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# RBFNN Approach for Recognizing Indian License Plate

[1]Rani Thakur, [2]Dr. Manish Manoria

[1] M.E.(computer science) TRUBA Institute of Engineering & I.T. Bhopal

[2]Dr. Manish Manoria Prof. of TRUBA Institute of Engineering & I.T. Bhopal

**Abstract**

In recent years, there has a lot of research on Indian license plate recognition, and many license plate recognition algorithms have been proposed and used. In this paper, a new license plate recognition approach is put forward based on the Radial Basis Function Neural Networks (RBFNN). On the basis of sharing features of a variety of license plates (LP), the vertical edge was first detected by canny edge detector. Then, some approaches were adopted to remove the invalid edge regarding the characteristics of edge grayscale jump and edge density, so that the regions having features of LP were preserved. Next, for searching LP region we apply horizontal and vertical projections and mathematical morphology (MM) operation. Then, color-reversing judgment was conducted by color analysis, and binarization was done based on center region in LP. After that, characters were segmented by means of prior knowledge and connected components analysis, and apply Radial basis function neural network for character recognition. With rich samples verified in dark hours and daytime under real conditions, the experiment indicates that it is feasible to adopt this algorithm in license plate recognition system (LPRS) to achieve accuracy.

***Keywords***- *License Plate, Plate Recognition, Neural Network, radial basis function (RBF).*

## I. INTRODUCTION

From the last few decades, Vehicle License Plate Recognition (VLPR) is the quite popular and active Research topic in image processing domain .The Fundamental issues in number plate recognition are high accuracy and high recognition speed. A number plate is the unique identification of a vehicle. Automatic Number Plate Recognition (ANPR) [1] is designed to locate and recognize the number plate of a moving vehicle automatically. All method for number plate recognition [10] has achieved higher recognition accuracy, but it does not work well still under some situations. With constantly increasing traffic on roads, there is a need of intelligent traffic management systems which not only detect and track a vehicle but also identify it.

The real-time license plate recognition is important in automatic traffic monitoring and law enforcement of traffic, however the area is very challenging. License Plate (LP) recognition helps in Identification of vehicle entering in secure premises.

Thus, License plate recognition is urgently needed in countries where the security issues are very critical.

As the LP detection and recognitions are two separate processes, the research on these two processes has always been performed separately. Different methods, techniques and algorithms have been developed and applied for these two processes. For example, some number plates cannot be recognized due to very poor illumination, motion blurred effect, fade characters and so on. Furthermore, all the available methods (There are different methods for LPR such as; Optical Character Recognition, template matching and learning-based approach [2]) performed license plate recognition after characters had been segmented. Also, the previously developed concepts from the field of image processing or the concepts from other domains are applied in order to get more accuracy; however, there is still a room for improvement. With ever declining cost of hardware devices, increasing speed of computing and ubiquity of embedded devices there is always a need for finding new solutions.

Furthermore, each country has its own LP numbering system, colors, language of characters, style (font) and sizes. Even within the same country the license plate differs from state to state and in terms of types of LP. Although some researchers have been performed on LP detection and recognition, but this research work is different from the previous works due to a number of reasons. In India License plate use the combination of Number and English characters in their license plate number as shown in Fig. 1.This study is related with the automatic detection and recognition of license plate for Indian vehicles. For the detection of the license plate, edge detection and basic morphology tools were used. According to the best knowledge of the authors, Radial Basis Function (RBF) Neural Network (NN) is only used in the recognition process, but the novelty of this work is that RBF was used for both detection and recognition. The Connected Component Analysis was used for character segmentation while the recognition process was based on selected extracted features.


Figure 1: Car Image with Indian Number Plate

## II. CHARACTER RECOGNITION BASED ON RADIAL BASIS FUNCTION

**Radial basis function:** Radial Basis Function (RBF) is an approach of Neural Network (NN) which allows viewing a design as a curve fitting problem. Radial basis function networks are feed forward, but have only one hidden layer. Like BP, RBF networks can learn arbitrary mappings: the primary difference is in the hidden layer. RBF hidden layer units have a receptive field which has a centre: that is, a particular input value at which they have a maximal output. Their output tails off as the input moves away from this point. The structure of RBF network is shown as Fig. 2.The basic form of RBF NN comprises of three layers: an input layer of source nodes connected to the environment, a hidden layer and an output layer with linear nodes). The nodes of hidden layers represent clusters in the input space. Hidden units are known as radial centers and are represented by same vector as of input units. If the input units are closed to the radial centers the output would be maximum and vice versa. Generally, the hidden unit function is a Gaussian. RBF have the advantage that one can add extra units with centers near parts of the input which are difficult to classify .The output layer supplies the response of the NN. The main benefit of RBFs over binary features is that RBF create approximate functions that smoothly vary and are istinguishable. Moreover, some learning techniques for RBF NN modify the centers and widths of the characteristic. These nonlinear methods may more easily fit the target function. The transformation from input space to hidden layer is nonlinear while from hidden to out layer is linear. Thus, RBF NN is a mapping function which map from non-linearly separable space to linearly separable space. Due to these benefits RBF was used in this research not only for recognition but also for detection purposes.

