Automatic **L**icense **N**umber **P**late **R**ecognition

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Abstract – In this era, everyone uses cars and transportation to reach at their destination, so because of this there is unlimited increase of vehicles. To verify and check whether a vehicle is registered related to traffic violation Police forces need Automatic License Number Plate Recognition. Automatic License Number Plate uses images of vehicle and then check for plate number for verification of vehicle. ALNPR can be used to check whether a vehicle is registered, and it also can be used for detecting and recognize license number plate in real time so that higher authorities (Police forces) can verify and track location of a vehicle. ALNPR uses OpenCV for computer visions. ALNPR uses OCR (optical character recognition) to identify image and read characters of vehicle's license number plate. These days, Automatic License Number Plate Recognition system is used in many fields like crossings of border, parking system, automatic toll collection, traffic control, and law enforcement (Police Forces uses this) etc. This ALNPR system uses four steps to achieve goal, four steps are: image identification, number plate localization, character segmentation from number plate and character recognition of number plate.

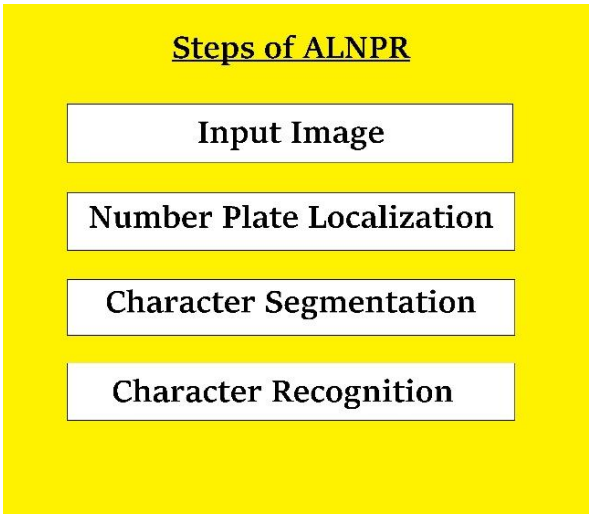
Key words: – ALNPR, OpenCV, OCR, segmentation

I. INTRODUCTION

Due to rise in traffic and number of vehicles on roads, it is very hard to handle law enforcement, traffic rules and regulation. There are tollbooths and traffic maintenance on freeways and parking complex to analyze traffic on roads and speed of moving vehicles. And, day by day numbers of vehicles are increasing continuously. It is very difficult to handle enforcement laws, traffic control, traffic rules and regulation manually, so to verify vehicles, check whether a vehicle is registered or not and track a vehicle (tracking of vehicle is possible with license plate number) need Automatic License Number Plate recognition (ALNPR). ALNPR system can be used to recognize characters from number plate from identified image, in this way, can get number plate number that can be used for verification of a vehicle and track a vehicle. A vehicle number can help in getting more information like name of owner, details of vehicle and can be used for further processing. This ALNPR system can be used at entrance of highly restricted areas like military zones, top government offices (parliament, supreme court) for enhanced security.

The ALNPR system is mass surveillance method that uses OCR on images containing vehicle images to recognize number plate. This ALNPR system is based on image processing in which vehicle's plate number is recognized. Basically, the main objective of this ALNPR system is design a system that get image from USB web camera to recognize vehicle's number that can be used to verify or track vehicle's location.

The ALNPR system is implemented using MATLAB. The ALNPR system is implemented with mainly four steps: first, input is provided from web camera where OpenCV is used to take images of vehicles from (computer visions), Second, from input that is an image containing vehicle, number plate is recognized and localized, Third, after localizing number plate of a vehicle in an image, character segmentation is applied to decompose image in sub images, Fourth, after character segmentation, to identify every character, character recognition is used. In this way, number plate of a vehicle is identified.



