Bangla Automatic Number Plate Recognition System using Artificial Neural Network

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***Abstract*— Bangla automatic number plate recognition (ANPR) system using artificial neural network for number plate inscribing in Bangla is presented in this paper. This system splits into three major parts- number plate detection, plate character segmentation and Bangla character recognition. In number plate detection there arises many problems such as vehicle motion, complex background, distance changes etc., for this reason edge analysis method is applied. As Bangla number plate consists of two words and seven characters, detected number plates are segmented into individual words and characters by using horizontal and vertical projection analysis. After that a robust feature extraction method is employed to extract the information from each Bangla words and characters which is non-sensitive to the rotation, scaling and size variations. Finally character recognition system takes this information as an input to recognize Bangla characters and words. The Bangla character recognition is implemented using multilayer feed-forward network. According to the experimental result, (The abstract needs some exact figures of findings (like success rates of recognition) and how much the performance is better than previous one.) the performance of the proposed system on different vehicle images is better in case of severe image conditions.**

***Index Terms*— Number Plate Detection, Number Plate Recognition (NPR), Bangla Number Plate, Artificial Neural Network.**

I. Introduction

During the recent years, intelligent transportation systems (ITSs) are most important implementations for analyzing and also handling the moving vehicles in roads and cities. Due to the growth in the number of vehicles, like other modern cities, Bangladesh needs intelligent traffic management system in order to cope with the constantly increasing traffic on today's roads. One of the effective solutions to manage the traffic of vehicles and control the traffic viaolation is employing an Automatic Number Plate Recognition (ANPR) System which is most important topics of ITSs. ANPR system identifies vehicles, via various techniques which mainly based on automated algorithms rather than manual. Image processing is one of these techniques which deal with images and/or video sequences taken from vehicles. All vehicles have their own plate numbers which is a unique property and that take into account for identifying vehicles.

Automatic Number Plate Recognition is an important research field due to its number of applications such as parking lot management, enterprise entrance management, automatic toll collection enforcement, traffic law enforcement, border surveillance, stolen vehicle search [2]. Many intensive research studies have been conducted in other countries in the area of automatic number plate recognition, to our knowledge; there is virtually no research studies conducted in Bangladesh in this area. However, ANPR for vehicle identification is an essential area in the development of intelligent traffic systems and surveillance. The use of vehicles in Bangladesh has increased rapidly due to urbanization and modernization, especially in recent years, and thus, traffic congestion in cities specially Dhaka, Chittagong has become a major issue due to inadequate road infrastructure (please put some relavant data of traffic in major cities in recent years indicating the growth and some data of traffic viaolation which actually will justify and show the significance of this research). Therefore, control of vehicles and identification of traffic violators to maintain discipline, is becoming a big problem in those cities. For this reason, development of Automatic Bangla number plate recognition system is seen as a highly essential requirement.

ANPR algorithms are generally composed of the following three processing steps: 1) extraction of a number plate region; 2) segmentation of the plate characters; and 3) recognition of each character. This task is quite challenging due to the diversity of plate formats, the non-uniform outdoor illumination conditions, complex background, and distance change during image acquisition [1]. To overcome these problems we apply image enhancement method and also a novel match filter proposed by V. Abolghasemi and A. Ahmadyfard to increase contrast of plate-like regions to avoid missing plate location especially in poor quality images and to detect candidate regions as plate [1]. This paper proposed a feature extraction method which is rotation, scaling and translation invariant to recognize characters of number plate in real time.

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II. Automatic Number Plate Recognition

In this section, the styles of number plate that are considered in this study are discussed, followed by a brief description of the proposed ANPR process. Table 1 shows various styles of number plates found on vehicles in Bangladesh. Each style is associated with a particular class of vehicle. The classes include private vehicle and commercial vehicles. Other categories of vehicles, such as embassy cars and military cars are not addressed since they are rarely seen. Styles of number plates can easily be distinguished based on two attributes: 1) the combination of colors used in number plates and 2) the compositional semantics of characters.

TABLE I
Styles of number plates under consideration Units for Magnetic Properties

Vehicle category	Plate color	Character color	Example
Private	Black	White	
Commercial	White	Black	

As shown in Table 1, each style has a different foreground and/or background color. However, two distinct colors (white and black) are utilized in these number plates. We shall pay attention to these two colors when searching for number plates in an input image. The compositional semantics of characters provides additional information for differentiating vehicles. As can be seen in Table 1, every number is composed of four parts separated by a hyphen and white space (e.g., ঢাকা – ক ০১-৩৮৩৩ or ঢাকা মেট্রো – খ ১২-৩৮২৪). The first part consists of one or two words. In case of one word, it means the district name, on the other hand it means metropolitan (e.g., ফেনী or ঢাকা মেট্রো). The second part contains a character that is used to recognize vehicle category (e.g., ক, ভ, হ). The third part contains two numerals which mean two sides of an area like north, south where the odd number used for north (e.g., ১১) and even number is used for south (e.g., ১০). Lastly the forth part consists of four numerals (e.g., ৩৮৩৩) which means the identifier number of a vehicle.

