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Automatic Number Plate Recognition System

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***Abstract*- Traffic control and vehicle owner identification has become major problem in every country. Sometimes it becomes difficult to identify vehicle owner who violates traffic rules and drives too fast. Therefore, it is not possible to catch and punish those kinds of people because the traffic personal might not be able to retrieve vehicle number from the moving vehicle because of the speed of the vehicle. Therefore, there is a need to develop Automatic Number Plate Recognition (ANPR) system as a one of the solutions to this problem. Automatic Number Plate Recognition (ANPR) is an image processing technology which uses number (license) plate to identify the vehicle. The objective is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate. The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in an image. Optical character recognition technique is used for the character recognition. The resulting data is then used to compare with the records on a database so as to come up with the specific information like the vehicle's owner, place of registration, address, etc.**

Keywords- Automatic Number Plate Recognition (ANPR), Optical Character Recognition Character Segmentation Image Segmentation, Number Plate.

I. INTRODUCTION

The Automatic Number Plate Recognition (ANPR) was invented in 1976 at the Police Scientific Development Branch in the UK. Automatic Number Plate Recognition system i.e., system is an image processing technology. However, it gained much interest during the last decade along with the improvement of camera and the increase in computational capacity.

It is simply the ability to automatically extract and recognition a vehicle number plate's characters from an image. The ANPR system works in three steps, the first step is the detection and capturing a vehicle image, the second steps is the detection and extraction of number plate in an image. The third section use image segmentation technique to get individual character and optical character recognition (OCR) to recognize the individual character with the help of database stored for each and every alphanumeric character.

We have implemented algorithm for Automatic Number Plate Recognition System using OpenCV. This algorithm initially used different inbuilt functions and implemented some user defined techniques related to image processing. Once the algorithm was implemented, it was checked with multiple input images having vehicle number plates. The input vehicle images consist of number plates that were aligned with some angle from horizontal axis. Once the algorithm was completely verified, the in-built functions of OpenCV were replaced by user defined functions.

The ANPR system consists of following steps: -

- Vehicle image capture.
- Preprocessing.
- Number plate extraction.
- Character segmentation.
- Character recognition.

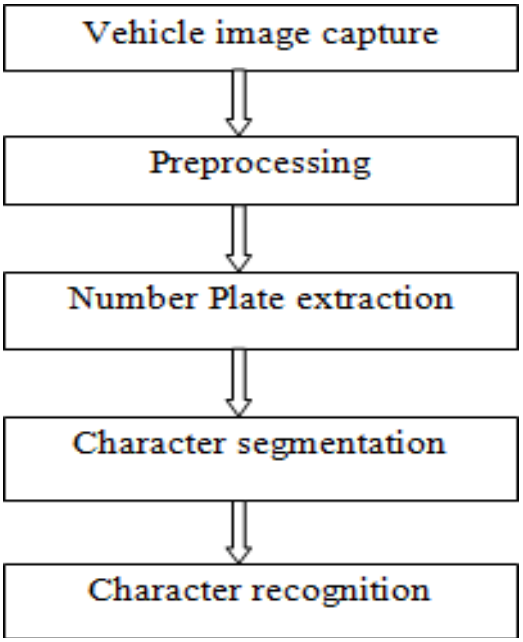


Fig 1. Block diagram of ANPR system.

II. ANPR SYSTEM MODEL

The decisive portion of ANPR system is the software model. The software model which uses image processing toolbox for chain of image processing techniques which are executed in OpenCV.

Typical ANPR System consists of four steps these are image acquisition, license plate extraction, character segmentation, and character recognition. For the efficient and accurate results various approaches have been used for this purpose.

1. Image Acquisition:
The first step is the acquisition of an image i.e. getting an image using the digital camera connected to the computer. These captured images are in RGB format so it can be further process for the number plate extraction. The database system that contains the personal information of the vehicle owner and several plate vehicle images, abbreviations and acronyms.

Fig 2. Captured image by digital camera.

2. Image Processing:
Captured RGB image is shown in fig 2. The captured image is affected by many factors like: optical system distortion, system noise, lack of exposure or excessive relative motion of camera or vehicle etc. result is the degradation of a captured vehicle image. And the adverse influence to the further image processing Therefore before the main image processing pre- processing of the captured image should be taken out which includes converting RGB to gray shown in fig 3, noise removal, border enhancement for brightness.

First, the original car image in color is converted to black and white image grayscale image as shown in figure 3. Thus, if the input image is a coloured i.e. RGB image represented by three- dimensional array in openCV, it is converted to a two- dimensional gray scale image before further processing. The example of original color i.e. RGB input image and converted gray scale image is shown below. So first step is conversion of color to gray is implemented.