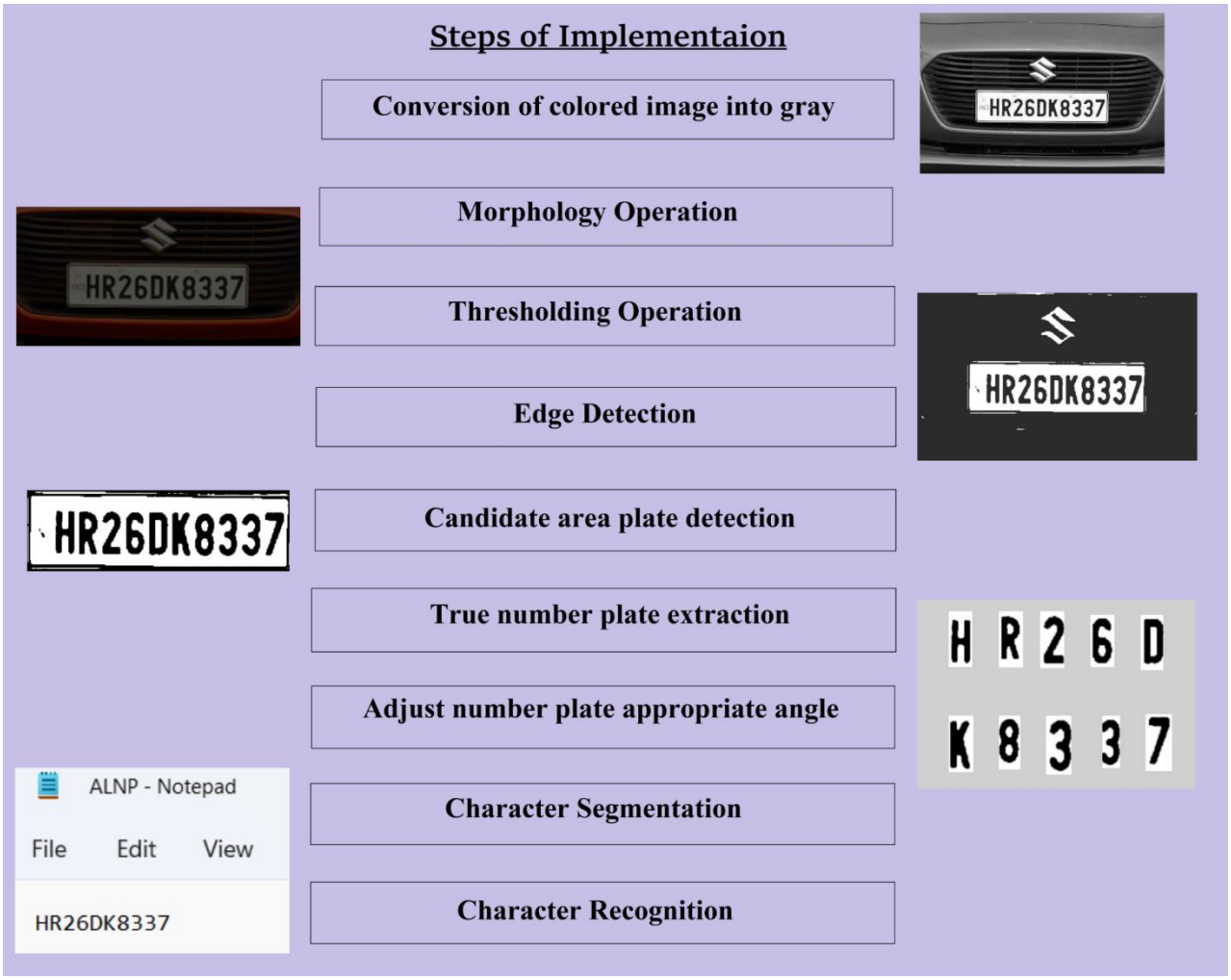
(Fig. Steps of ALPR)

II. IMPLEMENTATION

ALNPR is generally implemented in steps. Mainly, four main steps of ALNPR are: Image identification, Plate number localization, character segmentation and character recognition. Its implementation of this system is performed in many steps. In ALNPR system, input image is taken from camera that contains image of cars and image is large, but number plate is very small part of the image and image is taken from different background and different histograms, so number plate localization is difficult and there are many methods to localize number plate. And step of number plate localization affects further steps of character segmentation and character recognition.

