

# CNN based Automated Vehicle Registration Number Plate Recognition System

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**Abstract**—The objective of VRNPR is to extract vehicle license plate information from number plate of vehicles. As the traffic control and vehicle proprietor recognizable proof is a significant issue in every country, it is important to develop such a device that automatically detects those vehicle owners who violates traffic rules and drives fast [1]. There are many VRNPR systems are present but there is challenging factor like accuracy of extraction, speed of vehicles, lightening condition, quality of images[2]. In this paper, different methods of VRNPR and emerging technologies are used to get accurate result. The important work is the detection and recognition of the number plate which is accomplished by the Convolution Neural Network (CNN). Reason to choose CNN is the high accuracy of around 90% even with relatively small training size [4]. We categorize many VRNPR techniques as per their features they used in each stage and compare them in terms of their advantages and disadvantages, accuracy and processing speed.

**Keywords**— *Vehicle Registration Number Plate Recognition (VRNPR), Character Segmentation, Number Plate, Optical Character Recognition (OCR), Convolution Neural Network (CNN).*

## I. INTRODUCTION

This Programmed number plate recognition assumes a significant part in some genuine applications, for example, street traffic observation , access control at parking areas , Automated toll collection booths, etc. As vehicles are increasing day by day, it is hard to keep their record manually so we need VRNPR system [5].

Also road accidents, road traffic are increasing that also cause usage of VRNPR System. As we all know that the traffic system in developed cities like Dubai, Canada, Italy etc. is pretty good as compared to developing country like India just because of automatic number plate recognition systems. Just because of these systems, the traffic rules are strictly followed by citizens otherwise action will be taken against them. Also the number of accident are also

reduced because of VRNPR system so it is necessary to implement VRNPR system to whole India or other developing country for their development and protection of citizens.

VRNPR recognizes a vehicle's registration number plate number from an image captured by a camera device. It can achieve by the combining lots of techniques like object detection, image processing, and pattern recognition. VRNPR systems use various methodologies like Artificial Neural Networks, Optical Character Recognition, Probabilistic neural networks, Back-Propagation Neural Networks, inductive Learning, Convolution Neural Networks, etc. [6].

The limitation of previous model was the accuracy of the system and time taken by system to recognize the number plate, but in this paper we use latest and emerging technologies which help the system to maintain the accuracy of model and make it faster and better to extracts the number plate.

The important work is the detection and recognition of the number plate which is accomplished by the Convolutional Neural Network (CNN) along with various different methodologies. Reason to choose CNN is the high accuracy of around 90% even with relatively small training size. Convolutional neural networks have been considered as one of the most persuasive developments in the field of computer vision.

A Convolutional neural network yields a lot better result than traditional computer vision. These neural networks have proven successful in various different real-life application and case studies, like:

- Image, object detection, segmentation, face recognition [7];
- Self driving vehicles that contain CNN based vision frameworks;
- Crystal Structure classification using CNN.

## II. LITRATURE SURVEY

Various classifications were already proposed as methods which was implemented using different approaches like edge detection, OCR algorithm based on feed-forward neural network, plate localization, etc. The class of methods can be further broken down into various subclasses which include some constructive algorithms like application of Soble filtration technique , application of Hough Transform method, histogram approach, etc Results indicates that CNN based approach along with heuristics and morphological operations are generally more effective as compared to available literatures.

Nwe Ni Kyaw et al [4] proposed vehicle number plate recognition system for Myanmar vehicle number plates. He did an extensive survey and suggests some important observations that resolve the challenges of research in context with vehicle registration number plates. He proposed preprocessing along with Histogram Based noise removal Method. In this paper K-means and fuzzy K-means was used for feature extraction and claims high accuracy with proposed model.

Kashyap et al [5] He proposed an OCR based Number Plate Recognition system. He applied various image processing methodologies like Binary Image Processing, Gray-Level Processing, and Color Processing. He captured the image of number plate then processes it using OCR, where the characters on the image of number plate were changed into some text that can be decoded later. His algorithm is a combination of Artificial Neural Network, Probabilistic neural network, Optical Character Recognition, MATLAB. He claims for about 75-85% accuracy for Indian vehicle number plates.

Chirag Patel et al [7] A survey on various number plate recognition systems and proposed application of artificial neural network method for character recognition. They used image binarization and detected edges by help of sole or canny algorithms. They also used blob detection algorithm in order to find points of different brightness. They discussed different approaches of VRNPR on various parameters like image size, processing time and success ratio.