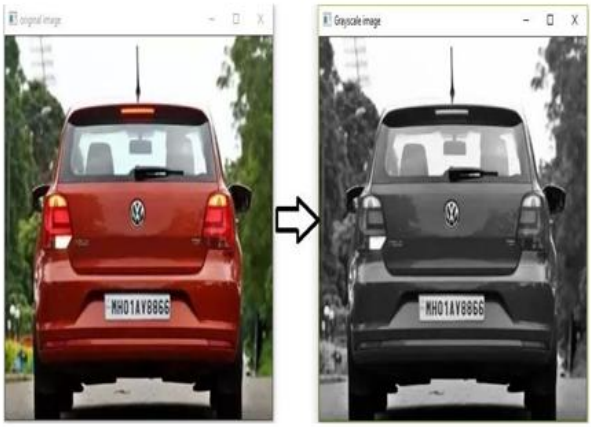


Fig. 3: -Converted from color image to gray image.

Dilation is a process in which given image is improved by filling holes in an image, sharpen the edges of objects and join the broken lines in an image and it also increase the brightness of an image. Using dilation, the noise from an image can also be removed. By shaping the edges sharper, the variation of gray value between neighboring pixels at the edge of an object can also be improved which will help in edges detention.

In Automatic Number Plate Recognition, the image of a vehicle plate may not always have the same brightness and shades. During the conversion of RGB image to gray form some important parameters like difference in color, lighter edges of object, etc. can be lost. So the process of dilation will help to nullify these losses.

Fig 4. Converted from gray image to smooth image.

Filtering can be done in two ways one is spatial filtering and second one is frequency domain. Farther the spatial filtering can be done in two ways first is mean filtering and second is median filtering. Pre-processing is carried out on the captured image to improve the quality of the

image so that the main processing on the image becomes easier. After the pre- processing, well contrast enhanced and changing the color image in to gray now it is to feed into the main body of ANPR system. Fig 4 shows the filtered image. After this pre- processing ANPR system has three main steps. Those are Localization, character segmentation and character recognition.

3. Plate Localization:

As a second step in ANPR system processing, the ANPR software should locate the possible number plate of vehicle and then extracted from the image for further processing. The initial phase in localization of vehicle number plate is by detection of the number plate size. The challenge is to include an algorithm that is able to detect the rectangle number plate region in the image which is called as Region of interest (ROI).

For extraction of the plate region, method based upon combinations of edge statistics and mathematical morphology will be applied to detect that region. In this method gradient magnitude and their local variance in the vehicle number plate image are computed. They are based on the property that the brightness variation in the number plate region is more remarkable and more repeated than elsewhere. Block-based processing is also useful in plate localization. Number plate localization is shown in fig 5.

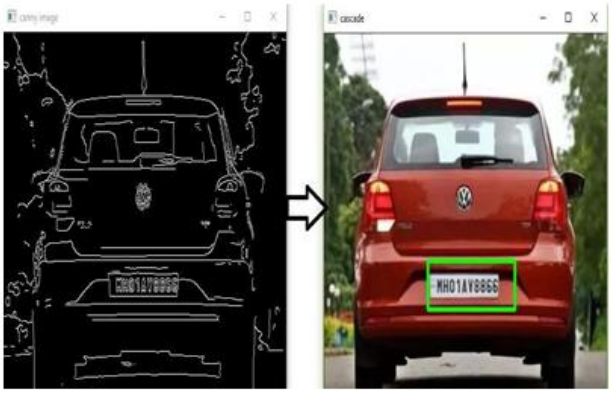


Fig 5. Vehicle Number Plate Localization

Another method is using yellow search algorithm. A yellow search algorithm is used to extract the ROI in an image. The image is search for the yellow colour pixels or some which are closer to yellow in value. If the pixel value is of yellow colour or close to the yellow colour the pixel is set to 1, otherwise the pixel value is set to 0.and we can find required ROI.

