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Automatic Number Plate Recognition

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AUTOMATIC NUMBER PLATE RECOGNITION

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Abstract

In this paper an attempt has been made to develop an automatic number plate detection and recognition system for Indian vehicles. The proposed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation and characters are recognized using optical character recognition technique. The system can handle noisy, low illuminated, cross angled, non-standard font number plates. The morphological transformation, Gaussian smoothing, and Gaussian thresholding the different image processing techniques, has been used in the pre-processing stage. The contours have been applied by border following and contours are filtered based on character dimensions and spatial localization for number plate segmentation and then for character recognition K-nearest neighbour algorithm has been used. The proposed system has good accuracy and can be used for e-challan surveillance, stolen vehicle detection and many other applications.

Keywords: Number/License plate recognition, Character segmentation; Character reconstruction, Optical Character Recognition, Automatic Number Plate Recognition (ANPR)

1. Introduction

In the current scenario there is rapid increase in the number of vehicles, [Sivaraman (2013)]. In order to have intelligent transportation system it is essential to identify the vehicles which requires automation of manual identification of licence plate i.e. ALRP system need to be implemented. LP specification of vary from one country to another.TheLicense Plate detection and recognition (LPDR) is a challenging task that plays a significant role in intelligent transportation systems[(ITS) (Slimani et al. (2020)]. In road network origin and destination flow information can be collected using latest data acquisition methods [Yang et. Al. (2020)]. The data can be capture using mobile phones, probe vehicles that are have GPS devices, ANPR cameras [(Antoniouet al. 2004, Rao et al. 2018)], bluetooth scanners [(Barcelo et al. 2010)].The upcoming of probe vehicles installed with Global Positioning

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System (GPS) gives more possibilities to determine travel times for a sample of vehicles (Woodard et al. 2017). Bluetooth scanners have been used to measure travel times of freeways in many countries [(Aliari and Haghani 2012; Diaz et al. 2016; Martchouk et al. 2011)]. For urban areas data from ANPR cameras are more accurate [(Rao et al. 2018)]. As compared to mobile phone and Bluetooth [(Li et al. 2011)]. Automated Number Plate Recognition (ANPR) cameras register the number plates and the passing moments of vehicles driving on a certain lane [(Li et al (2020)].Many researchers have done study on ALPR and have been suggested many methods but due to challenges but it is still an open problem due to challenges in the field of image processing [Alghyaline (2020)].[Sun et al. (2014)] proposed quantitative indicators and activity classification on the basis of vehicle trace features for traffic management. In different parts of India different type of number plates are used till last year there was no standard format, so in order to identify plates low, non-uniform illumination, distant plates, blurry plates, varied fonts etc. need to be taken into consideration. In Indian number plate first two characters specify the State of the Vehicle's Registration which can be captured for region identification.Varma et al. (2020) presented an image processing system for number plate using morphological transformation, Gaussian smoothing, and Gaussian thresholding technique and K-nearest neighbor for character recognition. The goal of ALPR is to extract the vehicle number from images by detecting the plate location and its dimensions in pixels and recognizing the plate content. The object detection operation could be used for both plate detection and character recognition. Khare et al. (2020) in order to improve performance of LPRS introduced partial character reconstruction method to segment characters of license plates.[Slimani et al. (2020)] detected licence plate based using wavelet transformation for vertical edge extraction and then verified using classifier. [Qadri and Asif (2009)] designed an ANPR system for security control in highly restricted area using Matlab. For licence plate detection image features like colour information, edges information and textures information are commonly used. [Jia et al. (2005)], used rectangularity, aspect ratio, and edge density for license plate (LP) identification. By transforming the color image into a gray image, Davis et al (2015) used vertical edge features to locate the LP and then applied adaptive thresholding technique to binarize the image and used the vertical edge detection algorithm (VEDA) to remove the vertical edges and finally to highlight the license plate region by highlighting the desired information (HDD) algorithm.[Ashtari et al. (2014)]proposed a modified template matching technique on color information to localize the LP based by finding a blue rectangle that appears on the side of an Iranian and European license plates.

In this paper an attempt has been made to develop a low cost, efficient automatic number

plate detection and recognition system. It consists of license plate localization and character recognition. First the license plate region is extracted from the input image on the basis of the high density, the vertical edges inside the licence plate are extracted from the input image and then license plate candidates are extracted. The KNN classifier is used for character candidate classification.

2. Methodology

The proposed ANPR system consists of four major phases viz., image capturing, number plate extraction, character segmentation, and character recognition as shown in Figure 1.