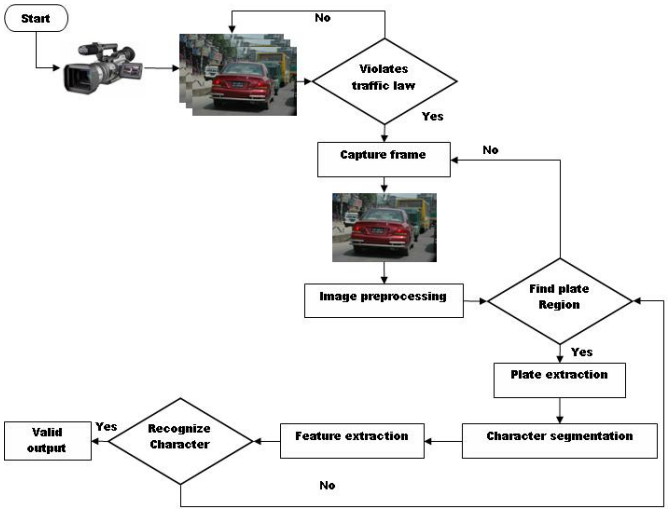


Fig. 1. Flow chart of NPR system

Fig. 1 shows the flow chart of proposed ANPR system. We assume that the system is integrated as an event detection system, for example a vehicle detector or traffic law enforcement system. If there is any traffic law violation detected, the camera along with the system is activated and the acquired image is sent to the ANPR process. There are three essential tasks involved in ANPR process, number plate detection, character segmentation and character recognition. In number plate detection, potential number plates are extracted from the image. If no number plate is found, the process returns to await another input image. Otherwise it goes to next step for character segmentation. The features of the segmented characters are passed through the character recognition process to recognize number plate.

III. Related Work

According to many research works, number plate recognition algorithms generally divide into three steps – extraction of a number plate region, segmentation of characters from the plate and recognition of each character. This section presents some previous research works for number plate recognition which is significant to proposed approach.

A. Number Plate Detection

Regard as previous methods for number plate detection, edge analysis method combined with mathematical morphology gives a better result [2],[3]. This technique provides strong edge information where the plates contain dark characters on light background, which can be used as an indication to detect the number plate but it fails in complex scenes. To improve the detection rate this combine edge information is used with other cues. Another technique named vector quantization (VQ) is used to detect the number plate region [4],[13] .VQ image representation is a quadtree representation by the specific coding mechanism, and it can give a system some hints about the contents of image regions, and such information boosts location performance.

Adaboost [5] are also used in number plate detection. In this method, it needs to train the planned classifier using a set of plate and non-plate images, after training a test image is feed to the system. The system detects the location of plate in the test image if there is a car in that test image. This is principle function of classifier-based algorithms. With respect to other classifiers, the most attractive features of Adaboost learning technique are speed and simplicity. The main drawback of Adaboost method is that it cannot detect number plate region when the range of variations for distance or viewing angle increases and also slow in comparison to edge based method. Various neural network architectures [6]- [8] are proposed and implemented for detecting number plate, such as the Pulse Coupled Neural Networks (PCNNs), the Time Delay Neural Networks (TDNNs) and the Discrete Time Cellular Neural Networks

(DTCNNs). Adding new number plate features in designing neural networks will improve the detection rate but it also increases the computational time.

Hough transform can be used to find the boundary box of a number plate in spite of characters. This technique is very sensitive to deformation of boundaries and has difficulty to extract plate region when the boundary of the plate is not clear due to damage or dirt. It perform well only when applied to close shots of the vehicle. Another disadvantage of this method is it has high computational complexity [9]. Color-based object recognition system is also used for number plate detection where color is a unique feature [10],[11] which is sensitive to the parameters like color of car, illumination condition and the quality of image. For this reason this system has limited use. To improve the performance of color feature it is combined with texture analysis which gives better outcome [2],[12]. One of the well known tools for texture analysis named Gabor is used for number plate detection where the arrangement of characters on plate produces a specific texture pattern which can be considered as a plate feature [13]. The computational complexity of Gabor filter is considerably high, due to multiple direction and scale in this analysis.

B. Character Segmentation

The connected-component based method is used for character segmentation [3]. The characters of the connected-components are confirmed by two properties of the number plate such as - the digits on the number plate are fixed and the characters lie in horizontal orientation. When the fixed numbers of character components in the plate image are not obtained, the number plate image is rejected. One of the tasks in character segmentation is found in [21] where the solution concerns about the reformation of the characters of upper and middle zone.