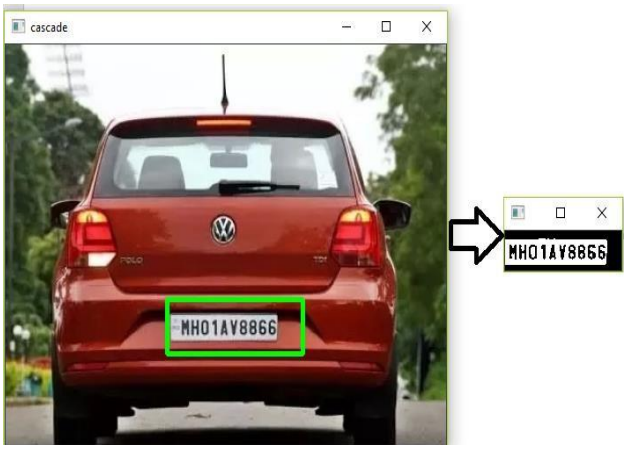
4. Plate Segmentation:

Number plate segmentation assumes an imperative role in ANPR system. A precise binary image is got after the license plate localization. In order to recognize the vehicle number plate characters afterwards, each character must be divided respectively.

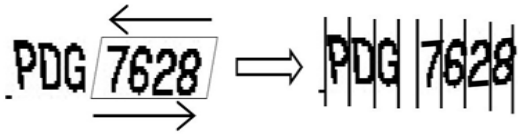
That is task of character segmentation. The individual characters have to be distinguished (segmented) from each other. In this step, the characters & digits of the plate are segmented and each is saved as different image.

Number Plate segmentation plays an important role in ANPR system. To obtain segmented characters in number plate, first plate image is converted into binary image. Then 'Lines' Function is used to divide text on the number plate into lines, which uses “clip” function.

“Clip” function crops black letter with white background. After cropping image, resizing is done and same operation is repeated for each and every character on the cropped image. Fig 6 shows the plate segmentation example.



(a)



(b)

Fig 6. Example of Plate Segmentation.

Because the images contain some noise it is further filtered and normalized. To make the final image to match up the standard template uniform that contains only two gray values of black and white.

5. Character Recognition:

This is the most important and critical stage of the ANPR system. Character recognition step will be identifying the characteristics of the character input image. In this stage, the segmented characters are rescaled to match the characters into a window. For this purpose, each character is normalized to the proper size of binary image and then follows by reshape to standard dimension before further processing.

Fitting approach is also necessary for template matching. Different methods were used for character recognition,

letters and characters in the paper. Finish the identification by calculating the similarity of features. For the similar characters, make the second identification with the method of feature point matching Another approach is that Once the lines in an extracted vehicle number plate are separated, the line separation process is now applied column wise so that individual character can be separated.

The separated individual characters are then stored in separate variables. The extracted characters taken from number plate and the characters on database which we have stored are now matched. The next phase is template matching. Template matching is an efficient algorithm for character recognition. The characters image is match up to our given database and the best resembling is considered.

Another method for character recognition is the optical character recognition (OCR) is used to compare each individual character against the complete alphanumeric database.

The OCR actually uses correlation method to match individual character and finally the number is identified and stored in string format in a variable. The character is then compared with the database for the vehicle authorization. The resultant signals are given according to the result of comparison. Templates will exist for all the characters i.e. A-Z and 0-9 as shown in fig 7.

The major steps in the OCR process are first the image is converted into a black and white image i.e., binary image. The next step would be to crop and separate the lines from the image rows. The same process is repeated on the columns of each row to separate each character.

The templates files are then loaded. The templates file is a file in which the images of all the letters and numbers have been stored and against which all the characters will be compared to identify the character.

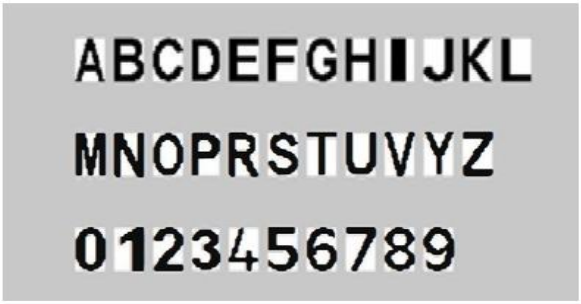


Fig 7. Database of templates.

5.1 Separation of lines from image: Black and white images are stored in OpenCV as a two- dimensional array containing 1s and 0s where 0 represents black and 1 represents white. The values in a single row are all added together. If the sum is not equal to zero, then it means that there is at least one non-zero value in the row. However, if the sum is equal to zero, then it indicates that the row contains only zero elements. A row with all zeroes is a row with only blank space and without any text and a row with some non-zero elements is a row with some portion of the text. So, a row with all zeroes is removed. The group of rows between 2 eliminated rows represents a row of text. This group is extracted and passed to the next block for extracting individual characters.

