Abstract
As automatic vehicle number plate detection has many applications in traffic systems, vehicles number plate detection has been intensively studied in many countries. In this paper, a simple and efficient method is presented which is mainly designed for Indian vehicles number plate detection. The presented method is based upon edge detection with sobel operator, dilation and template matching process. The proposed method has been tested over real images and from the results it shows good performance in number plate detection.

Keywords
Vehicle Number Plate Detection, Segmentation, Dilation, Template Matching

I. Introduction
In intelligent traffic systems, vehicle number plate detection is an essential stage. Vehicle number plate detection is a form of automatic vehicle identification [1]. As the use of the vehicles has been increasing, the control of the vehicle is becoming a big problem. For effective control an automatic vehicle identification system has been developed. The vehicle number plate detection has many application in traffic monitoring system including highway electronic toll collection, traffic volume, vehicle tracking, policing, border, custom security and so on. Since every vehicle carries a unique number plate, by image processing techniques vehicles can be identified by only their number plates.

In Digital image processing, an image may be defined as two dimensional function f(x, y) where x and y are spatial (plane) coordinates and amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of image at that point. Digital image processing starts with one image and produces a modified version of that image. Digital image analysis is a process that transforms a digital image into something other than a digital image, such as a set of measurement data, alphabet text, or a decision. Image digitization is a process that converts a pictorial form to numerical data [2]. Image processing techniques have been developed tremendously during the past five decades.

II. Literature Review
The problem of automatic VNP recognition is being studied since the 90’s [3]. The early approaches were based on characteristics of boundary lines. Johnson and Bird [4], proposed knowledge-guided boundary following and template matching for automatic vehicle identification. Choi [5], and Kim [6], proposed the method based on vertical edge using Hough transform (HT) for extracting the license plate. E.R. Lee, P.K. Kim and H.J. Kim [7], used neural network for color extraction and a template matching to recognize characters. S.K. Kim, D.W. Kim and H.J. Kim [8], used a genetic algorithm based segmentation to extract the plate region. Tavsanoglu and Saatci [9], proposed an approach to form orientation map as recognition feature using a Gabor filter for recognizing characters. Yoshimura and Etoh [10], used Gabor jets projection to form a feature vector for recognizing low resolution gray-scale character. Lotufo, Morgan and Johnson [11], proposed automatic number-plate recognition using optical character recognition techniques.

III. Work Done
Fig. 1, shows the diagram of the proposed method for vehicle number plate detection.

![Proposed Method](image-url)
A. Original Image
Original Image is an input of this system. This input image is an image captured by a camera from a distance of 4-5 meters as shown in fig. 2.

![Original Image](image1)

Fig. 2: Original Image

B. Pre-Processing
Under the Pre-Processing we have done two processes
- RGB to Gray conversion
- Median filtering

RGB to Gray conversion: The RGB image is converted into a Grayscale image to make the analysis easy. Fig. 3 shows the Grayscale image. We have used the MATLAB RGB2gray function for this conversion.

![Grayscale Image](image2)

Fig. 3: Grayscale Image

Median Filtering: 2-D Median Filtering is then implemented to remove speckle noise, salt and pepper noise.

C. Plate Region Extraction
Location of the plate is extracted with the help morphological dilation and erosion, as shown in fig. 4.

![Extracted Plate Location](image3)

Fig. 4: Extracted Plate Location

D. Segmentation
Segmentation of an image entails the division of image into regions of similar attribute. In this method the segmentation is achieved by the application of the edge operators. Sobel operators are used for the edge detection as shown in fig. 5. Masks for horizontal and vertical directions are shown.

![Sobel Mask](image4)

Fig. 5: Mask for Horizontal Direction

\[ M(i,j) = \sqrt{(S_x)^2 + (S_y)^2} \]

S_x: Mask for horizontal direction
S_y: Mask for vertical direction

In this we have also done sobel detection with threshold using some fudge factor. By this edges are more clear and are detected better as shown in fig. 8.

The image resulting from edge detection cannot be used as a segmentation result. Supplementary Processing steps must follow to combine edges into edge chains that correspond better with borders [12].

E. Dilation Operation
Morphological-dilation operation with rectangular Structuring Element (SE) of size 3x3 is then performed on the binary image. Dilation is a morphological transformation that combines two sets by using vector addition of set SEs and Erosion can be obtained by dilating the complement of the black pixels and the taking the complement of the resulting point set. Results of the dilation is shown in fig. 9.

F. Character Recognition
Character recognition is then done by comparing with the pre-stored template. As the number plates may be in any condition, the characters may be deformed and noisy. These defects should be tolerated by Character recognition techniques. We have used the character template shown in Fig. 5. The character template that best matches the input characters are then displayed.

![OCR Templates](image5)

Fig. 6: OCR Templates used for Matching

IV. Technology Used
The whole work was done in MATLAB R 2010 a. To test the proposed method, experiments were performed in MATLAB.

V. Results
This method has been tested over a large number of images in order to analyze its performance. It segregates character in 95% accuracy. The performance of the test results demonstrate that the proposed method is efficient to be used for the license plate recognition system.
VI. Conclusion

In this paper, we presented a simple and efficient vehicle plate detection method. The proposed method is mainly designed for detecting Indian vehicle number plate and can be extended to multinational vehicle number plate in future studies. This method has four main stages which are preprocessing, edge detection, dilation and lastly applied template matching. This method has been tested over a large number of images which proved the efficiency and accuracy of the method.

References