Advanced Vehicle Monitoring System with Multi-Object Automatic Number Plates Detection

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Abstract—The ANPR (Automatic Number plate Recognition) system is based on image processing technology which automates number plate detection and use it whenever required. The system first would capture the image of the vehicle, captured images are then extracted by using the segmentation process which includes Otsu thresholding scheme and Optical Character Recognition (OCR) technique to identify the characters, obtained data is then compared with the data stored in their database. The process is done by implementing steps such as Image acquisition, gray processing, image binarization, number plate recognition and template matching using OCR in MATLAB. Images are considered with suitable blurring and noise elements, under this erroneous environment number plate recognition is demonstrated that forms a real-time application which serves the purpose of security in restricted military areas, tolling, restricted parking areas, etc.

Keywords— ANPR, Optical Character Recognition (OCR), gray processing, image acquisition, image binarization, and template matching.

I. INTRODUCTION

With the raising demand for automobile usage, it's not possible to manually keep a record of vehicles data. There need to be a manual-security operations 24*7 to note down the number. It's a time-consuming process and requires manpower. Furthermore, the data stored manually is not readable after a long time. To vanquish over all these limitations a system is developed which would automatically detect the number plate and store it in its database. The working process demonstrates the automated image capture of an automobile when it enters the security region. The processing of this captured image is done through the software stored in the system. Authentication is done to verify the details in its database that either allow or restrict the vehicle. This type of automated systems cease the entry of intruders and also monitor the suspicious activities.

However, this type of automation can also be applied in remote sensing applications where researchers mainly focus on detection and recognition of ships which are either in deep ocean or inshore [1].

Vehicle plate detection plays a crucial role in the field of Image processing especially to authenticate in highly restricted areas. Many algorithms have been proposed for the automation in plate detection [2][6]. However, each one has its own advantages and limitations. Most of them operate on taking still images or videos of an automobile at specific angles which may not be flexible all the time. A dynamic automated system has to be developed which is flexible to operate in real time environments.

A traditional number plate detection system developed using MATLAB involves capturing an image from camera and is converted to Grayscale image. Then image processing techniques like Dilation, Edge detections and Low pass filtrations are applied. Binarization of the processed image is initiated to detect alphanumeric characters from the plate and these characters in optical form are converted into electrical form using Optical Character Recognition (OCR) scheme where characters are matched to the predefined customized templates [3] for extraction. However morphological processing can also be done using Sobel operators [4].

However, there are certain benchmarks [5] setup in distinguishing and detecting the plates under different conditions. Owing to this, advancements in the number plate detection and character recognition while maintaining the efficiency in the research plays a crucial role.

Value addition from the paper

The proposed paper elucidates an alternative approach where an image is segmented by Otsu Thresholding scheme and double binarized for object detection and plate detection. As a value addition, implementation is carried out by considering the blurred (noise added) image and the number plate extraction is carried out considering multi object detection at a time, apart from taking only a single object detection for a blurred noisy image.

Demand for the usage of automobiles have been raised drastically. Owing to this, there is a rapid growth in vehicles violating the traffic rules, theft of vehicles, ingoing to restricted areas, abnormal number of accidents lead to upturn in the crime rates linearly. Mainly in case of recognizing the vehicles, the ANPR will play an important role.

Section II describes the methodology, where an algorithm is proposed for image processing and OCR from image, Section III illustrates the results by considering three test images which are blurred and noisy and explains how the algorithm works in detecting the number plates, Section IV describes the future work where ANPR can be combined with IOT for more enhanced tracking systems and Section V gives the conclusion.

II. METHODOLOGY

Image segmentation is a process of partitioning an image into continuous regions where depending on their pixel intensity values. Thresholding is a process of image segmentation where a Grayscale image is converted to binary image based on certain threshold value. Thresholding an image that separate two classes foreground and background by maximizing intra class intensity or by

minimizing inter class variance which is mainly an Otsu's Thresholding scheme [7][8].