The most commonly used algorithm for character segmentation is applying projections [9],[14]. There are two types of projection – horizontal and vertical. Horizontal projection is used when the number plate contains two rows. Character segmentation is more difficult due to many reasons such as stuck characters, screws, and mud covered in plates. For this reason vertical projection is used.

C. Character Recognition

In the character recognition, some well-known schemes were used such as artificial neural networks, fuzzy logic, Support Vector Machine (SVM)-based character recognizer and template matching. The character sequence of number plate uniquely identifies the vehicle. In [15] they proposed to use artificial neural networks for recognizing of number plate characters, taking into account characters properties to be as an associative memory. Using neural network has advantage from existing correlation and statistics template techniques [16] that allow being stable to noises and some position modifications of characters on license plate. Their approach is considered to identify vehicle through recognizing its number plate using, Hopfield networks with 42x24 neurons as the dimension of each character. The network must memorize all the Training Data (36 characters) and recognize correctly characters on number plate with probability of 87%.

In [17] they employed a Feed forward neural network for LPR system. The structure of neural network includes input layer with 366 inputs, one hidden layer with 50 neurons and output layer with 46 neurons. Described above gradient descent back propagation method with momentum and adaptive learning rate is used for neural network training. Neural network is trained on the quality images showed by alphabetic characters with supervisor outputs. Each neural network output shows one possible character, which has to be classified. Neural network correctly classifies number plate characters with probability 95% in the presence of 50% noise density.

Additionally, in [8], the authors designed a system implementing four Support Vector Machines (SVM) and report an impressive average character recognition rate of 97.2%. The architecture, however, is strictly designed for Korean plates, thus leaving no response in license plates of other countries. One of the most important specification that nominate Fuzzy system to recognize standard plates is that it has high accuracy and speed which suits real time system requirements [18]. After the output matrix extracted from feature extraction step, it will be the input of Fuzzy logic system where the system will try to understand the inputs represent which character or number. The pattern matching technique is a suitable technique for the recognition of single-font, not-rotated, and fixed-size characters. Although this method is preferably used in binary images, properly built templates also obtained very good results for gray-level images [19]. In [10] the authors applied template matching based on minimum Euclidean distance and 90% of the photos under various illuminations are read correctly within 0.3s.

D. Image Pre-processing

A major cause of failure in detecting number plate is low quality of image. In order to improve the quality of plate image, we used a pre-processing algorithm proposed by V. Abolghasemi, A. Ahmadyfard [1]. They used the density of vertical edge to detect candidate for plate region. Our images consist of rectangular array 480×640 pixels that provide enough information of the image when processing time is low.

E. Gray Scale Conversion

From the 24-bit color value of each pixel *(i,j)* the R, G and B components are separated and the 8-bit gray value is calculated using the formula:

$$gray(i, j) = 0.59 * R(i, j) + 0.30 * G(i, j) + 0.11 * B(i, j) \ldots (1)$$

F. Image Enhancement

In order to increase image contrast only at plate-like regions of image, V. Abolghasemi and A. Ahmadyfard use the density of vertical edges as a criterion to detect candidates for plate regions [1].

G. Density of edge

In order to calculate vertical edge density in the image, first calculate gradient image using Sobel operator. Then

(a)

(b)

Fig. 2. (a) Sample image (b) Converted gray scale image

comparing this gradient image against a predefined threshold the edge image is obtained in Fig. 3(a). To avoid missing weak edges across the plate region, the threshold is set to a low value.

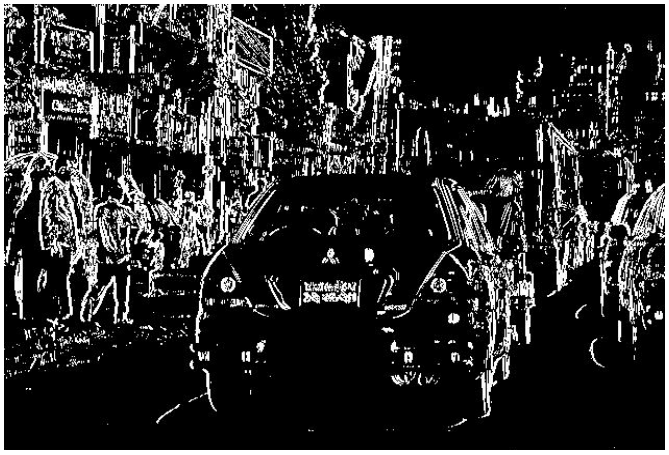
$$h = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In the next step, 2D Gaussian filter is applied on this gradient image Fig. The size of estimator has been selected from average size of number plates in the database which is 60×60. Fig.3 (b) shows the result of the edge density after convolving the binary edge map with this Gaussian kernel.