Aniruddh Puranic et al [8] proposed a methodology of implementation of support vector machine to extract vehicle model, they applied feed forward NN based OCR as well median filtering mechanism along with histogram equalization with character segmentation in MATLAB. As a result they claimed that template matching strategy will yield up to 80.8 % accuracy implemented using template. They advised for using genetic algorithms to consider legitimate frames for vehicle as well as plate classification.

V.HimaDeepthi et al [9] provides a distinct approach by completing the task in two sequential stages by preprocessing of subject images followed by localization. Initially they applied root mean square method followed by mathematical morphology and symmetric wavelets in order to obtain noise ratio. On dataset of about 280 images they achieved correct output of 77.14% on the database and around 92.14% on the subject images.

R. Ghosh et al [10] proposed a registration plate recognition system specially for vehicles of India. They adopted a filtering method which was based on region of interest. Initially they had taken an image source from the video. The number plate portion of whole image is considered before optical character recognition. They proved about 92.31% robustness of their proposed system.

Wanwei wang et al [11] proposed a multi tasking based CNN vehicle registration plate recognition with a new approach which was focused on lowering the computational cost as well. They had taken a comprehensive data set of Chinese vehicle registration plate and then train the CNN in order to enhance recognition rate. They proved about 98% accuracy which was better than previously achieved statistics.

Tomas Björklund et al [12] proposed CNN based vehicle registration plate recognition with a new approach which was focused on the training of CNN over synthetic number plate images. They generate synthetic images that was responsible for illumination and pose conditions and then encountered the same with real registration number plate images, they used synthetic images to train the CNN. They had taken the real vehicle images that were captured under natural light. They achieved around 93% results over synthetic images.

Jacob et al [14] synthesized the issues associated with vehicle registration number plate, they discussed about the diversities in registration number plate shape and size, diversities in background and character colors, unclear or blurred image findings due to viewing angles, smog and various other unfavorable conditions. They finally proposed that CNN based approach may be proven more fruitful results as compared to morphological approaches.

## III. VRNPR SYSTEM MODEL

VRNPR algorithms can be divided in five steps:

- (1) Vehicle image capture
- (2) Pre-processing
- (3) Registration Number plate detection
- (4) Character segmentation and
- (5) Character recognition

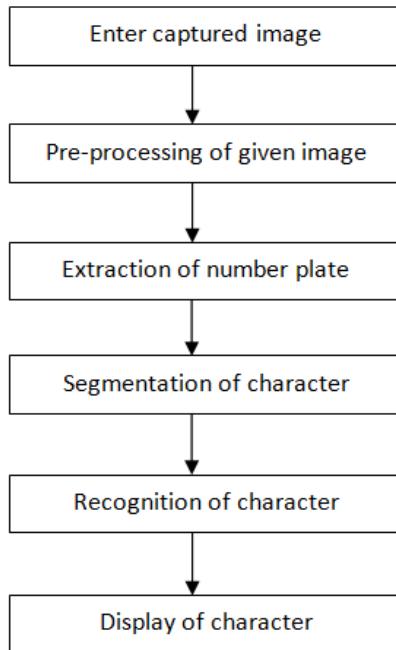


Fig.1: Flow Diagram of VRNPR

Almost all the research and methods had covered all the 5 process in one way or the other. As it is shown in Fig.1, the first step is to capture image of vehicle, it looks quite easy but it is very difficult to capture image of moving vehicle in real time such that all the numbers and alphabets clearly visible. After capturing the image, pre-processing is done so that it is easy to extract the number plate. Most of the researchers model two approaches.

1. RGB to gray scale conversion using Average method.

$$\text{img} = (\text{R}+\text{G}+\text{B})/3$$

2. Edge detection and noise reduction using Sobel Operator.

After the pre processing dilation is done for the removal of stationary objects and background image. As the dilation complete image will be ready for the number plate detection using Hough transform. Then the final step character recognition comes which is done by using Optical character recognition technique and Histogram approach.

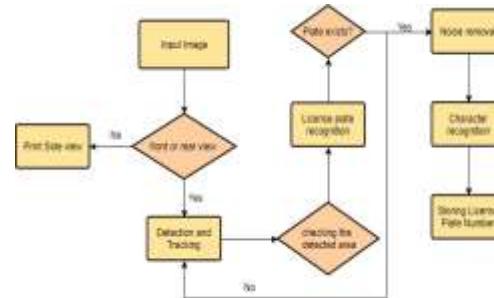


Fig.2: Flow chart of VRNPR

#### A. Image Acquisition

First step is to capture the image of car using digital camera connected with PC. The captured image is in the RGB format so we need to convert it into suitable form for further process of the Number Plate extraction. The captured image is further process for detection of number plate.