For Number plate localization, few steps are needed to add to make number plate localization easier and faster. There are many methods for number plate localization, here an efficient and effective method is used. This ALNPR system work on images that are taken from USB web camera and images contains cars. Images are taken from different backgrounds, different histograms, different orientation, and illumination conditions. It is needed to make images better to extract number plate and character segmentation. Histogram equalization can be used to filter

lightning and contrast problems. Histogram equalization is an image processing technology that spread out most frequent intensity value to improve contrast of image. Morphology operation and vertical edge detection can be used to localize number plate in image. Morphology is an image processing technology that apply structuring element on input image to make output image of same size of input image. Vertical edge detection is used to reduce amount of data from image that is unneeded while having important structures of an image, in this we can localize number plate in an image.



(Fig. Steps of Implementation)

A. **Conversion of colored image into gray image –** The method is used in this system doesn't depend on the colors of image, it means that this system will allow only gray colored images, for that we need to convert colored image into gray image. Color components of RGB (red, green, and blue) are not used in this method. When this system gets a colored image of three-dimensional in MATLAB, then it is converted to gray colored two-dimensional image. All further processing steps will be implemented on gray colored images. The main reason for using only gray scale image is that it makes algorithm easier

and reduce other computation requirements and it can be used for extracting descriptors from an image.

(Fig. Input image)

(Fig. Gray scale image)

B. Morphological operation – Morphological operation is an image processing technology that processes image on based of its shapes, it creates output image of same size of input image by applying structuring element to an input image. In this ALNPR system morphological operation is used to apply structuring element on gray scale image of a vehicle and then create same size of output image by subtracting from original input image. Dilation is an application of morphology that adds pixels to boundary of an object. Dilation improves images quality by making objects more visible, joining the broken lines in an image and filling holes in an image, sharpening the edges of objects and by increasing brightness of an image. Noise or irrelevant data from an image can be removed by using dilation. By sharpening the edges of an image, variation of gray scale value between neighboring pixels at an edge can be improved which will help in edges detention. Dilation

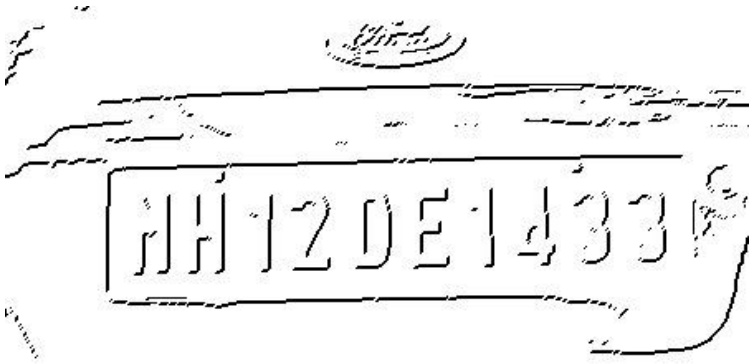
process can help in nullifying losses that are made during the process of conversion of colored image into gray scale image like difference in color etc.

(Fig. morphology image)

C. **Thresholding operation –** Thresholding operation is image processing technology in which gray scale image is converted into binary image. It is process of image segmentation. This operation is performed in a way that objects or foreground pixels can be separated from background pixels, so it's an image processing technology. This thresholding operation is used to select area of interest from an image and ignore other parts of image that are not useful. The operation of thresholding in image processing compares each pixel value of an image to a specified threshold. So, this operation will divide all pixels of an image into two groups: 1) pixels having lower intensity value than threshold value 2) pixels having greater intensity value than threshold value.