To increase image contrast in plate-like regions using the local density of edges in the image (Fig. 3(b)) a new formula for image enhancement based on edge density is given below:

$$I'_{ij} = f(\rho W_{gij})(I_{ij} - \bar{I}_{Wij}) + \bar{I}_{Wij} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where I, I′ are gray scale image and enhanced image respectively and ρWgij and I_{Wij} are local edge density and average intensity value, regarding window W centered at pixel Pij, respectively. f(ρWgij) is the weighting function which assigns appropriate weights for pixels intensity. This function is showed in Fig. 4.



(a)

(b)

Fig. 3. (a) vertical edge map, (b) smoothing using 2D Gaussian kernel

Enhancement method affects edge density 0.15-0.45 approximately which are likely to be candidates for number plate. The intensity of pixels with edge density of more than

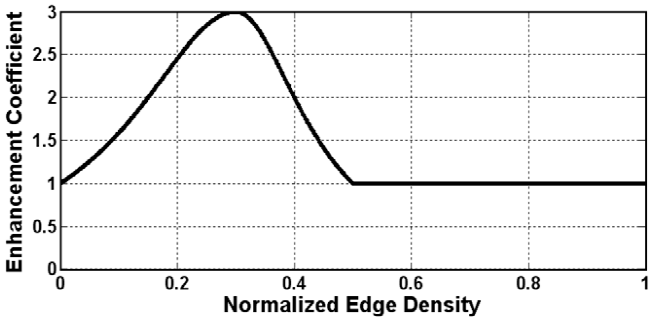


Fig. 4. The enhancement coefficients $f(\rho W_{gij})$.

0.5 remains unchanged. This range for parameter ρ has been achieved, empirically. The weighting function f in enhancement formula as follows:

$$f(\rho W_{gij}) = \begin{cases} \dfrac{3}{\frac{2}{(0.15)^2}(\rho W_{gij} - 0.15)^2 + 1} & if \quad 0 \le \rho W_{gij} < 0.15 \\ \dfrac{3}{\frac{2}{(0.5-0.15)^2}(\rho W_{gij} - 0.15)^2 + 1} & if \quad 0.15 \le \rho W_{gij} < 1 \\ 1 & if \quad \rho W_{gij} \ge 1 \end{cases} \quad \ldots\ldots (4)$$

Fig. 5 shows the result of image enhancement where the image contrasts at the plate region has been considerably improved.

(a)

(b)

(c)

Fig. 5. (a) enhanced image, (b) before enhancement, (c) after enhancement

H. Number Plate Detection

It is observed that density of vertical edges at the number plate area is considerably higher than its neighborhood. This special feature does not occur in other regions. To have this unique property and also low complexity of edge-based methods, Sobel operator is used to get edge information for the plate detection. To detect the number plate from enhanced image we used a match filter designed by V. Abolghasemi, A. Ahmadyfard [1] that remove most of clutter part in image from the region of interest at the first stage. The computational time for this filtering is low. In order to detect number plate first we calculate the edge density as describe in the previous section. After that Gaussian kernel is used for smoothing. The result is shown in Fig 6.

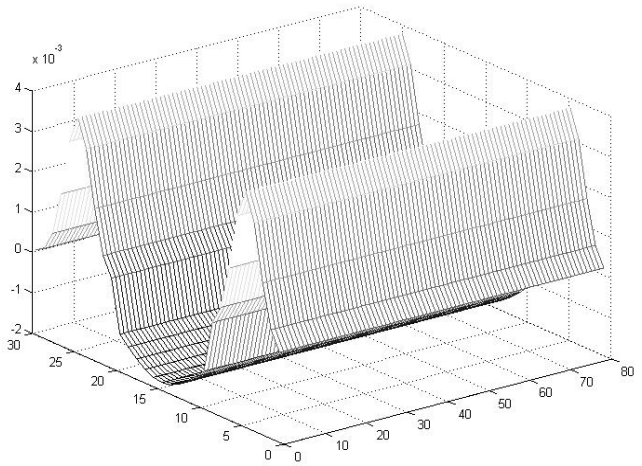
I. Match Filter

Mixture of Gaussian functions emphasizes the constancy of intensity values within plate region, along horizontal

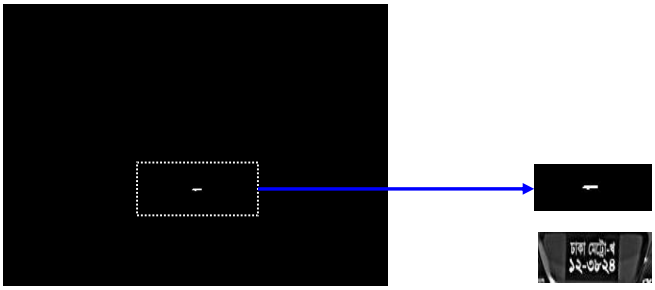
Fig. 6. Result of smoothing.