Fig.3: Captured image by camera

#### B. Image Processing

After capturing the image, preprocessing is done. The main function of this process is to enhance the quality of the image that will be used for the character recognition. The captured image is influenced with many elements such as: quality of image, brightness of image, lack of presentation, motion of the camera and the bad influence to the further image processing. Various processes that we are going to apply are converting RGB image to Grayscale, noise reduction and binarization of image.



Fig.4: Conversion of RGB into gray scale

### C. Plate Localization

As the preprocessing of image is done, the next task is to detect the number plate from the given gray scale image. The basic idea behind the recognition is to identify the plate size. For doing so, we have many method like Sobel's edge detection method and Hough's Line detection method. Further by using the intersection points of the shapes, we get to know whether it is a rectangle or not depending upon the number of points in the group. As we get point of rectangles, we successfully extract the rectangular parts from the image, out of which we are able to find the license plate depending upon the properties of plate like major and minor axis length, area, bounding etc.



Fig.5: Detection of license plate

### D. Plate Segmentation

After detecting registration number plate of vehicle, segmentation of number plate is done. Character segmentation is done on the binary image of the extracted license plate. Segmentation is a key process from a set of processes in the automatic vehicle Registration number plate recognition;

since it is the basic step and all further operations on image for VRNPR depends on it. If the process of segmentation doesn't gives the required output, then a input character may be get divided in more than one

pieces, or a set of more than one character may be accidentally merged in to a single character. We can make use of a method called as horizontal projection for performing segmentation operation on a number plate, or one from the more suave methods, like making use of neural networks for segmentation of images. In this approach of performing segmentation of images we can make use of two types of segmentation:

1. Horizontal method of Segmentation

2. Vertical method of Segmentation.

Firstly we have to apply vertical method of segmentation on registration number plate of vehicle this will vertically segments the characters. Next we have to perform horizontal segmentation operation; we get the extracted characters from the registration number plate, as output of this operation.

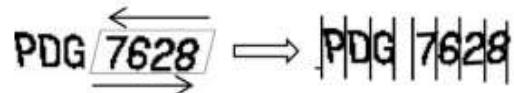


Fig.6: Segmentation of image

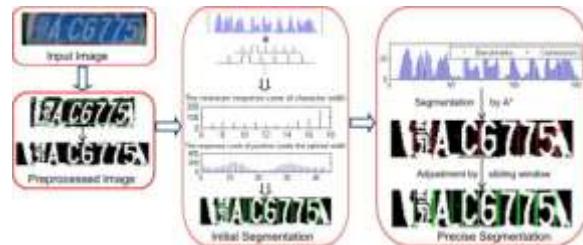


Fig.7: Segmentation of image1

### E. Character Recognition

After segmentation of image is done, character recognition is processed, which is one of the most vital step in VRNPR model. In this step, we have to perform character recognition; this is initiated by performing feature extraction which is the basic operation for recognition of character. In the process of feature extraction the data is transmuted from a source bitmap representation into a form which is more convenient for the computer to process.

The classification of information is done on the basis of features which are extracted in the previous step. These extracted features are then organized by using

either the, syntactic methods, neural methodologies or statistical approaches. In this paper we have made use of Distinctive strategies for recognition of character and letters.

In the phase of template matching characters which are obtained from the registration number plate and set of characters which are stored on database are coordinated. Optical character recognition (OCR) is one more technique for character recognition in this approach we have to look at the each and every individual character against the entire database having alphanumeric data. The OCR approach for character recognition uses relationship strategy for matching individual character and we get the recognized numbers as output of this phase, this obtained number is than stored in string format in database.

Characters are compared with the database for the vehicle registration authorization. The outcome obtained in the form of signs is organized in accordance of the sequence of comparison. Templates are available for every character from A-Z and 0-9 as shown in figure 8.



Fig.8: Training model Character used for template matching

#### F. Training model

In the character recognition module, we are classifying an image of character into one of the 36 classes that contains 26 alphabets from A, B, C... ,Z and 10 numeric values from 0, 1, 2...9. To train our model, we use Advanced Convolution Neural Network to train the training sets which were obtained from images available on Kaggle's data sets which contains around 1200.images of number plates of Indian vehicles. The total number of data for each class is around 150. After successful training, our model can recognize registration number plates. Consider a 256 x 256 image. CNN scan that image pixel by pixel just like a  $2 \times 2$  window. The  $2 \times 2$  window slides throughout the image in left to right and top to bottom manner.



