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A Simple and Effective Method for License Plate Localization

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Abstract

Today the world is growing with new advancements and technologies. These new technologies save the processing time that was consumed by doing manually. One of these technologies is automatic license plate recognition that is used in daily life at toll bars, parking, security, criminal case, and so on. License plate recognition consists of three main stages—plate localization, plate segmentation, and character recognition. Among these, localization is the performance enhancement stage as if the plate is not localized accurately then how the plate will get segmented and how the characters on the plate will be recognized. So, localization must be accurate for an efficient recognition. In this article, the localization is done by filling the holes in an image after edge detection using MATLAB. This method achieved a good accuracy.

Keywords: *Image processing, license plate localization, ALPR, edge detection, median filtering, open area operation*

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INTRODUCTION

There is a rapid growth in the development of automatic systems. One of them is license plate recognition system that helps in identifying and recognizing the license plate of any vehicle automatically within few seconds. As a license plate is the only identification of the vehicle, so a system is made to detect the license plate that is used for various applications like security, toll bars, traffic law enforcement, fraudulence, stole vehicles, and so on. For the plate to be localized, an image is passed from three steps as shown in Figure 1.

In the first step, the image is processed by enhancing the image quality as per the requirement. The quality of image can be enhanced by binarization, filtering, histogram equalization, contrast enhancement, and so on. This step is known as *preprocessing*. In the second step, the candidate regions are detected by using various methods and features [1]. These detected regions may or may not be the true candidate region. This step is called as *plate detection*. In the third step, the detected regions are verified for the true candidate region and the required plate is localized. So this step is called as *plate localization*.

Various techniques have been developed in the past years that worked well in detecting the license plates. These methods can be categorized as edge-based [2–5], filter-based [6, 7], color-based [8, 9], and character-based [10, 11] methods. But still, it is a challenging task to localize the number plate properly. Number plate localization is the only stage in ALPR system that can enhance and build up the system's performance. The difficulty arises where the license plates is having complex background, variation in sizes, skewer, and so forth. In this article, the plate is localized using edge detection method that contains no cuts at the plate boundary that is the boundary of license plate is fully enclosed.

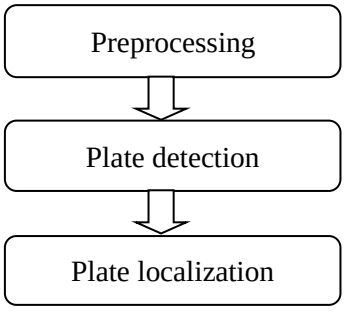

Fig 1: *Steps Involved in License Plate Localization.*

This article is further organized as follows: Section 2 consists of existing methods and Section 3 represents proposed work on number plate localization. Finally this article is concluded in Section 4.

EXISTING METHODS

This section briefly describes about existing methods for plate localization. These methods can be categorized as: feature-based detection methods and learning-based detection methods.

Feature-Based Detection Methods

In [12], color feature is used for the rough detection of candidate region and edge feature is used for detecting the true position with precision rate of 75%.

In [13], boundary feature is used to detect the plate region with Region Proposal Network. Candidate vehicle proposals are generated using convolutional features then Region Proposal Network is used to detect the license plates by correlating the vehicles and license plates. Finally, detection performance was enhanced by processing license plate boundary using canny operator.

In [14], the feature used to detect the license plate is rectangular area with 17 cm as height and 32 cm as width. This rectangular feature is used in Egypt because the dimension of the license plate is fixed.

In [15], corner points of the image are extracted using Harris corner algorithm and then aspect ratio is applied for sliding window to find the most probable region of interest. Finally, the plate is localized well.

In [16], green color is detected in the image as the license plates of Bangladesh are having fixed color, that is, green. So, after extracting this color feature, aspect ratio of plate, that is, 1:2 is used for the localization and 93% of the detection rate is achieved.

Edge detection method is used in [4] after applying gradient on Gaussian filtering. The edges are detected by hysteresis thresholding using canny detector. This method achieved 84.28% accuracy rate.

