Automatic Number Plate Recognition

PROJECT REPORT

Image Processing (CSE4019)

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ABSTRACT

Automatic Number Plate Recognition system is an application of computer vision and image processing technology that takes photograph of vehicles as input image and by extracting their number plate from whole vehicle image , it display the number plate information into text. Mainly the ANPR system consists of 4 phases: - Acquisition of Vehicle Image and Pre-Processing, Extraction of Number Plate Area, Character Segmentation and Character Recognition. The overall accuracy and efficiency of whole ANPR system depends on number plate extraction phase as character segmentation and character recognition phases are also depend on the output of this phase. Further the accuracy of Number Plate Extraction phase depends on the quality of captured vehicle image. Higher be the quality of captured input vehicle image more will be the chances of proper extraction of vehicle number plate area. The existing methods of ANPR works well for dark and bright/light categories image but it does not work well for Low Contrast, Blurred and Noisy images and the detection of exact number plate area by using the existing ANPR approach is not successful even after applying existing filtering and enhancement technique for these types of images. Due to wrong extraction of number plate area, the character segmentation and character recognition are also not successful in this case by using the existing method. To overcome these drawbacks we proposed an efficient approach for ANPR in which the input vehicle image is pre-processed firstly by iterative bilateral filtering , adaptive histogram equalization and number plate is extracted from pre-processed vehicle image using morphological operations, image subtraction, image binarization/thresholding, sobel vertical edge detection and by boundary box analysis. Sometimes the

extracted plate area also contains noise, bolts, frames etc. So the extracted plate area is enhanced by using morphological operations to improve the quality of extracted plate so that the segmentation phase gives more successful output. The character segmentation is done by connected component analysis and boundary box analysis and finally in the last character recognition phase, the characters are recognized by matching with the template database using correlation and output results are displayed. This approach works well for low contrast, blurred, noisy as well as for dark and light/bright category images. The comparison is done between the ANPR with Adaptive Histogram Equalization and

Iterative Bilateral Filtering that is the proposed approach and the existing ANPR approach using metrics: MSE, PSNR and Success rate.

Introduction

One of the important methods that are used in Intelligent Transportation System is Automatic number plate recognition (ANPR). In transportation, Vehicles play important role. Day by day the human population is increased and use of vehicles is also increased due to increased human needs. As a result of it the control of vehicles is becoming a big complex problem. ANPR system is one of the methods used for the effective control of these vehicles that allow the extraction of number plate information without the needs of human. This automated system is an application of computer vision and image processing technology that allows one to extract number plate information from image or sequence of images. Image processing deals with the extraction of useful and meaningful information from digital images by various image processing techniques.

ANPR system is a combination of integrated software and hardware that will read vehicle number plates automatically without the need of humans. ANPR is an image processing technological solution that captured photographs of vehicles and firstly by detecting and extracting the number plate from whole vehicle image, it segments the characters from the plate area and then by using the any of the character recognition technique for example template matching scheme, it display the license number plate information into text consists of numerical or string.

Objectives:-

It is required that an automated license plate recognition system be designed and implemented. The system takes digital images of vehicles with their license plates visible and extracts license plate characters as a string of alphanumeric characters, and yields hypothetical user data from a related database corresponding to the extracted characters as output. The designed system is to work with reasonable accuracy if the digital image is of good resolution, and vehicle license plate has standard font in the region of interest.

Motivation:-

ANPR applications have a wide range of applications, which use the extracted plate number and optional images to create automated solutions for various problems. These include:-

• **Parking** - the plate number is used to automatically enter pre-paid members and calculate parking fee for non-members by comparing the exit and entry times.

• **Access Control** - a gate automatically opens for authorized members in a secured area, thus replacing or assisting the security guard. The events are logged on a database and could be used to search the history of events

• **Law enforcement** - the plate number is used to produce a violation fine on speed or red-light systems. The manual process of preparing a violation fine is replaced by an automated process which reduces the overhead and turnaround time. Using a list of stolen cars or unpaid fines, an ANPR system deployed on the roadside, may perform a
real-time match between the passing cars and those on the list, hence raise alerts for passing cars on the list.

