Image Processing Based Intelligent Parking System using Number plate recognition

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Abstract: In this work, an automatic license plate detector is proposed using digital image processing methods in which video camera can be implemented at the entry point of the vehicles which is further processed by breaking the video into frames such that license plate comes into focus range of the camera. We have developed a system where all these processes are automated using an intelligent algorithm on MATLAB. The systems use different color spaces which are converted first from RGB channels which are further used by image Binarization. Binarized image is applied to connected component analysis in which properties of the regions i.e. Area, Bounding box containing height and width parameters and centroid are used to exclude the unwanted portions in the image and to segment the characters of license plate in the frames. Further template matching is implemented to extract the license plate number in text form. The proposed system is experimented on a private parking spot in the locality in which video clips are taken for the vehicles in the entry point and proposed method is applied on the frames of the clips where license plates are focused from the viewer’s point of view. Experimental results show 90% accuracy of detection of number plate regions and characters in the collected dataset. Results can be improved further for other language number plates as well as this work is carried out on Indian license plates written in English Language.

Index Terms: - Smart car parking systems, LPR, connected component analysis, template matching, image processing etc.

I. INTRODUCTION

The Recognition of automatic license plate plays a vital role in enormous number of applications of intelligent transport system such as programmed toll collection, overcrowded pricing, unattended parking lots and traffic legislation. Depending upon the working environment, LPR changes from one application to other. Dynamic scenes are created when pointable cameras move or zoom over suitable angles. There may or may not be a multiple number of license plates in a dynamic scene image. Whenever the image of a license plate is viewed, it may have arbitrary dimensions, position and alignments. The detection of license plates can become quite reasonably challenging, if intricate backgrounds are involved [1 2]. Locating and identifying license numbers and license plates are the two major processes involved in LPR system. In the former one, depending upon the characteristics of license plates, the determination of license plate applicants is done. The commonly involved characteristics have been originated from alphanumeric characters and format of license plate [3]. The characteristics concerning license plate format comprises of geometry, shape, grayness spatial frequency of color texture, symmetry height-to-width ratio, arrangement of numbers and their alignment. In genuineness, a small set of strong, dependable, and easy-to-identify object geographies would be suitable. In the identification stage, the license plate applicants already determined are examined. In the identification stage, Number separation and Number recognition are two main jobs are involved. The techniques used in separation of characters from license plates in the past are connected components, template matching and projection morphology.

1. Three major parts are developed in the process of vehicle license plate tracking and recognition system through video surveillance namely:
   2. License Plate Extraction part to get the vehicle license plate’s location contained in the video frame.
   3. License Plate character segmentation part to segment out the vehicle license plate location along with characters in it. This covers the license plate character segmentation and recognition.
   4. Template matching part in which segmented characters are matched to alphanumeric templates of characters obtained offline.
   5. The literature review regarding the relative literature has been given in next section which pins out latest trend in license plate recognition systems.
II. EXISTED WORK

Various LPR techniques have been offered in the technical literature and are characterized based on the characteristics, such as detection of edges on number plates, comprehensive image material, surface, colour, dimensions and alignments. The rectangular shaped region on the number plate with all known dimensions and alignments and the rectangular region from images are extracted by an algorithm called edge detection method. This method inspects the variations in amplitudes of focused pixels to convert the greyscale image into an edge image. The Sobel operator algorithm is used to filter the detection of edges on license plates to describe the borders between two areas in 2-D image, with its kernel scanning in both horizontal and vertical axis [5] [6]. The Canny and Sobel methods are based on matrix multiplication, they are dependent on controlling processing power, which is expensive, while operates on low-cost devices the method suffers on performing lag. The extra or unused regions from the license plates are removed by Morphological detection system and then selecting the appropriate license plate area, which is faster than the edge detection method [8]. However, there are numerous problems in morphological detection system, which does not give appropriate result while using complex images and fails in the test of an algorithm and was not tested in a low-cost device. The earlier edge detection methods are very precise and effective but when these methods are not compromised with intricate images and these methods are not designed to operate in low-cost devices CCA algorithm detects a binary image and split it into two parts on the basis of pixel connectivity and this algorithm also serves for low resolution license plate detection [8]. In order to detect the connected objects another algorithm namely contour detection algorithm is applied which is based on aspect ratio and area of license plate. For texture analysis the Gabor filter is used which distinguish textures in infinite orientations and scales [9 10]. Some other important methods for texture analysis include wavelet transform and Haar-Like method.

III. PRESENT WORK

The major portions of present work are license plate localization from the frames in which region of interest containing characters has been figured out. After that template matching is applied in order to recognize the alpha numeric digits in the segmented region. The steps involved in both processes are described below.