Fig.9: Sample Kaggle's data set

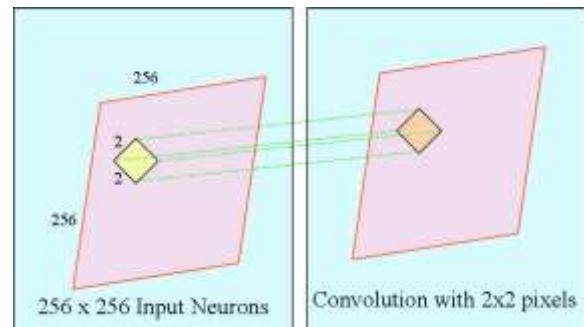


Fig.10: CNN Image Scanning

## IV. PROPOSED ALGORITHM

### A. Image preprocessing

1. RGB to gray scale conversion by averaging method.
2. Edge detection using Sobel Operator

$$T_x = \begin{pmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{pmatrix} * B$$

$$T_y = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} * B$$

where, B is original image

$$\text{edge pixel } E_G(m,n) = |C(m,n) * T_x| + |C(m,n) * T_y|$$

where  $C(m,n)$  represents pixel values of input image C.

### B. Image subtraction

Removal of stationary objects and Removal of image background we use image subtraction Algorithm.

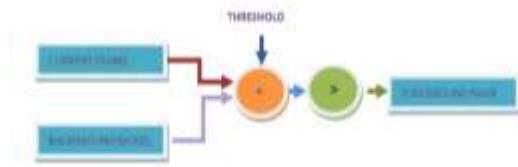


Fig.11: Image Subtraction

### C. Dilation process

It is used to improve image quality and to extend white region of binary image

$$A \oplus B = \{z \mid (B^8)z \cap A \neq \emptyset\}$$

### D. Identification of number plate

1. We use Hough Transform method for number plate recognition.

for all  $g(a_i, b_i) > \text{threshold value}$  do  
for all P do

$$\rho = a_i \cos(\phi_g(a, b)) + b_i \sin(\phi_g(a, b))$$

find index value k corresponding to  $\rho$  and increment  $A(k, \phi_g(a, b))$

where P→plane

2. Morphological methods and Heuristics approaches for locating the registration number plate.

### E. Recognition of character

1. OCR (optical character recognition) method is applied for recognition of character.

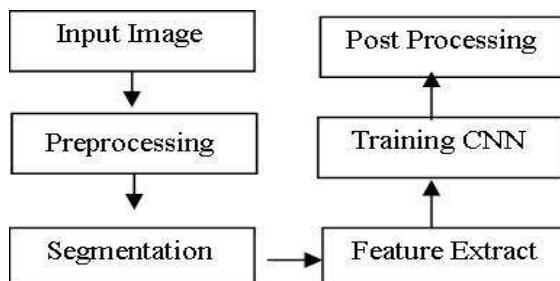
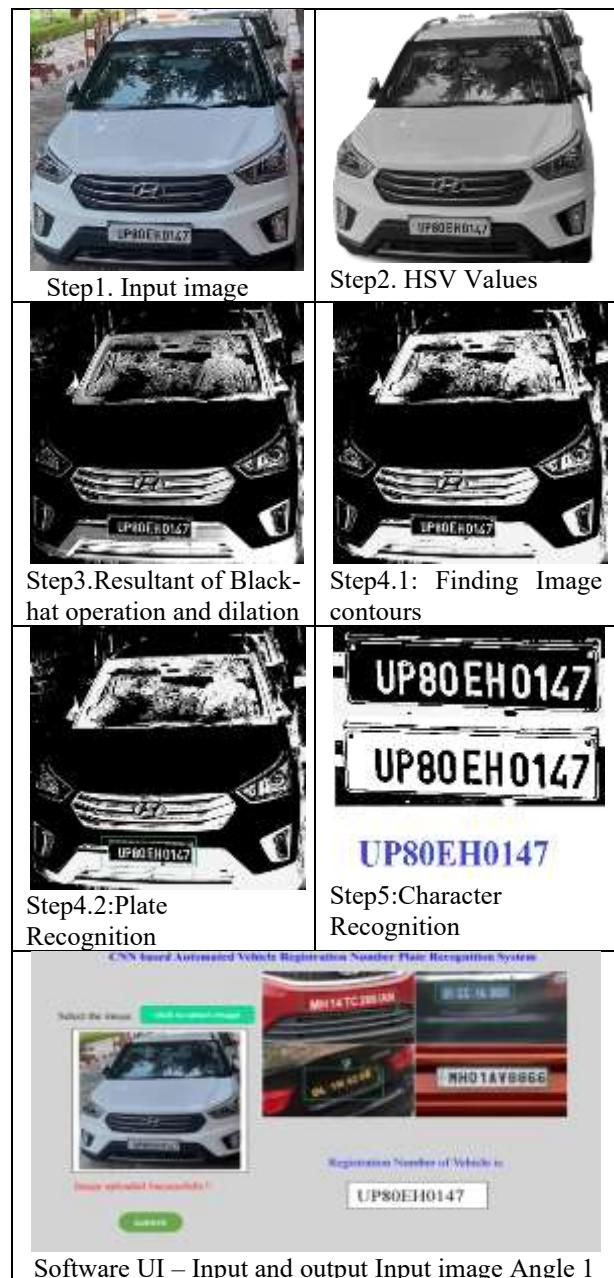