First a customized motion blur is created using **fspecial** and **imfilter** commands using suitable parameters for the generalization of algorithm for all test images within this parameter range. Optionally noise is also added to create a real time test image in MATLAB. This noise is basically a Gaussian noise with suitable mean and variance. The steps in processing this image and obtaining number plate is as follows:

- A common method in extracting the plate is by using Weiner deconvolution method to minimize the blurring effect. The above described method is operated in a loop. The loop repetitions are kept equal to the range of the parameter which is present in the blurred image.
- An image with maximum blur removal is considered from all the images in the loop iterations to which image processing techniques are applied. Noise can't be removed completely if it is added to the image. In this case, images processing techniques are applied to this noisy image.
- This image is then binarized using Otsu Scheme [9][10]. It involves object extraction first and plate extraction next.
- Unwanted regions in the image are filtered and image is segmented and resized to obtain Number Plate Region.
- Bounding Box is applied to this region to detect the characters in the plate.
- Template matching is demonstrated using the stored set of number plates for OCR [11] and the output is compared with the valid plates to allow access in real time.

OCR is done by comparing the pixel intensities from each bounding box to the stored set of alpha numeric intensities by a correlation factor. Whenever a bounding box pixel intensity matches with any of alpha numeric intensities correlation factor will be high and the desired character is detected.
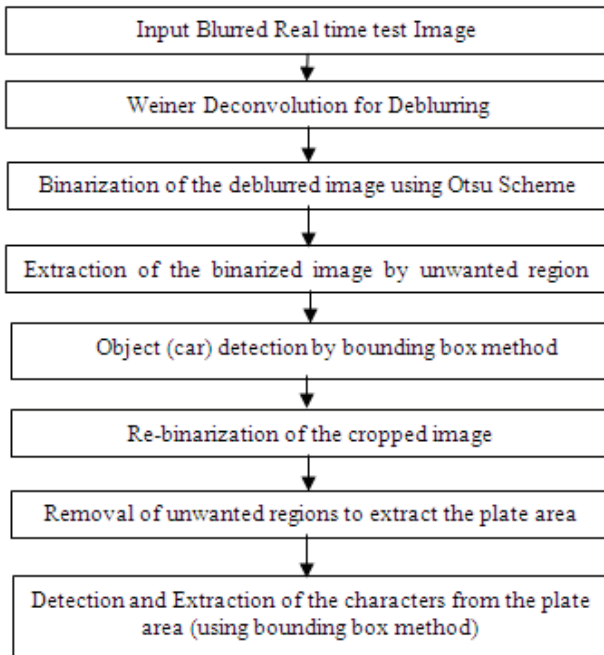

Fig. 1. Flowchart for number plate extraction

III. RESULT

Three different applications with real time test images are considered to extract number plate. These include

- Extracting the number plate from a noisy blurred car image.
- Detecting the plates from a noisy blurred multi car image.
- Detecting and extracting the plates from a blurred multi car image.

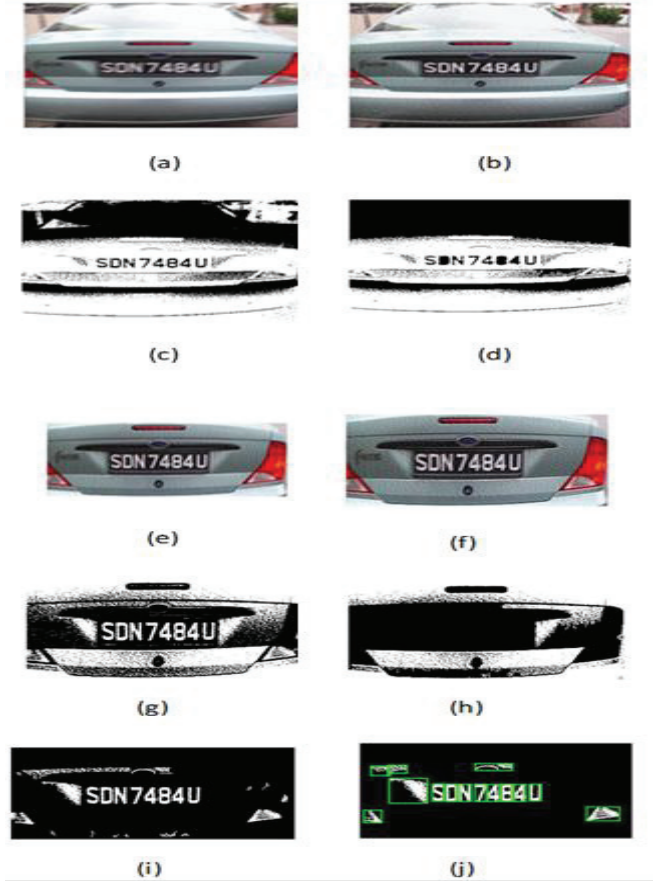### A. Extracting the number plate from a noisy blurred single car image.