5.2 Separation of characters from line: Extracting characters from each line is similar to extracting lines from the image. All the operations which were being performed on the rows while extracting lines are now performed on the columns. The values in a single column are all added together. If the sum is not equal to zero, then it means that there is at least one non-zero value in the column. However, if the sum is equal to zero, then it indicates that the column contains only zero elements. A column with all zeroes is a column with only blank space and without any text and a column with some non-zero elements is a column with some portion of the text. So, a column with all zeroes is removed. The group of columns between 2 eliminated columns represents a character. This group is extracted and passed to the next block for identifying individual characters.

5.3 Identifying individual characters: Once the characters have been extracted from the image, they are passed to the read letter block for identification. A template file containing all the characters in Times New Roman font is stored in the same folder. This folder is loaded. Two-dimensional correlation function is then used to find the best match between the extracted character and the characters stored in the templates file. The character from the templates file that gives the highest correlation is the extracted character and it is written into a text file.

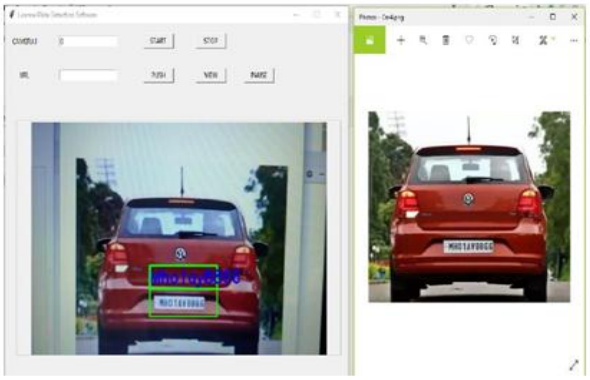
III. SIMULATION RESULTS

This section presents the simulation results of the developed ANPR system.

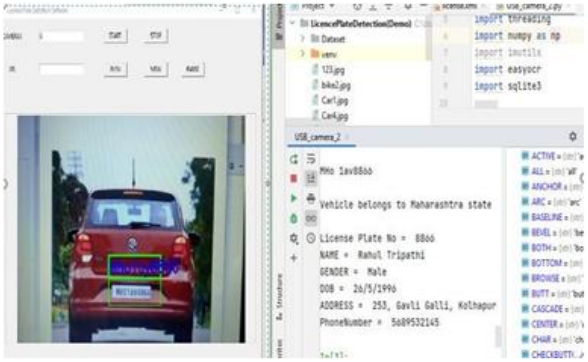
Firstly, the camera is interfaced using OpenCV with the PC. The camera is attached using USB port. Different images of cars having different colors and structure types are taken and stored in PC. The different effects of the day lights are also considered during the processing. The images are in RGB format and the resolution is 800 x 600 pixels. The white region represents the yellow or color closer to the yellow. It can be observed that the yellow search algorithm successfully detect the ROI that only contain vehicle number plate. The smearing algorithm used next to extract the vehicle number plate. Once the vehicle number plate is extracted, it is converted into the

binary format. The row and column segmentations methods are used next to extract the individual character in the vehicle number plate.

Finally OCR is used for character recognition and each and every alphanumeric character is recognized. Optical character recognition technique is used for the character recognition. The resulting data is then used to compare with the records on a database so as to come up with the specific information like the vehicle's owner, place of registration, address, etc.



(a)



(b)

Fig 8. Final Output.

IV. CONCLUSION

In this paper, the automatic vehicle identification system using vehicle license plate is presented. The system use series of image processing techniques for identifying the vehicle from the database stored in the PC. The system is implemented in OpenCV and it performance is tested on real images.

The simulation results shows that the system robustly detect and recognize the vehicle using license plate against different lightening conditions and can be implemented on the entrance of a highly restricted areas.The implementation works quite well however, there is still room for improvement. The camera used in this project is sensitive to vibration and fast changing targets due to the long shutter time. The system robustness and speed can be increase if high resolution camera is used.

The OCR methods used in this project for the recognition is sensitive to misalignment and to different sizes, the affine transformation can be used to improve the OCR recognition from different size and angles. The statistical analysis can also be used to define the probability of detection and recognition of the vehicle number plate.

V. FUTURE WORK

Today advances technology took Automatic Number Plate Recognition (ANPR) systems from hard to set up, limited expensive, fixed based applications to simple mobile ones in which "point to shoot" method can be used. This is possible because of the creation of software which ran on cheaper PC based and also non specialist hardware in which their no need to give pre- defined direction, angels, speed and size in which the plate would be passing the camera field of view.

Also Smaller cameras which can read license plates at high speed, along with smaller, more durable processors that can fit in police vehicles, allowed law enforcement officers to patrol daily with the benefit of license plate recognition in real time.

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