• **Marketing Tool** - the car plates may be used to compile a list of frequent visitors for marketing purposes, or to build traffic profiles, such as the frequency of entry verses the hour or day.

• **Tolling** - the car number is used to calculate the travel fee in a toll-road, or used to double-check the ticket. Such routine tasks, possibly handling large volumes of traffic, maybe more efficiently done if automated than if done by humans. This would reduce associated costs of operation, increase processing speed and minimize errors that may result due to fatigue or monotony if a human operator were involved.

Literature Survey

- Christos-Nikolaos E. Anagnostopoulos presented a brief tutorial on LPR. LPR includes three steps: - license plate detection, character segmentation (CR) and optical character recognition (OCR). This paper provides a brief review of literature, according to their methodology used in the three steps of license plate recognition.

- Shan Du, Mahmoud Ibrahim, Mohamed Shehata and Wael presented survey on existing ANPR techniques by categorizing them according to the features used in each phase and compare them in terms of recognition accuracy, processing speed, pros and cons.

- Sahil Shaikh, Bornika Lahiri, Gopi Bhatt and Nirav Raja proposed method for number plate recognition. For plate localization, several images processing techniques: - enhancement, component analysis and edge detection are used. Connected component method used for extraction of individual number plate characters. Template Matching is used for Character Recognition .

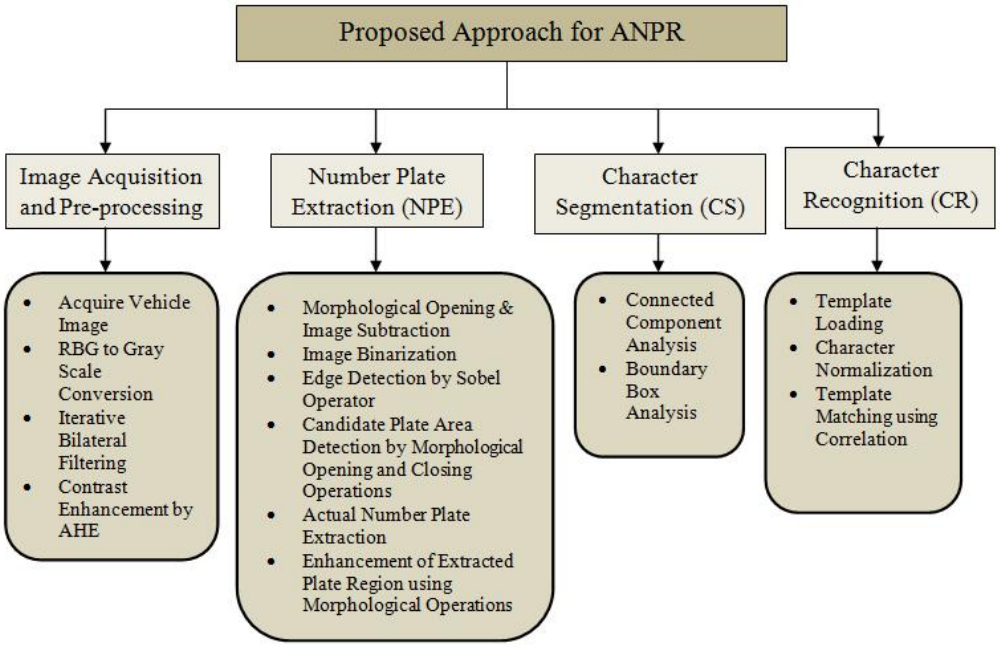
- Norizam Sulaiman proposed the development of automatic vehicle plate detection system. In this method after pre-processing the candidate plate is detected by some feature extraction method, character segmentation is done by boundary box analysis and character recognition is done by template matching .

- Reza Azad and Hamid Reza Shayegh proposed a fast and real time method which has an appropriate application for tilt plates .