Morphological open operation with Structural Element of the plate's size is performed on grayscale image to extract the edge feature of the HD image [17]. This extracted image is subtracted from the grayscale image by which edges are enhanced around the plate region. An image close operation is applied to darken the edges after removing noise using open operation. Connected Component analysis algorithm is applied using four connectivity that labels white pixels. Aspect ratio and number of white pixels are calculated and compared using prespecified properties. The localization is done at a success rate of 96% for daylight far view and 99.4% for near view.

Learning-Based Detection Methods

In [18], machine learning method (Linear Discriminant Analysis) is used for the plate detection and achieved success rate of 98% with runtime of 1 second.

In [10], Maximally Stable Extremal Regions detector is used that can extract dark areas from light areas. Finally, verification is done by deep learning and achieved 98.5% detection rate.

Different features are extracted from three different levels of image: grayscale image, filtered image, and contrasted image. The maximum value from these different levels is selected using maximum pooling strategy [19]. Then, using Adaboost algorithm these features are compared with trained features. The detection rate of 98.56% is achieved.

PROPOSED METHODOLOGY

The proposed method is designed for license plate localization which is a feature-based detection method. The feature used for the detection of license plate is edge feature. The proposed method includes three main stages after acquiring the vehicular image: *Preprocessing*, *plate detection*, and *plate localization* as shown in Figure 2.

First, the image is acquired from the phone camera which is not much a high-quality camera. The rear view of the vehicle is captured in the daytime which consists of complex background, sun rays, and shadows on it. The processing after acquiring the image is done as discussed below:

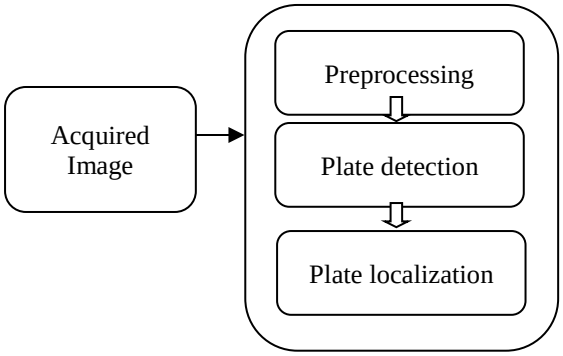

Fig 2: *Steps Involved in Proposed Method*.

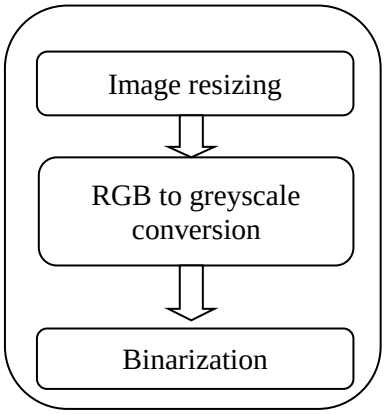

Fig 3: *Steps Involved in Preprocessing*.

Preprocessing: It is the first processing stage after the image acquisition. This is processed to enhance the image features. In this proposal, preprocessing includes three steps as shown in Figure 3.

Image resizing: Image resizing means to change the size of the image. The images with large dimensions are difficult to process so the images are resized. In this, the image has been resized to 512 × 512 that makes the device easy to recognize the image.

RGB to grayscale conversion: RGB image contains three main colors that are Red, Green, and Blue. Each of these colors contain 256 different intensities (256 [Red] × 256 [Green] × 256 [Blue] = 166777216 intensities). As it is complex to deal with a huge value of intensities, so it is transformed to grayscale image that contains only 256 intensities which make it easy for the processing. The RGB image and grayscale image are shown in Figures 4 (a) and (b), respectively.

Binarization: Grayscale image is converted to binary image that contains only two intensities, that is, 0 and 1 (Black and White) which is helpful in further processing. The converted binary image is shown in Figure 5.

Plate detection: After preprocessing, the license plate is detected. There are several techniques that can be used to detect the license plate like Hough Transform, Wavelet Transform, Edge detection, and so on. In this paper, edge detection technique is used. The plate is detected in three steps as shown in Figure 6.

Edge detection: This is an easy, simple, and fast method to detect license plate. Edges are those areas of image where there are abrupt changes in the intensities. The edges are detected from the binarized image that gave a clear view of the image boundaries as shown in Figure 7(a).