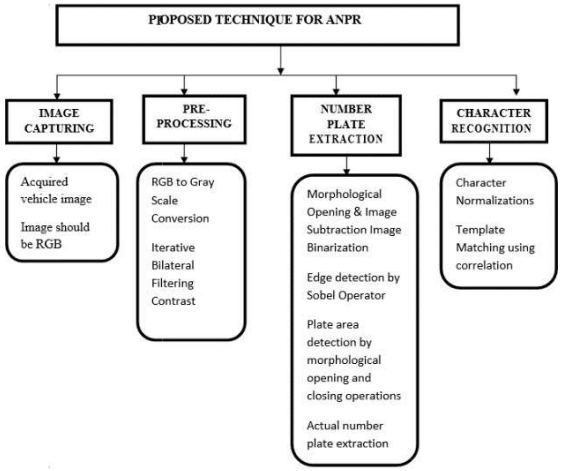

Figure 1:

3. Image Capturing

Image capturing is the process of acquiring an image. It is a matrix with X rows and Y columns represented as function f (x, y) having intensity values for each colour stored as a small squared region called pixels. The captured coloured image is converted to grayscale.

Figure 2: Coloured image

4. Image Processing

Due to the complexity the RGB image is influenced by many factors such as noise, blur- ring. Therefore, before the main image processing, pre-image processing must be performed which involves converting the RGB to gray. The conversion to gray scale results in reduce size of the image [Kranthi et al. (2011), Goyal and Bhatia (2016)]

Pre-Processing

The pre-processing is the first step in number plate recognition. It consists the following major stages: Binarization and Noise Removal

i. Binarization: The input image is first processed to improve its quality and prepare it for the next stages of the program. First, the program will convert RGB images to gray images. Gray scale image, contains 8 bits and each pixel represents one of the 256 values, where the value 0 represents black, 255 represents the white and other values are intermediate shades between black and white (Kranti et al. (2011). The image is loaded and its properties like width, height and n channels are retrieved and height=0, width=0 pointers are set for accessing image data. In order to convert to gray scale image, the byte value of image for each height and width is calculated by calculating average of r.g.b values of the image and finally gray scale image is displayed.

Figure 3: Image converted to gray scale from colour image

5. Noise Removal

In this noise removal section, will remove the noise image, while maintaining the sharpness of the image. A large amount of data is available in gray level images and all data may not be significant. The edge detection is important part of processing and is done filtering, differentiation and detection. In order to remove noise, the image is passed through filters. Conversion of coloured to gray scale results in change in brightness and is measured by derivatives, the second derivative is zero for maximum change the differentiation stage considers the locations where there is a significant change in intensity and detection stage, localize the points where there is a significant change in intensity. After the number plate localization, optical character recognition is performed using segmentation, feature extraction and number recognition. Gaussian kernel is used to smoothen the image. This technique is highly effective to remove gaussian noise. OpenCV provides a cv2.GaussianBlur () function for this task [Shaikh et al (2013)]

Figure 3: Smoother Image/Pre-Processed Image

5. Image Cleaning:

At the end of the previous stage of image pre-processing, a binarized image, with values of either 0 or 255 is returned using inverted adaptive gaussian thresholding. The binarized image is the input to the detection and recognition stage. Edges characterize object boundaries which are useful in segmentation that is the process of partitioning digital image in to segments to identify the objects in a scene. The sobel edge detection is applied to find the edges of the given image as given in figure below. There are many methods for detection but studies have shown that sobel method have better performance as compared to other methods. This step explores the property of English Digits, because of the digits & characters; image will have sharp edges in the number plate area [Faradji et al. (2007)].

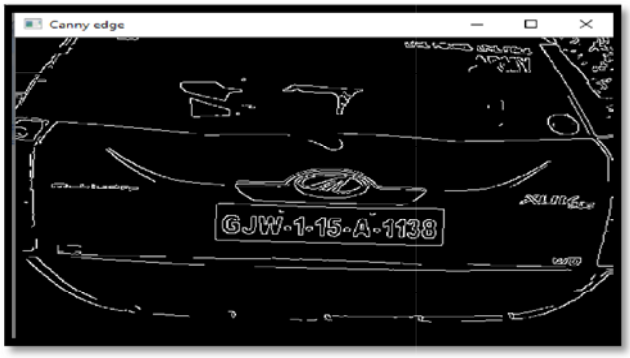

Figure 4: Edge of the Image

The basic step in accepting a vehicle Number Plate is to see the size of the plate and we are performing Gaussian blur, sobel operations and morphological transformation to find the edges and contours in the image and loop through each contour to identify number plate, [Ashari (2014)]. Here we calculate the derivatives from the image. Using derivatives we calculate the gradients, and high change in gradient indicates a major change in the image. OpenCV provides a cv2.Sobel () function to calculate Sobel operators [Kaur and Kaur (2014)].