- Najeem Owamoyo, A. Alaba Fadele and Abimbola Abudu presented Automatic Number Plate recognition for the Nigerian vehicles in which number plate extraction is done using Sobel edge filter, morphological operations and connected component analysis, vertical projection analysis is used for character segmentation .
- Divya Gilly and Dr. Kumudha Raimond presented an efficient method for LPR system mainly consists of: - plate detection (PD), segmentation of characters (CS) and character recognition (CR) phase. This method consists of template matching technique .
- Isack Bulugum presented an algorithm that is used to recognize the license plate from the front end and rear end of the vehicle. The methods that are used during implementation of the system are: Pre-processing, Plate Extraction, Character Segmentation (CR) and Character Recognition .
- Rupali Kate presented proposed algorithm based on morphological operation with certain area criteria tests for number plate detection. Segmentation of the plate characters was achieved by the application of region props, labelling and fill hole approach .
- P.Mohan Kumar, P.Kumaresan and Dr.S.A.K.Jilani presented Real time vehicle license plate identification system. This approach is based on region-props image processing technique .

Methodology

The proposed approach for automatic number plate recognition system is represented in this section. The existing ANPR methods works well for dark and light/bright images but it does not work well for low contrast, blurred and noisy images. But this proposed approach for ANPR works well for low contrast, blurred and noisy images as well as for dark and light/bright images. The proposed approach is divided into 4 main parts



1) Acquisition of Input Image

2) RGB to Grayscale conversion

3) Noise removal by using Iterative Bilateral Filter

4) Contrast enhancement by Adaptive Histogram Equalization (AHE)

5) Morphological Opening and Image Subtraction

6) Image Binarization /Thresholding

7) Vertical Edge detection by Sobel operator

8) Candidate Plate Area Detection

9) Actual Extraction of Number Plate Area

10) Enhancement of Extracted Plate Area

11.)Character Segmentation(CS)

12.) Character Recognition(CR)

Acquisition of Input Image

The first step of ANPR is to capture the input vehicle image by means of digital camera. Different category of images can be acquired during camera capturing. Our database consists of pre-captured images which we use to test our code.

RGB to Grayscale conversion

The captured input vehicle image is in RGB format. In this step RGB image is converted into gray-scale image. An RGB Image consists of 3 layers R, G, B as it is clearly seen through its name whereas grayscale has only one layer. Some algorithms can only applied on 2-D image rather than 3-D, hence we convert an RGB image into a grayscale image, for instance, Black and White conversion of an image, convolution of an image, etc.

Noise removal by using Iterative Bilateral Filter

Iterative bilateral filter is used in proposed approach that provides the mechanism for noise reduction while preserving edges more effectively than the median filter. The iterative bilateral filter results into less blurring effect while smoothing an image than the median filter. The image reconstructed with iterative filter has high PSNR and low MSE value as compared to the image reconstructed with the median filter. Hence the image filtered with iterative bilateral filter has better quality than the image reconstructed with median filter.

Contrast enhancement by Adaptive Histogram Equalization (AHE)

Contrast is the difference between lowest and highest intensity level. In the proposed approach the contrast is enhanced by adaptive histogram equalization (AHE). In AHE the test functions according to which we enhance the contrast of input image depend upon gray levels of image, local properties and spatial co-ordinates of pixels while in case of histogram equalization (HE), the test function value depend only on the gray levels of image. The image reconstructed with adaptive histogram equalization (AHE) has high PSNR and low MSE value as compared to the image reconstructed with histogram equalization (HE). Hence the image enhanced by AHE has better quality than the image that is enhanced with histogram equalization.

Morphological Opening and Image Subtraction Operations

Firstly the disc shaped structuring element is created and then the opening operation is performed on the adaptive contrast enhanced image by this structuring element. After this, in the image subtraction operation, the morphological opened image is subtracted from adaptive contrast enhanced gray scale image so that the number plate region gets highlighted.