Filling of the holes: The holes, loops, or enclosed areas are filled after the edge detection as shown in Figure 7(b). As the area of license plate containing a bigger loop than all the other loops, so it is sufficient to detect the plate. But, this will not work on the images where the license plate areas are having cuts at the boundary as there will not be a closed area to be filled and the license plate cannot be detected in such cases.

Median filtering: After detecting the edge and filling the holes, median filtering is done that pads the image with 0s on the edges by which the edges might get distorted. The median filtered image after edge detection and filling the holes is shown in Figure 8.

Plate localization: After detecting the probable plate regions, the true license plate is localized. The localization is done in two basic steps as shown in Figure 9.

Area open operation: As seen in filtered image that there are small objects irrelevant for the localized image so these are removed using area opening operation. This operator can remove the connected objects with predefined pixels from the binary image. The image after applying this operator is shown in Figure 10 (a).

Localized plate: The plate is finally localized by multiplying two images, the binarized image and the image obtained by applying open area operator. The localized image is shown in Figure 10 (b).

Fig 4: *(a) RGB Image; (b) Grayscale Image.*

Fig 5: *Binarized Image.*

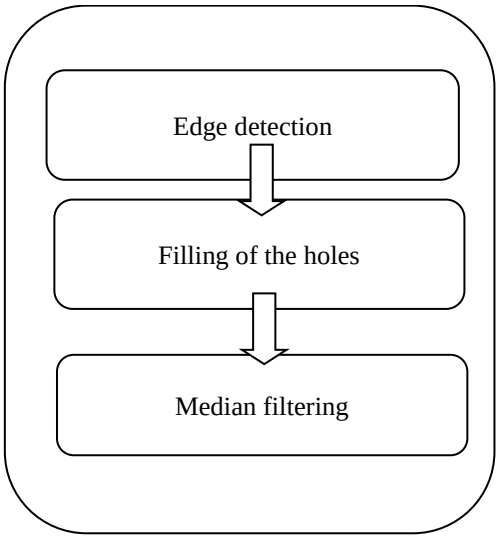

Fig 6: *Steps Involved in Plate Detection.*

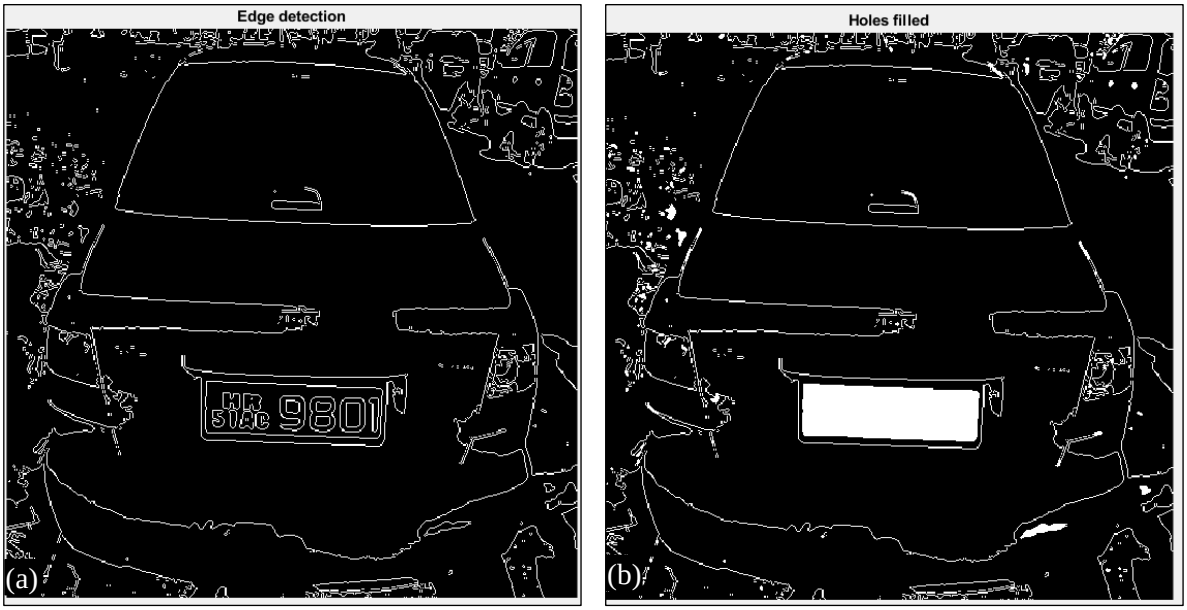

Fig 7: *(a) Edge Detection; (b) Holes Filled.*

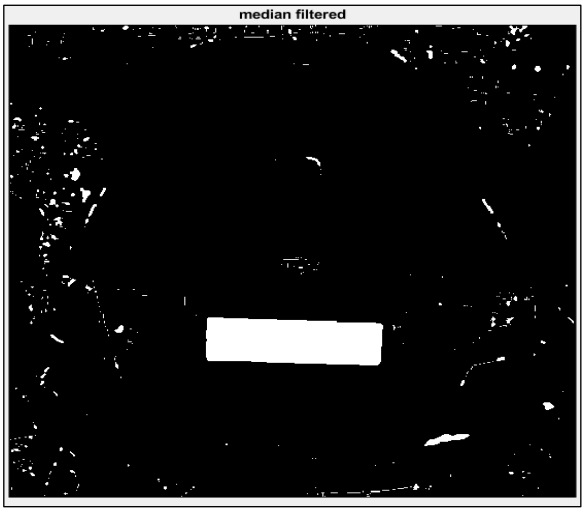

Fig 8: *Median Filtering.*

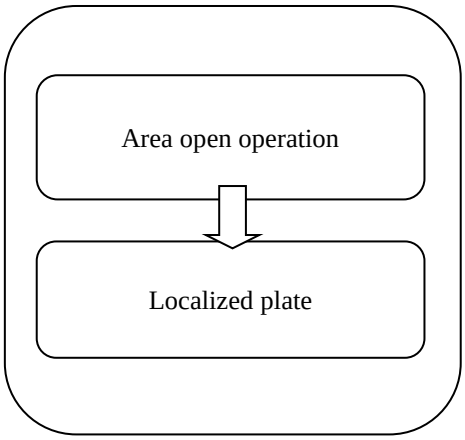

Fig 9: *Steps Involved in Plate Localization.*

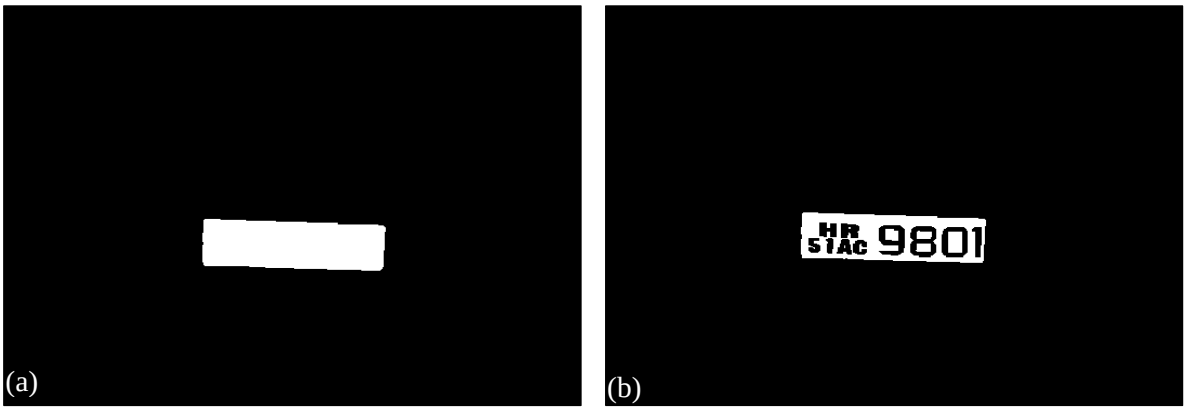

Fig 10: *(a) Image After Area Open Operation; (b) Localized Plate.*

CONCLUSION

In this article, a simple and effective approach for number plate localization is proposed that completely based on holes filling in an image. Edges are detected to make a clear view of the area around the plate region that is to be filled and finally the noise and small lines are removed using median filter and area open operation, respectively. The proposed technique is mainly designed for the images that have number plates within an enclosed boundary. The localization is done accurately and in a very less time. In future, the localization of multiplates, segmentation, and character recognition in various weather conditions can be done.

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