(Fig. Thresholding image)

D. Edge detection – Edge detection is used to find boundaries of objects in an image, that works by detecting discontinuities of brightness in an image. This process helps in areas of image processing, computer vision by using image segmentation and data extraction within images. Simply, vertical edge detection is used to detect vertical edges within images. This vertical edge detection works by using a horizontal gradient operator followed by a threshold operation to detect the extreme values of gradient. Histogram is a type of graph that represents values of variable quantities over a given range. In this Automatic License Number Plate recognition system, both horizontal and vertical histograms are used which will give column wise and row wise histogram graph respectively. These histograms show column and row wise sum of difference of gray values between neighboring values of pixels. First, horizontal histogram is calculated, horizontal histogram is calculated by traversing through each column of an image. The process of these histograms' calculation starts from second pixel and get difference of first and second pixels, then calculate difference between third and second pixel and in this way, it gets sum of difference of pixels. In the same way vertical histogram is calculated but rows are used instead of columns. In this way edges are detected that help in number plate localization.



(Fig. image with edge detection)

E. Candidate plate area detection – Morphological operation removes unwanted and irrelevant data from an image. Candidate plate area detection is used to extract true candidate area from the entire image. Sometimes, morphological operation is not able remove irrelevant data from an image like background area maybe selected as candidate plate, so, to remove fake candidate plate, plate validation or closing and opening is done using the aspect ratio of plate and horizontal cuts.

F. **True Number Plate Extraction –** After getting candidate plate area, to extract number plate area bounding box analysis is used. Bounding box helps in image processing. Bounding Box means referring to boundary coordinates of image, that is used to detect target object in an image and create collision box for that. In this step, number plate is localized where probable number plate is present. Firstly, probable areas of interest of

number plate are stored in an array. Out of these areas, the area having maximum histogram value is selected as most probable candidate plate.

(Fig. Number plate extraction)

G. **Adjust Number Plate appropriate angle –** When extracted number plate is not in horizontal position then this step is performed to rotate number to an angle to make it horizontal. Slop and rotation angle are below:

$$M = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\theta = \tan^{-1}(M)$$

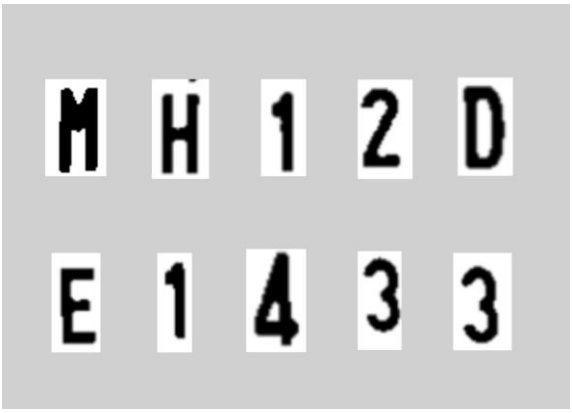
Here M is slop and θ is rotation angle.

H. **Character Segmentation: -** Character segmentation is important step because in this step, characters from number plate are extracted. This step will create sub images of characters from number plate (breaking a whole image into sub images). Main aim of this step to get characters from number plate without losing feature of characters. This step contains sub step to achieve character segmentation, basically, characters will be segmented from number plate.

1. Character region enhancement – In this step number plate image will be converted into binary image for character region enhancement by using gray thresh function. In this step erosion operation will be used that will in make characters thick.

2. Connected component analysis – In this step, noise other than characters from number plate will be removed.

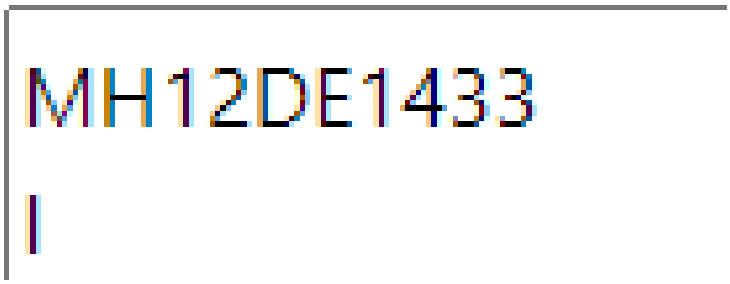
3. Vertical projection analysis – Character segmentation is used to make sub images of each character from whole image of number plate. This step will help in finding gaps between characters, that will help in character segmentation based on number of valleys in projection.



