steps like any other number plate recognition system but with many customizations that is required for the variation of our number plated. They development steps are as follow:

- Capture Image
- Edge Detection
- Threshold
- Number Plate Localization
- Number Plate Extraction
- Number Plate Recognition

The steps are also shown in figure 2.

5. CAPTURE IMAGE

First of all, we need clear image to locate number plate. For this purpose there are many specialized camera with high configuration which can take image of moving vehicles. But for simplicity we use Nokia 5310c Mobile to capture image. After capturing image we get an image of a vehicle like Figure 3.

6. EDGE DETECTION

After getting the image we need to detect the Edges of the Number Plate from the whole image. Edge detection [22] is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply. The simplest Edge Detection methods rely on finding the first order differences between adjacent pixels. In our implemented system we use Sobel Edge Detection [23] Operator where the operator uses two 3x3 kernels which are convolved with the original image to calculate approximations of the derivatives - one for horizontal changes, and one for vertical changes. After Edge detection the captured image is looks like Figure 4.
THRESHOLD

Then we need to segment the portion of our Number Plate region from the whole image. Thresholding is the simplest method of image segmentation, which involves separating an image into regions corresponding to objects. We usually try to segment regions by identifying common properties. The simplest property that pixels in a region can share is intensity. In our approach we use threshold as Otsu [24] method which stores the intensities of the pixels in an array. The threshold is calculated by using total mean and variance. It involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, i.e. the pixels that either falls in foreground or background. The aim is to find the threshold value where the sum of foreground and background spreads is at its minimum.

After threshold the image looks like as Figure 5.

NUMBER PLATE LOCALIZATION

The next task is to localize the plate region. For localizing number plate we use the Hough transformation [25] [26] which is a feature extraction technique used to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform. We are using the simplest case of Hough transform is the linear transform for detecting straight lines for our system.

We modify some portion of Hough transform for line drawing. Our modification works as follow. Hough transform gives all possible r and theta corresponding one pixel. To pick those r and theta, the pixel is voted by those pixels which are in the number plate region. Every pixel voted is stored in accumulator array corresponding to r and theta. After that we pick r and theta which has highest value. To vote in accumulator array we only calculate those theta values which range 75-105. Because of average number plate in captured image may be rotated in this range.

After localization the output image looks like Figure 6.

NUMBER PLATE EXTRACTION

This the most important part of our ANPR system. After localization of the Number Plate we need to exact only the Plate image. For this extraction purpose we used our own algorithm. The steps of our algorithm for this step works like below:

First we create an image matrix and then traverse it to get maximum feature points of rectangle shape area. In here input image has three basic color and those are red, black & white. Our feature points are red and for that we set point 100 for that pixel value and for black and white we set respectively -30 and -50. Then on that matrix we go to get the maximum value for rectangle shape where value is summed by rectangle area pixel values describe above. For maximum value we get a rectangle shape which gives us feature number plate region and then we crop that rectangle shape.

The pseudo code our algorithm for this step is given below:

| Initialize Maximum value to zero. |
| Go for rectangle shape. |
| Calculate value for that rectangle shape and save to current value. |
| Store rectangle shape if maximum value is less than the current value |
| Then save that rectangle shape |

After extraction the output image looks like Figure 7.

NUMBER PLATE RECOGNITION

We use an OCR to recognition character from extract number plate. For Bengali language we used an open source OCR that uses Tesseract 3.0 [27] which can be trained for different character recognition. We have trained Tesseract 3.0 for Bengali character. After training Tesseract 3.0, then we use it a bangle open source OCR named SHABDAYON [28] which is developed in C++ language. As we developed our system using java so we had to linkage java code and C++ code. First we create a exe of OCR which is called through command line (cmd) and give the number plate region area which one detected by our system previously and send it to OCR then it take various process and back us TEXT of the number plate. The text output is then stored our database. Then we check it is valid or invalid number plate from server.

After recognition the image through the OCR we get our text output like Figure 8.
11. EXPERIMENTAL RESULTS
We tested our system with several Bangla license plates to measure the accuracy of the system. The system is designed in JAVA (J2SE) for recognition of Bangladeshi license plates. The images for the input to the system are colored images with the size of 1200*1600. The test images were taken under various illumination conditions. The results of the tests are given by Table.

Table 1: Results of Tests

<table>
<thead>
<tr>
<th>Units of ANPR System</th>
<th>Number of Accuracy</th>
<th>Presence of Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Plate Localization</td>
<td>70/80</td>
<td>88</td>
</tr>
<tr>
<td>Number Plate Extraction</td>
<td>62/80</td>
<td>77</td>
</tr>
<tr>
<td>Recognition of character</td>
<td>50/80</td>
<td>62</td>
</tr>
</tbody>
</table>

It is shown that accuracy for the Localization of plate region is 88%, 77% for the Extraction of the plate and 62% is the percentage of accuracy of the recognition unit.

12. CONCLUSION
In this paper, we have developed a complete System of ANPR for Bangladeshi vehicles using standard algorithms and with some of our own algorithms for some steps. Our system is very efficient in detecting Number Plate region of any vehicles and successfully able to extract detected Number Plate from Captured image but our recognition part still has some flaws in some cases. If we can train our OCR efficiently with popular Bangla fonts then we will surely get good recognition. The main reason of this recognition problem is because of the variation of the fonts especially for hand written fonts used in our Bangladeshi vehicles. There is no fixed rule in our country for writing the number plates. If we have some fixed criteria in this case like our developed country then our system will work without any problem. Still this problem can be minimized if we can properly train the tesseract engine of OCR with lots of bangle fonts.

13. REFERENCES