The Indian LP includes 10 characters, the first two characters is English alphabet, the second two is digit, the next two are English alphabet the other four are numbers [9]. So, we adopted four subnets, that is, state character subnet, number subnet, letter subnet, and number subnet. There are three layers such as input layer, hidden layer, and output layer.

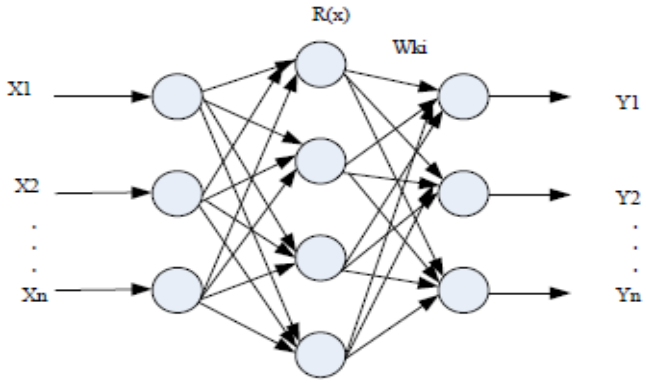


Figure 2: RBF Neural Network

$$R_i(X_k) = EXP(-||x_k - c_i||^2/2\sigma_i^2)$$

$$y_k = \sum W_{ki} Q_i - \theta_k$$

The center of network and the weights were ascertained by error-corrected algorithm and supervise learning algorithms [10]. Where, $c_{hi}$ is the center vector, and σi is the width of the center. In this paper, σi was supposed to be 10, and the 64 dimensions network features were taken as input vectors. There were 30 samples used to train for every character in every subnet. Error threshold of number subnet is 0.1, and other subnets are 0.5. Finally, the number of center vector $c_i$ of training output is such as, 447 (state character subnet), 987 (number subnet), 707 (letter subnet), and 268 (number subnet).

## III. NUMBER PLATE CLASSIFIER

The car number plate at the India has up to ten characters as shown in Figure.1 Usually the number plate consists two main sections, state with district number and unique license number of vehicle. In order to speed up the process, we use histogram projection to separate number plate into groups. The first group usually consists of two letters, two digits [3]. The second group mainly includes the unique license number. Therefore, two sets of RBFs [8] are designed

according to these two groups of characters. One set of RBFs is designed for recognizing characters of number plates and the other one is designed for characters representing the state. In the experiments shown in, it is concluded that RBF based classification could obtain higher accuracy than method of SVM based. In the following experiments, only RBF method is adopt. For real time character recognition of number plates, there are many factors causing misrecognition. For example, the numbers may also appear slanted due to the orientation of the video system, the illumination condition may vary according to the time of day and the changing weather, and the characters in number plate may be obscured by rust, mud, peeling paint, and fading color [5]. In addition, the contrast between characters and number plate surfaces can be affected by their colors. Therefore, the recognition system must be robust to many changes in dealing real time images. Furthermore the recognition system must be fast and not too expensive in real-life application. In order to solve these problems mentioned above, in our RBF-based recognition system [4] [6], two kinds of RBFs are set up first. Each RBF has one type of number samples as one positive label and all or some of the other samples as another negative label. After training, each RBF gets its own values of parameters. The decision value of the testing sample will be calculated based on the values of parameters obtained. The final recognition result will be achieved according to the class that gives the maximum decision value. We summarize the RBF [4] [6] based algorithm for number plate recognition in this paper as follows. The research design is divided into four (4) main phases: The main phases of a VLPR process are: Image Acquisition, Image Pre-processing, LP Detection, Character Segmentation and Character Recognition. The complete block diagram of the proposed method is shown in Fig. 2. In order to recognize a number plate, we go through the following steps.

### Algorithm

Step 1 Pre-process the image of number plate.
Step 2 Perform edge detection and morphological operation to find the candidate area
Step 3 Extract the feature vector of each normalized candidate
Step 4 Train RBFNN based on saved sample database.
Step 5 Recognize the number plate by the set of RBFNN train in advance.
Step 6 If there are no more unclassified samples, then STOP. Otherwise, go to Step 5.
Step 7 Add these test samples into their corresponding database for further training.

In traditional approaches, characters in a number plate were first segmented one by one so that each subimage contains only one character of the number plate. However, as mentioned at the beginning of Section 3, number plates were often wrongly segmented because of poor image quality. Moreover, we may not find as many samples for certain characters as for others so that we may not have enough training samples for certain characters.