Fig 2: a. Real time Blurred and Noisy test image
b. Weiner Deconvolution for Image Deblurring
c. Test image binarization
d. Unwanted region removal
e. Object detection- Extracted plate area
f. Resizing the extracted plate area
g. Binarizing the plate area
h. Removal of unwanted regions in the plate area
i. Extraction of characters
j. Bounding box assignment for every character in the area

Fig 2 shows the Number plate extraction for a blurred noisy image. Here image is blurred randomly using Point Spread function of known limits in MATLAB and Gaussian noise with random mean and variance with are within certain limits is added. This blurred image undergoes Weiner Deconvolution which is executed in a looping fashion to obtain a set of deblurring images.

The image with optimal pixel intensity correlation with the original is taken which undergoes segmentation and binarization using Otsu thresholding scheme. Here first the region with plate area is detected later characters are

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detected from the plate area after suitable unwanted region removal.

Bounding box is applied to each and every extracted character in the area which is then given to OCR which converts the optical characters to electrical form using pixel intensity correlation.

B. *Detecting the plates from a noisy blurred multi car image.*

(a)   (b)

(c)   (d)

(e)   (f)
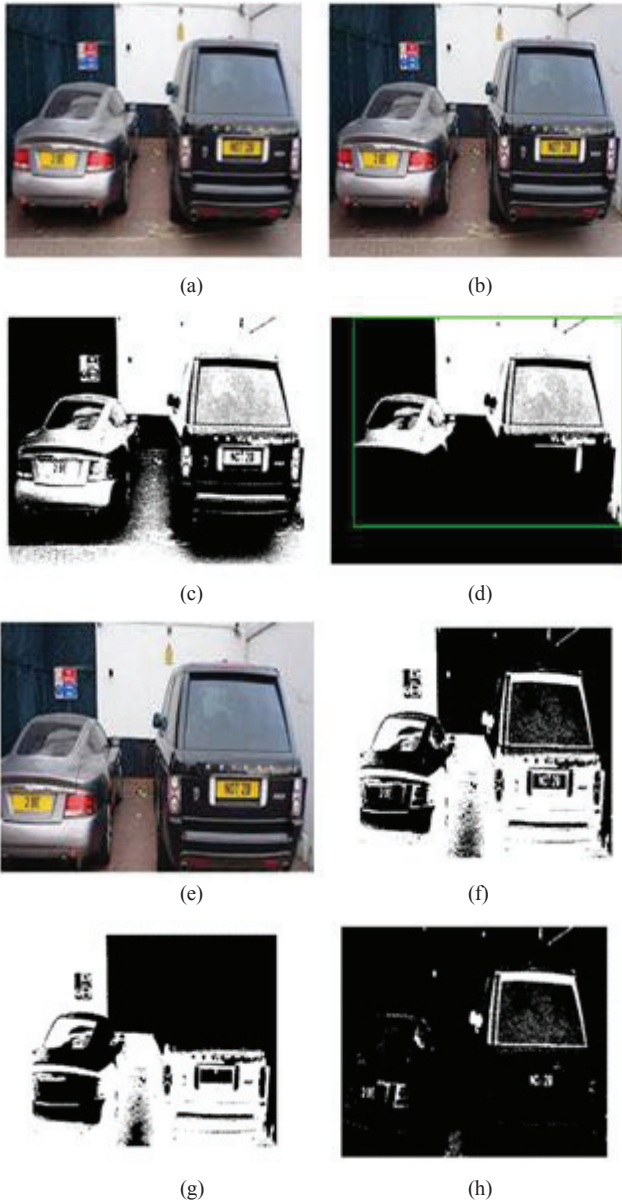
(g)   (h)

Fig 3:   a. Real time Blurred and Noisy multi car test image
         b.Weiner Deconvolution for Image Deblurring
         c. Test image binarization
         d. Unwanted region removal- Car object extraction
         e. Image cropping from the bounding box for car detection
         f. Binarization of the cropped image for plate detection
         g. Removal of unwanted regions in the plate area
         h. Detection of characters in the plate area

Fig 3 shows the plates detection from two car objects. It follows the same process as application 1, here double binarization is considered for segmentation. One in segmenting car objects from test image and the other for detecting plate area from the segmented cars image.

From the result it is seen that though the plate characters are detected extraction cannot be done as bounding boxes are not applied to the characters because of the noise effects. From this it is inferred that multi object extraction depends on the noise effects.