(Fig. character segmentation)

I. **Character recognition –** After character segmentation, character recognition is used to match or compare each character against alphanumeric database. This step can also be called Optical Character Recognition (OCR). Optical Character Recognition (OCR) uses correlation method to compare each character with alphanumeric database and after matching a character it stores that character in a string to a variable. Then, these characters can be compared with database for vehicle verification and localization. For OCR, firstly image should be converted into binary image (black and white). Then, to separate each character it is needed to crop and separate the lines from image rows and also for columns of each row. Then all characters are stored in a template file.

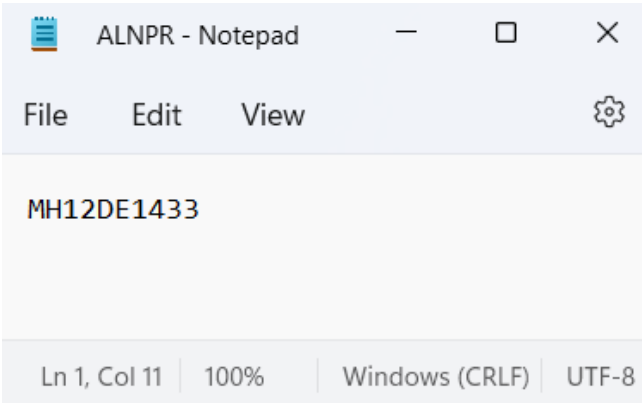
1. Separation of lines form image – After converting image into binary image, it is stored in MATLAB as 2-Dimensional array. It will be stored in binary form 1s and 0s where 1 represents white and 0 represents black. Then values of a single row are added, if the value of sum is greater than 0 then it means there a value that is non-zero value, if sum of values is 0 then it means row contains 0 values. A row with sum of value with 0 represents that it doesn't contain portion of character and a row with no-zero value represents that it contains some part of character. After this process, row with zero value will be removed.
2. Separation of characters from line – Separation of character from line is same as separation of lines from image, here columns will be used instead of rows. Values of a single columns are added, if the value of sum is greater than 0 then it means there a value that is non-zero value, if sum of values is 0 then it means columns contains 0 values. A column with sum of value with 0 represents that it doesn't contain portion of character and a row with no-zero value represents that it contains some part of character. After this process, columns with zero value will be removed.
3. Identifying individual characters – After extracting characters from image, all characters are passed to read letter block for identification. A template file containing all the characters will be loaded and then 2-dimensional correlation function will be used to find best matches between template file and extracted characters. Those characters who will give high correlation with template file will be stored in a text file.



(Fig. character recognition)

III. RESULTS

After all steps, the characters who are highly correlated to template file of all characters will be stored in a new text file. This text file will an output. This text file contains number of license plate number that can be used for further authorization of vehicle.



(Fig. Result Output)

IV. CONCLUSION

In this paper, the Automatic License Number Plate Recognition (ALNPR) system is represented that can be used for check for authorization of vehicle, getting details of vehicle and localize vehicle etc. This ALNPR system uses image processing technology for recognition of number plate of vehicle. This ALNPR system works well on different types of number plate, different angle of number plate and wide variation of conditions.

Although this system works well, there is still some points to improve. The speed of this can increase with use of high-resolution camera, which will be able capture better ad clear images.

At present in this system there are certain limits on few parameters like speed of vehicle and skew in the image, these limits can be removed by enhancing algorithm further.

V. FUTURE SCOPE

In future, it needed to find more features of character and then enhance algorithm for character recognition. Still some further research to do because there many types of number plate like two row plate, so this can't for it, in future work this problem will be solved.

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