direction. On the other hand, expected edge density along vertical direction at the middle of region are maxima and it decreases when approaching to plate borders. This function properly models the low edge densities above and below the car plate. The mathematical equation of this mixture model is:

$$h(x,y)=\begin{cases} A.\exp\left(-(x-m/6)^2 \Big/ 0.2\sigma_x^{\,2}\right) & for\ 0\le x<m/3, 0\le y<n \\ B.\exp\left(-(x-(m/3+m/6))^2 \Big/ 2\sigma_x^{\,2}\right) & for\ m/3\le x<2m/3, 0\le y<n \\ A.\exp\left(-(x-(2m/3+m/6))^2 \Big/ 0.2\sigma_x^{\,2}\right) & for\ 2m/3\le x<m, 0\le y<n \end{cases}$$



(a)



(b)

Fig. 7. (a) 3D plot of match filter, (b) Detected number plate area.

The function represents a rectangular m × n mask. As can be seen from Fig. 7, the filter varies only in vertical, i.e. x direction. The symbol σ_x is the variance of the main lobe toward x direction. The value of this parameter based on approximate plate height in car image. Parameters A and B (A<0 and B>0) are set empirically.

This matched filter is convolved with estimation of the edge density for finding instance(s) of number plate. This filtering process provides a strong response at plate-like regions, while does not provide considerable response elsewhere. The zero mean value for the filter results no response at constant edge density such as asphalt, walls, sky, etc [1].The result of this filtering on edge image is compared against a predefined threshold to find candidates for number plate (Fig.7(b)).

J. Number Plate Extraction

To extract the boundary of number plate we use morphological operation, refers to a broad set of image processing operations that process images based on shapes. The characters of a number plate arranged in regular order and the vertical edges of this area are considerably dense as compared to the other mess part of the image. To find the boundary from the candidate region morphological closing is applied on edge image (Fig.8(a)). For this purpose, a

rectangular structuring element (SE) with 3×10 pixels is used. Although morphological operation is used only to the candidate region to find the plate boundary, the process is not time consuming. To detect true region from the modified candidates, simple geometrical features such as shape, aspect ratio and size of region are used. Fig.8(b) shows the result of the detected plate.

(a) (b)

Fig. 8. (a) Result of closing operation, (b) corresponding detected number plate.

K. *Character Segmentation*

Character segmentation is a process by which characters of a number plate are being extracted from the plate's background to correctly recognize the number plate. To extract the bangla characters and words from the number plate first we convert the image into black and white. Since in most of the cases, Bangladeshi number plates contain more than one lines of text; we use horizontal projection obtained by summation of rows pixels which is defined by equation (6) to detect and segment rows in two different lines. Because binary plate images were adjusted their tending angles to zero, the result of row segmentation is nearly perfect. The positions with minimum values of horizontal projection are the start or the end of a row in plate. After horizontal projection we use concatenate operation on them to bring in a single line.

$$P_x(x) = \sum_x I(x,y) \quad \ldots\ldots\ldots\ldots\ldots \quad (6)$$

Fig. 9. Horizontal projection plate.

Due to some obstacles like stuck characters, screws and dash (-) character in plates, Bangla character segmentation becomes more difficult. For this purpose we use vertical projection (equation (7)) to separate each bangla characters and words. Fig. 10 shows the analysis of vertical projection. Here locating valleys is a very important step due to the reason that segmentation lines are created between the characters within number plate in these valleys.

$$P_y(y) = \sum_y I(x,y) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

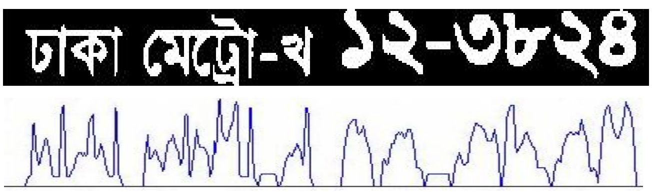


Fig. 10. Vertical projection.

In this vertical projection, screws and dash (-) character are removed which have very small frequency. After applying this process we get 9 top pick where there are 7 characters and 2 words from the number plate. Now we remove the redundant area form each output of the segmentation process. Fig. 11 shows the overall process of the segmentation.

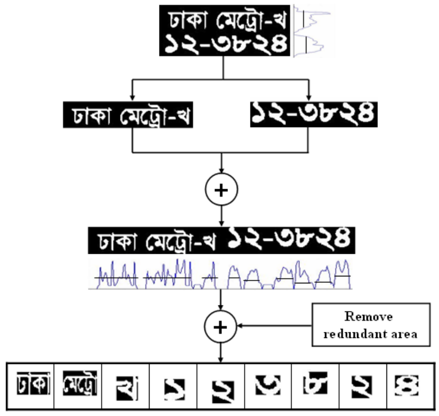


Fig. 11. Character segmentation system

L. *Feature Extraction*

Feature extraction plays an important role in the recognition system. This effectively reduces the number of computations and hence reduces the learning time and faster the recognition process.