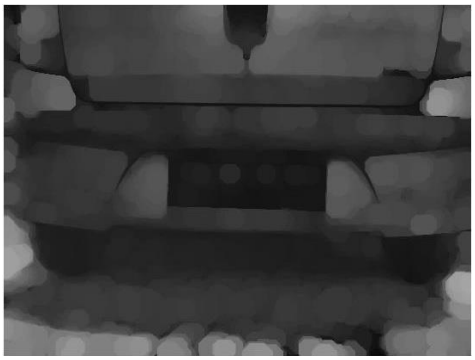


Image Binarization

The image is converted to black and white format in this step. The purpose of applying color conversion is to reduce the number of range of the color scale from (0-255) to (0-1). In this step the subtracted gray scale image is converted into binary image. Firstly the global threshold level is calculated by using Otsu's thresholding method which involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, that is, the pixels

that either fall in foreground or background. After this according to the calculated threshold value, the subtracted gray scale image is converted into black and white image.

Edge Detection by Sobel Operator

Edges are detected by sobel operator. Sobel operator consists of two types of masks. One is horizontal sobel mask and vertical sobel mask. It is a gradient based method. It works with first order derivatives. It calculates the first derivatives of the image separately for the X and Y axes. The derivatives are only approximations because the images are not continuous. To approximate them, the following kernels are used for convolution:

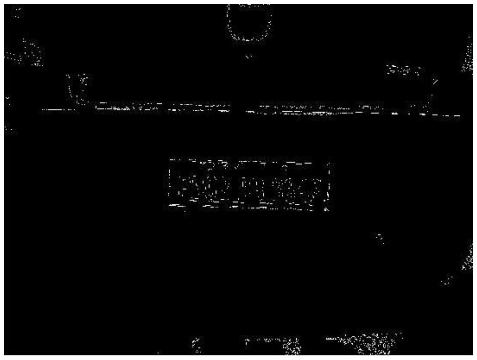
-1	0	1
-2	0	2
-1	0	1

Horizontal

-1	-2	-1
0	0	0
-1	-2	-1

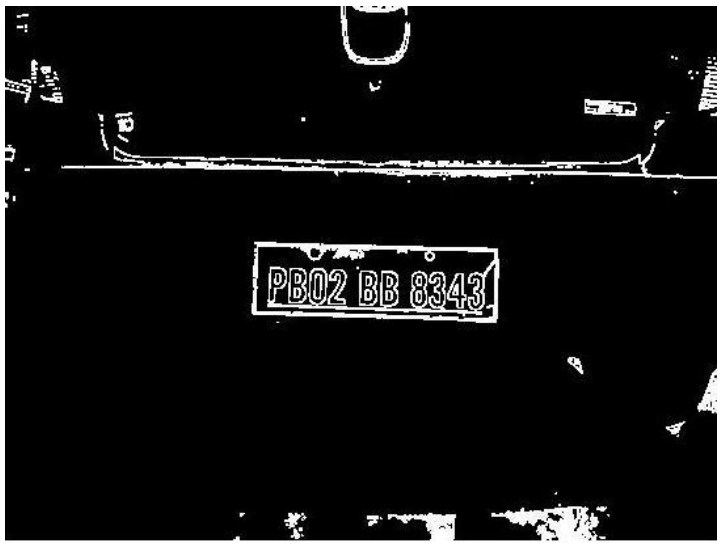
Vertical

Kernels used in the Sobel edge detection



Detection of Plate Region by Opening and Closing Operations

For the detection of candidate plate area, firstly dilation operation is applied on this edge detected image and then the holes are filled in this dilated image using MATLAB imfill function. After this the unwanted portion of image is removed by using opening operation and finally the candidate plate region is detected by using morphological erosion operation. Then morphological opening and morphological erode operations are used for detection of exact candidate plate area.



Actual Extraction of Number Plate Area

After the detection of number plate area that area is extracted from the image. The efficiency of number plate extraction depends on accurate detection of number plate area. In the proposed approach, after the detection of candidate plate area, the row and column indices of plate