Fig.12: Steps - Optical Character Recognition

2. Histogram approach Connected pixels method used for character recognize.

## V. OBSERVATIONS AND RESULTS

We are testing our algorithm on a set of data which comprises around 300 images and get the desired results with around 99% accuracy even when applying the images of vehicles from various angles as it is supposed that we obtain vehicle image from various different angles. Below is the set of images that illustrates various operations of our proposed algorithm.



Software UI – Input and output Input image Angle 1



Software UI – Input and output Input image Angle 2

CNN based Automated Vehicle Registration Number Plate Recognition System

Select the image  



Registration Number of Vehicle is  
UP80EH0147


Software UI – Input and output Input image Angle 3

CNN based Automated Vehicle Registration Number Plate Recognition System

Select the image  



Registration Number of Vehicle is  
UP80EH0147

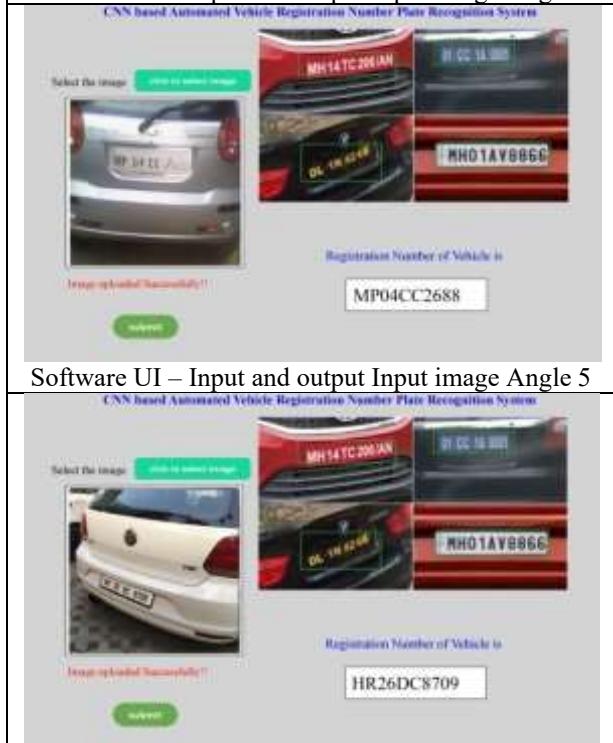

Software UI – Input and output Input image Angle 4

CNN based Automated Vehicle Registration Number Plate Recognition System

Select the image  



Registration Number of Vehicle is  
MP04CC2688

Software UI – Input and output Input image Angle 5

CNN based Automated Vehicle Registration Number Plate Recognition System

Select the image  



Registration Number of Vehicle is  
HR26DC8709

## Software UI – Input and output Input image Angle 6



CNN based Automated Vehicle Registration Number Plate Recognition System

Select the image  



Registration Number of Vehicle is  
DL1T2818

Software UI – Input and output Input image Angle 7

## VI. CONCLUSION

The major work proposed in this paper is detection and recognition of registration number plate, which is fulfilled by the use of Convolutional Neural Network (CNN). Reason to choose CNN lies into its high rate of accuracy of about 90% even in the case when we take a small training data set. Convolutional neural networks have emerged as a boon in the field of computer vision. There rate of performance is far ahead when compared with traditional ones and have produced resounding results as well.

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