Center of the image

Center of the image can be obtained by using following equation:

$$Center\_x = width / 2 \quad \ldots\ldots\ldots\ldots \quad (8)$$

$$Center\_y = height / 2 \quad \ldots\ldots\ldots\ldots \quad (9)$$

Feature 1 - 24

These features check how the black pixels are distributed in the image. First the number of pixels inside the image is calculated that is *total_pixels* of each character.

$$Total\_pixel = height \times weight \quad \ldots\ldots\ldots \quad (10)$$

The feature 1 and 2 are the percentage of black pixels located in the upper and lower areas of each character, in other words, the pixels located up and down the central point.

$$Feature1 = up\_pixels / total\_pixels \quad \ldots\ldots\ldots \quad (11)$$

$$Feature2 = down\_pixels / total\_pixels \quad \ldots\ldots\ldots \quad (12)$$

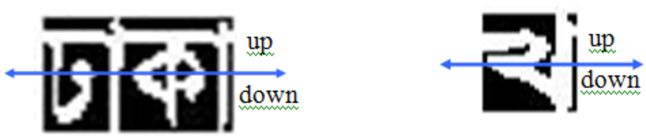


Fig. 12. Dividation of the image into upper and lower areas

The feature 3 and 4 are the percentage of black pixels located in the left and right areas of each character, in other words, the pixels located in the left and right of the central point.

$$Feature3 = left\_pixels / total\_pixels \quad \ldots\ldots\ldots \quad (13)$$

$$Feature4 = right\_pixels / total\_pixels \quad \ldots\ldots\ldots \quad (14)$$

Fig. 13. Dividation of the image into left and right areas

Now split the image into 4 sub regions and calculate the percentage of black pixels located in every region. Again sub divides every region into four and calculates the percentage of black pixels of those regions. The features 5 to 8 are the percentage of black pixels located in every sub areas of each character.

$feature_n = sub\_area\_pixels_n / total\_pixels$ … … … …(15)

Where n = 5 to 24

Fig. 14. Spilt image region

Feature 25

The feature 25 is the average of the distance between all the black pixels and the central point.

$$feature25 = \frac{1}{Total\_Pixels} \times \sum_y \sum_x \sqrt{(x-i)^2 \times (y-j)^2} \quad \ldots (16)$$

Where (i, j) are the coordinates of a point and (x, y) are the coordinates of central point.

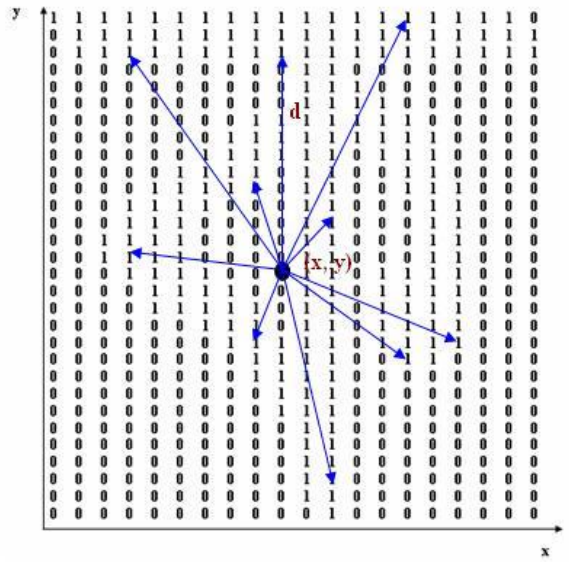


Fig. 15. Calculate distance between black pixels and central point

M. Recognition

The segmented characters are recognized using Multilayer Perceptron (MLP) Neural Network. For segmented Bangla character recognition, the three layers feed forward supervised neural networks are designed shown in Fig.16 where one is input layer, one is hidden layer, and one is output layer. Hidden layer consists of 158 neurons and the output layer has 40 neurons since there is 40 output of the network. The network is fully connected and use back-propagation learning algorithm. Transfer function for hidden neurons and the output neurons is Log-Sigmoid function. The learning rate is 0.0001. The network was trained with 38 Bangla characters and two words of 6 fonts.