C. *Detecting and extracting the plates from a blurred multi car image.*

(a)   (b)

(c)   (d)

(e)   (f)

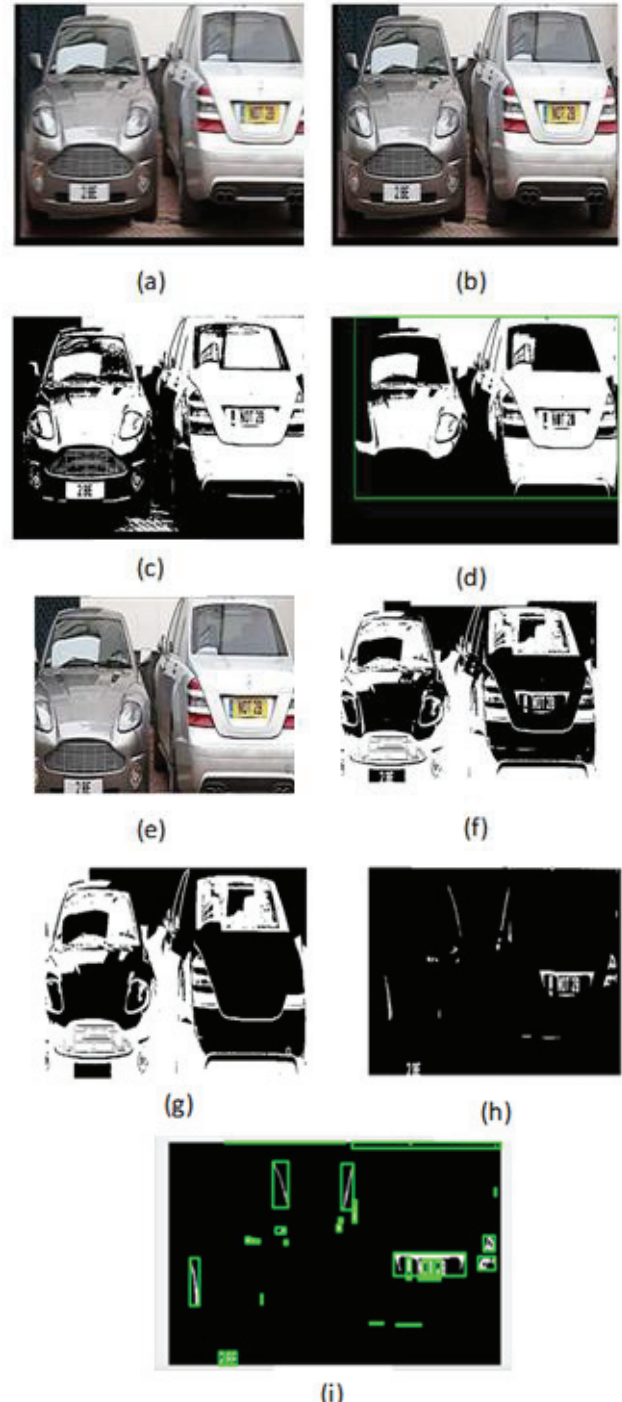(g)   (h)

(i)

Fig 4:   a. Real time Blurred test image
         b.Weiner Deconvolution for Image Deblurring
         c. Test image binarization
         d. Unwanted region removal- Car objects extraction
         e. Cropped image
         f. Rebinarization for extracting the plate area
         g. Unwanted region removal
         h. Detection of characters in the plate area
         i. Extraction of characters using bounding boxes for OCR

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Fig 4 shows the plate detection and extraction for the two car objects in a test image. Here extraction is possible as noise effect is nullified and detection is done in the presence of motion blurring. Bounding boxes are applied to all the extracted characters in the test image.

It is also seen that the bounding boxes are applied to some unwanted sections as well because they have similar pixel intensity values as that of plate characters. However, they are eliminated in OCR as correlation factor to those will be less in template matching as compared to the actual extracted characters.

IV. FUTURE WORK

Automated Number plate Detection system should work on:

- Problem of Rotated Number plates.
- Detection from Brocken Characters in the plate
- Reducing the character error rate in the detection.

Tracking can be done by suitably interfacing ANPR software with Internet of Things (IOT) [12]. Implementation of OCR based vehicle monitoring system is an asset for providing the dynamic and extensive way for the authentication of the vehicles.

V. CONCLUSION

In this paper a more generalized way of detecting a number plate is presented. Here an image is double binarized for object and plate detection especially in case of multi object detection scheme for more dynamic operations. The efficiency of this algorithm is high as the character ambiguity rate is less and characters can be identified even in noisy environments.

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