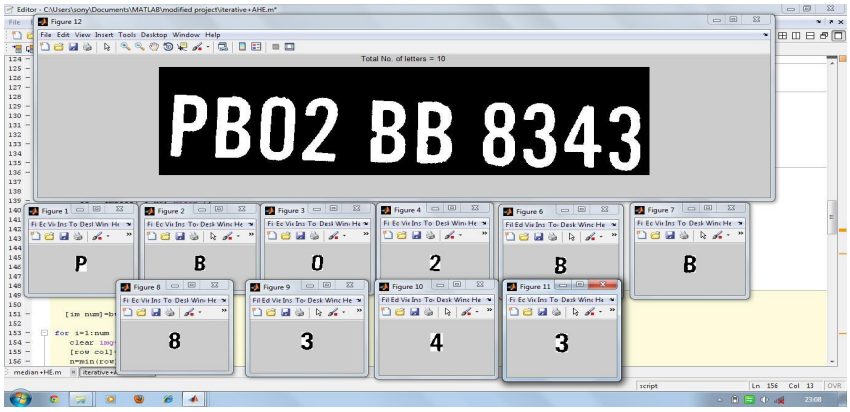
area plate area are found by Boundary Box Analysis (BBA) and then that portion is extracted from the image.

Enhancement Of Extracted Plate Area

The extracted number plate may consist of various noise, unwanted holes, frames, bolts etc. So enhancement of plate region is done. In the proposed approach the enhancement of extracted plate region is done by using various morphological operations.The result of plate region enhancement by morphological dilation, erosion, opening and closing operation on extracted plate region.

Character Segmentation

Character Segmentation (CS) step acts as bridge between the number plate extraction and character recognition phase. In this phase the characters on number plate area are separated or segmented. There are many factors such as image noise, space mark, plate frame, plate rotation and illumination variance etc. that make the character segmentation difficult. In the proposed approach the character segmentation is done by Connected Component Analysis (CCA) and Boundary Box Analysis (BBA). Firstly labels are assigned to connected components and the labeled characters are extracted using boundary box analysis.



Character Recognition

Character recognition (CR) is the last phase of ANPR system. The inputs to this phase are segmented characters and output of this phase is license plate number. The character recognition is done by template matching (TM) using correlation. Correlation is the degree of similarity between the segmented characters and the template characters. In the character recognition step firstly make template by taking 42 X 24 pixel A to Z alphabet and 0 to 9 number images. Read all image and store them in database and this result into 36 character templates. After the loading of templates, character normalization is done. In character normalization, all the segmented characters are resized to template size 42 X 24. Sometimes the segmented characters do not have the same size so the better way to overcome this problem is to resize the characters into one size (equal to template size) before actual recognition starts. In last the segmented characters are matched with template characters using correlation. The similarity between the template characters and segmented characters is measured and the template that is most similar to the character is recognized as target. The value of correlation is calculated by comparing the normalized segmented character image with each template character image and selecting the most relevant image and writes that character into text file.

Conclusion

In Automatic Number Plate Recognition System the number plates are extracted from background vehicle images in number plate extraction phase. The Segmentation phase, segments the character individually and Character Recognition part recognize the segmented character. Number Plate Extraction is most crucial step in the ANPR system which influences the overall accuracy and processing speed of whole system as character segmentation and character recognition phases are also depend on extracted plate area that is the output of number plate extraction phase. Sometimes due to low quality, low contrast and noisy images we cannot detect and extract exact number plate location. As a result of this wrong extraction of number plate area, the character segmentation and character recognition are not successful in this case because these two phases are also depends on successful extraction of number plate area. The existing ANPR method works well for dark and bright/light categories image but it does not work well for Low Contrast, Blurred and Noisy images. But our proposed ANPR approach works well for Low Contrast, Blurred and Noisy images as well as for Dark and Light images. In our proposed approach, after the extraction of plate area, the extracted plate is enhanced by using morphological operations to enhance the quality of extracted plate so that the segmentation phase gives more successful output.

Future Work:-

The future research of ANPR should concentrate on high definition plate image processing, multi-style plate recognition, and multi-plates processing at a time, video-based ANPR using temporal information and recognition of ambiguous characters and so on. So the main issues for future research are:

1. Multi-style plate recognition, high definition plate image processing and multi-plates processing.
2. For video-based ANPR we need to first extract the frames that have the passing cars. Extracting the correct frame with a clear vehicle number plate image is another challenge especially when the vehicle speed is very fast.

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