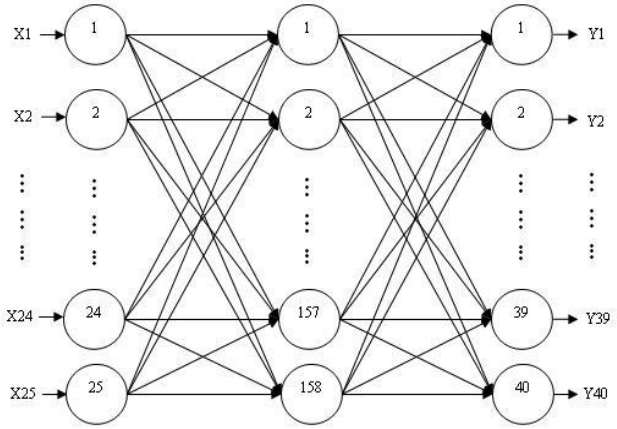


Fig. 16. Network design for the system

The input data convert into 25 feature column matrix before entering the neural network. For each of the Bangla characters, targets are set. When a test character feature column matrix is matched with any one of target set which is already determined from trained character set feature column matrix, then it has considered as a recognized Bangla character.

IV. Experiment & Result

The performance and accuracy rate of the proposed system are measured by testing three major phases with a set of real time video frames that contains car images where the plates are viewed from different angles and distance. The scenes are mostly complex. To implement our system we used P-IV with 2.16 GHz Dual core processor and 1GB RAM and MATLAB 8.0. The following definitions are applied:

Success Rate = (Total of Success/ Total Number of Input Sample) x100 %

For number plate detection and extraction we applied the method proposed by V. Abolghasemi and A. Ahmadyfard, the performance of this algorithm is shown in Table 2. The experiments shows the algorithm well performs for car plates viewed within ± 20 degrees. The experiments also show an acceptable robustness to the illumination changes. The success rate of number plate detection and extraction is 92.1% which takes 1.3 seconds. Table 7 shows the comparison among applied method and other well reported methods. After extraction, the characters and words of a plate are segmented which result is shown in Table 3. The segmentation process takes 0.16 second which success rate is 97.53%.

Segmented characters and words are passed through the MLP network for recognition. The MLP network was trained with six different Bangla font; these are SutonnyMJ, ChondonaMJ, AtraiMJ, DhanshirhiMJ, BhagirathiMJ and GoomtiMJ. The experimental result of characters and words recognition is shown in Table 4. The success rate of the Bangla characters and words recognition process is 84.16% which take 1.3 seconds to recognize. Table 5 and 6 shows

the overall system performance. From table 8 it can be seen that proposed method of recognition outperforms the methods reported in [15],[18]. Fig 17 shows some example of successful number plate detection and character recognition.

TABLE II
EXPERIMENTAL RESULTS OF NUMBER PLATE DETECTION AND EXTRACTION

Video sequence	Total number of sample frame	Number of plate detected from frames	Success rate (%)
1	25	22	88
2	30	28	93.3
3	20	19	95

TABLE III
EXPERIMENTAL RESULT OF CHARACTER SEGMENTATION PROCESS

Number of extracted plate	Input type	Total number of input	Success rate (%)
22	character	154	99
	word	44	99
28	character	196	95.6
	word	65	95.6
19	character	133	98
	word	38	98

TABLE IV
EXPERIMENTAL RESULT OF CHARACTER RECOGNITION OF DIFFERENT FONTS

Set	Font name	Input type	Number of input sample	Recognized	Success rate (%)
1	SutonnyMJ	character	20	19	95
		word	12	11	91.67
2	Chondona MJ	character	20	18	90
		word	12	11	91.67
3	AtraiMJ	character	20	16	80
		word	12	9	75
4	Dhanshirhi MJ	character	20	17	85
		word	12	10	83.3
5	Bhagirathi MJ	character	20	17	85
		word	12	10	83.3
6	GoomtiMJ	character	20	15	75
		word	12	9	75

TABLE V
REQUIRED PROCESSING TIME

Phase	Average time (sec.)
Number plate detection & extraction	~1.3
Character Segmentation	~0.16
Character recognition	~1.2
Total time	~2.66

TABLE VI
OVERALL SYSTEM SUCCESS AND FAILURE RATE

Phase	Success rate (%)
Number plate detection & extraction	92.1
Character Segmentation	97.53
Character recognition	84.16