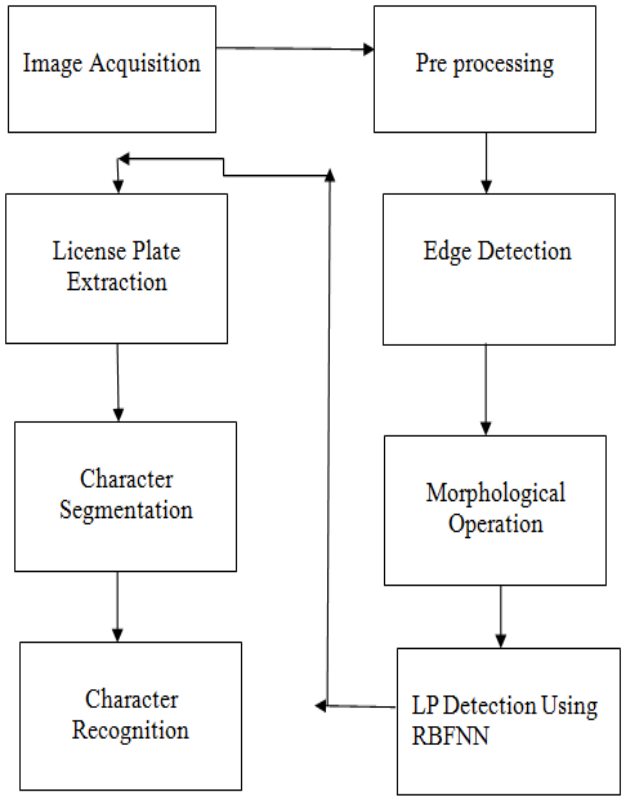


Figure 2: Framework of Proposed work

## IV. EXPERIMENTAL RESULTS

Experiments have been performed to test the proposed algorithm and to measure its accuracy. The system is simulated in MATLAB version 7.10.0.499(R2010a) for the extraction and segmentation of number plate.80 color Images were used for testing the technique. All the images being normalized to size 640 x 480 because some images were double this size and also it is normal to use the size. The images were taken of different color and variable sized number plates. The distance between the camera and the vehicle varied from 3 up to 7 meter.

However, the proposed method is sensitive to the angle of view, physical appearance and environment conditions. Table 1 tells about the percentage accuracy of the proposed algorithm:

It is shown that accuracy for the extraction of plate region is 93.75% and 90% for the segmentation of the characters and accuracy for reorganization is 90%. The overall system performance can be defined as the average of (extraction of plate, segmentation of character, recognition of character) units' accuracy rates .We get overall accuracy of our system is 91.25%

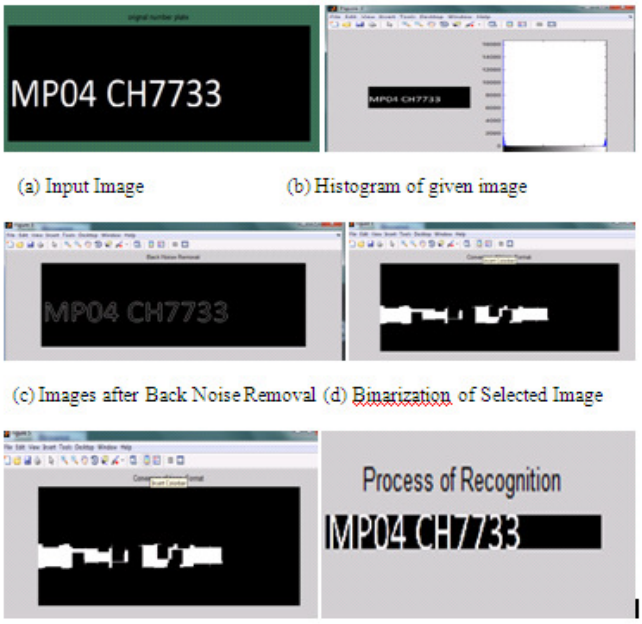


Figure 3: Shows the Output of Proposed Work

TABLE 1: Experimental Result of Proposed Work

| Module | NUMBEROF CORRECT DETECTION | PERCENTAGE OF ACCURECY % |
|---|---|---|
| Number Plate Extraction | 75 | 75/80=93.75% |
| Segmentation | 72 | 90% |
| Recognition | 72 | 90% |

## V. CONCLUSION

The proposed method is mainly designed for Indian license plate. Our method is based on the morphological algorithms and connected components analysis. To measure the efficiency, our method has been tested over a large number of images. All the images were taken in outdoor environment in different times of the day so they have different illuminations, but all pictures were taken in day light. Only the pictures from the front of a vehicle were included in the data sets. The resolution of the used digital camera was 2.0 megapixels. All the pictures were stored in "jpeg" format. The size of the images used was almost the same, but it does not matter as it is not a matter of concern and we achieved a satisfactory result on captured image.

Accuracy is not acceptable in general, but still the system can be used for vehicle identification. It may be concluded that the project has been by and far successful. It can give us a relative advantage of data acquisition and warning in case of stolen vehicles which is not possible by traditional man handled check posts. While thousands of vehicles pass in a day. Though we have achieved an accuracy of 93% by optimizing various parameters, it is required that for the task as sensitive as tracking stolen vehicles and monitoring vehicles for homeland security an accuracy of 100% cannot be compromised with. Therefore to achieve this, further optimization is required. Also, the issues like stains, smudges, blurred regions & different font style and sizes are need to be taken care off.

In this study, some problematic features like distance, light and corner are restricted. In future study can be make solution for those problems. This study is interested only for Indian license plate recognition. In future study can be interesting with international plate recognition.

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