5.1. Morphological Transformation: These are the operations based on image shapes and are performed on binary images. The basic morphological operations are Erosion, Dilation, Opening, and Closing. The different functions provided in OpenCV cv2.erode (), cv2.dilate (), cv2.morphologyEx () are used.

5.2. Contours: Border following also known as contour tracing algorithm is used for generating contours. Contours are the curves containing all the continuous points of same intensity. These are very useful tools for object recognition. OpenCV provides cv2.findContours () functions for this feature. During the Adaptive Gaussian Thresholding stage, Inversion operation is applied as finding contours is like finding a white object from the black background

Figure 5 (a): Contours Based on Image

Figure 5(b): Top Contours on Image

The outcome of applying contours to a binarized image is shown in Figure 5.

5.3. Plate Localisation: Plate localization plays an important step in ANPR system here we will crop the rectangle part after looping through each contour and then we will clean the image contour and feed it to pytesseract to recognise the numbers and characters[Patel et al (2013)].

A bounding box is added to each number plate in this phase. If any of the plates suffer from distortion of angles, It performs affine transformation, a mapping between two spaces which is used to preserve line and marks. The parallel line preserves its parallelism after the conversion. The ratio between the lengths of the dwelling points on a straight line is maintained. The angles within the lines and lengths inside the points, however, are not maintained. The plate angle correction in OpenCV can be achieved through the getRotationMatrix2D feature [(Kiran et al.(2020)].Number plate localization has been shown in fig. 6.

Figure 6: Vehicle Number Plate Localisation

6. Plate Segmentation: The separation of the number plate plays an important role in the ANPR system. We get each character with a picture of a number [Patel et al. (2013), Soomro et al. (2012)]. In this phase two types of segmentation horizontal vertical segmentation is used. The vertical segmentation is performed on the number plate for vertically segmentation of the characters. It is followed by horizontal segmentation to get character from the plate. The fig. 7 shows the segmented plate.

Figure 7: Examples for Plate Segmentation

7. Character transformation and Recognition: This is the most important and basic phase of the ANPR system it detects individual characters. The separation is based on extracted features [Kaur and Kaur (2014)]. OCR technology is used for letter recognition [Du et al (2013]. In pytesseract it is a mechanical or electronic translation of images of handwritten or typed text (usually carried by a scanner) in text edited [Patel t

al. (2013)]. The Output of License plate has shown below which pytesseract methodology which is Tesseract –OCR engine has:

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number is:  [GJW-1-15-A'-1138}
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Once overlapping characters have been removed, each contour representing a character on the number plate is resized to ensure compatibility with the learning model's input format, where each font character fed during the training process is a resized image. The character is predicted after the resized picture is fed to the model. This is done to create a string of characters for each outline. In the prediction process, the remaining outline groups that do not represent the number plate fail. The number plate is known as the category with the largest number of predicted characters (Kiran et al (2020).

Figure 9: Number plate and characters have been recognised and

8. Training the model

For training the model, K Nearest Neighbours (KNN) algorithm has been used. The randomized search has been used to extract the best hyper parameters for the model. The model implementation has been done using K-Neighbors Classifier of Scikit-learn. To evaluate the effectiveness of the proposed system different car images are used and license plate detection and character recognition accuracies were recorded. The proposed method effectively detects the license plate and recognize its characters in different situations to a detection accuracy goes up to 97.8% and recognition accuracy goes up to 98%.


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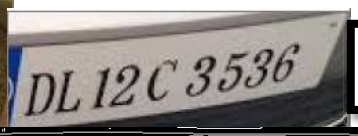
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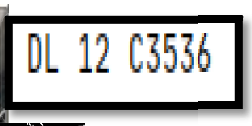
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Gray Scale Image
DL8CX 4850


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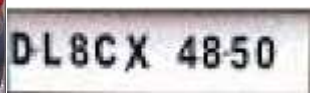
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Figure 10: Some results of the localization and recognition of Indian license plates.

Fig. 10 results show recognizes the vehicle license plate for to various situations and can be actualized on the passage restricted zones, e-challan surveillance, stolen vehicle detection, and safety purposes.

9. Conclusions

A low cost, efficient automatic vehicle identification system has been proposed that uses a license plate for identification. It consists of two steps: the license plate detection and the character recognition. The system is implemented on Jupyter Lab, the vehicle rear image is captured and processed using series algorithms for detection. In the first stage, the license plate candidates are generated based on vertical edges to detect the license plate considering high-density areas and then classified using KNN classifier. The system has 97.8% accuracy for detection and 98% accuracy for recognition. The proposed system works well but there is still scope for improvement.

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