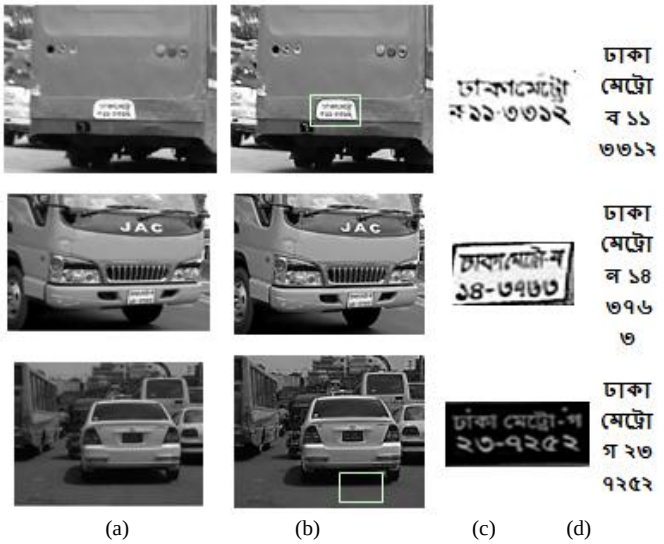
TABLE VII
COMPARISON OF SOME METHODS FOR NUMBER PLATE DETECTION

Ref.	Platform & processor	Method	Time (sec.)	Detection rate (%)
Applied method using [1]	MATLAB 8.0, P- IV 2.16GHz	Edge statistic and Morphology	~1.3	92.1
[1]	MATLAB 6.0, P- IV 3.0GHz	Edge statistic and Morphology	~1.1	90.4
[10]	P- III, 1 GHz	Combination of Color and Shape information of plate	~0.3	89.2
[20]	MATLAB 6.0, P- IV, 3.0GHz	Edge statistic and Morphology	~1.2	82.7
[2]	C++ P-IV, 3.0GHz	Mathematical Morphology	~0.1	86.0

TABLE VIII
COMPARISON OF SOME METHODS FOR NUMBER PLATE RECOGNITION

Ref.	Platform & processor	Method	Time (sec.)	Recognition rate (%)
Proposed Approach	MATLAB 8.0, P- IV 2.16GHz	Character recognition MLP	~1.2	84.16
[15]	MATLAB Not reported	Character recognition : Hopfield MLP	~3 Not reported	87 80
[18]	MATLAB 6.0 Dual-Core 1.7GHz	Fuzzy Logic + Template matching	~2.45	95.5

Total Process success rate = 92.1% X 97.53% X 84.16%
= 75.51%



(a) (b) (c) (d)

Fig. 17. Examples of successful number plate detection and recognition (a) Gray scale image, (b) after enhancement plate region detected, (c) successful number plate extraction and (d) successful character recognition

Though there are many sign boards, bill boards, name plates of many organizations and banners beside the road in Bangladesh, which contains many written words and characters, so that the detection process of ANPR is failed to find out the number plate region from a specific vehicle. Another reason for failure the detection process is that vehicles contain many characters and words which confused the detection process to detect the appropriate plate region.

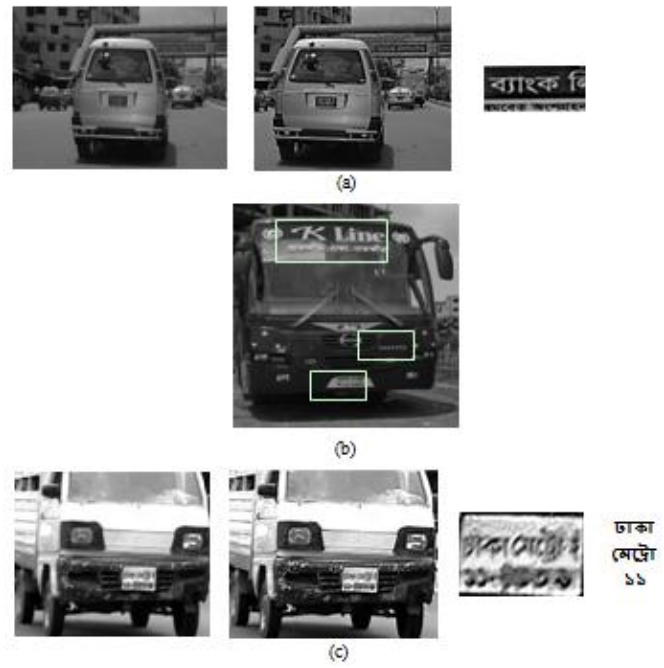


Fig. 18. (a) and (b) Examples of failure for detection and (c) failure of recognition character.

In contrast many number plates of Bangladesh have smashed in such a way that after detection and extraction, the ANPR system can't recognize the words and characters properly. Fig.18 shows some example of failure of ANPR system. On the other hand there are some characters in Bangla font (e.g., খ – ঋ, ভ – ভ) which also create similar pattern, mislead the recognition process for correct recognition.

V. Conclusion

The purpose of this project is Automatic recognition of Bangla number plates using an Artificial Neural Network. The operation of an automatic number plate recognition system can be used by the police force to catch traffic law violators instead of employing manual labor. In this project we use edge density technique proposed by V. Abolghasemi, A. Ahmadyfard to improve image quality and also applied their proposed method for number plate region detection and plate extraction because in the perspective of Bangladesh the background scenes are more complex and also the weather of this country is always changing. After the plate extraction we apply the segmentation process to isolate the characters and words from the plate. Then we applied a feature extraction technique which is rotation invariant to extract the features of the isolated characters and words after that this pattern pass through the MLP network to recognize each characters and words to identify the number plate. In future, the proposed approach is applied in service and also is extended the work for measuring the speed of vehicles.

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