License Plate Localization

The main step in the License Plate Identification System comprises the localization of the License plate. The image captured constituting the complex background is filtered in this step and the resultant image provides the number plate image with high contrast regions. Due to the presence of the ambiance in the snapshots the scene becomes complex. There is a need to consider a specified frame, so that one can focus on the specific images, this can be achieved by excluding the background from the image. Hence, an appropriate and specific window frame size must be taken into consideration. The window size is predicted by the probable dimensions of the number plate. The steps involved in license plate detection are as under.

- Extract the frames of the video to perform frame processing
- Convert RGB frame into binary image and apply rectangle detection using bounding box property of connected component regions. Extract only those rectangles having Height/width ratio b/w 3 and 4.5 and discard the other frame regions.
- Convert the input RGB frame into different color spaces to perform better segmentation and use the marked regions output in step 2.
- Apply Gabor filtering in order to enhance the edges of the characters and obtain binary image by thresholding the Gabor filter output.
- Apply Connected component analysis on the binary image by considering properties i.e. Area, centroid and bounding box etc. to filter out the license plate area in the frame
- Extract blocks having area size b/w 20+500 pixels and discard the rest. It eliminates the larger and very smaller blocks in the image.
- Further reduction of objects has been carried out using centroid + bounding box properties contain height to width of characters.
- Apply cropping command to get the segmented characters region needed for template matching.
3.2 Character Recognition

The premium aim of this step is to provide classification and complete identification to the Binarized images that comprises of the characters obtained from the number plate localized regions. The figure given below describes the functioning of the OCR via flowchart:

![Flowchart representing the process of OCR](image)

Following are the steps which result in Character Recognition:

- Template Database: Production of format database is essential before the character recognition can begin. So according to the text style of the License plates, the database is created. This database comprises of alphabets A-Z and digits 0-9.
- Comparing Segmented Characters After the templates are stacked in the memory, the ALPDR system compares each segmented character to every one of the templates and provide with the nearest positive value.
- This process is repeated until all the segmented characters are recognized.

IV. Results and Discussions

Proposed algorithm has been applied on number of video frames taken from a private car parking. In order to verify our algorithm we have implemented it on variety of frames. Few out of total frames used for the experimental results have been shown in proposed work.
Table 1: Frames in RGB format and character segmentation of the localized License plates

<table>
<thead>
<tr>
<th>Frames</th>
<th>License Plate localized</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Frame 1" /></td>
<td><img src="image2" alt="Segmented License Plate 1" /></td>
</tr>
<tr>
<td><img src="image3" alt="Frame 2" /></td>
<td><img src="image4" alt="Segmented License Plate 2" /></td>
</tr>
<tr>
<td><img src="image5" alt="Frame 3" /></td>
<td><img src="image6" alt="Segmented License Plate 3" /></td>
</tr>
</tbody>
</table>
V. Classification Accuracy

The number of characters detected after presented license plate detection system and the ground truth reality of the characters provides the effectiveness of the presented method based on sensitivity of localized characters and specificity of rest of the image which considers as background portion. Hence Detection Accuracy (DA) which defines sensitivity parameter of localizing the number plate characters can effectively represent the accuracy of automatic license plate detector by proposed method. Detection Accuracy (DA) is the number of (actually) actually localized characters which are accurately detected by any license plate detector system. Higher efficiency implies higher detection accuracy.

\[
DA_{\text{characters}} = \frac{\# \text{Correctly detected characters}}{\# \text{Total characters in the number plate}} \times 100\% \quad (1)
\]

Accuracy of license plate detection can also be evaluated in terms of number of total frames that are experimented and license plate localized in number of frames that are tested.

\[
DA_{\text{frames}} = \frac{\# \text{Frames in which license plate detected}}{\# \text{Total number of frames tested}} \times 100\% \quad (2)
\]
Table 2. Table one showing different parameters for evaluating performance of the algorithm.

<table>
<thead>
<tr>
<th>Database individual</th>
<th>Total characters in license plate</th>
<th>Correctly localized and detected characters</th>
<th>Detection Accuracy of characters</th>
<th>Total frames tested</th>
<th>No. of frames in which license plate localized</th>
<th>Detection accuracy of frames in which license plates localized</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB11BV6619</td>
<td>10</td>
<td>10</td>
<td>100%</td>
<td>10</td>
<td>8</td>
<td>80%</td>
</tr>
<tr>
<td>PB03S2525</td>
<td>9</td>
<td>9</td>
<td>100%</td>
<td>10</td>
<td>9</td>
<td>90%</td>
</tr>
<tr>
<td>PB11AL9728</td>
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<td>10</td>
<td>100%</td>
<td>10</td>
<td>8</td>
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<td>10</td>
<td>100%</td>
<td>10</td>
<td>8</td>
<td>80%</td>
</tr>
</tbody>
</table>

Table 3. Approximate overall Accuracy of localized plates in frames tested

| Overall accuracy | 90% |

VI. Conclusion

The proposed method consists of two main phases which are plate localization/detection and character recognition. The Indian license plate has its unique characteristics so that any LPR method used has to be modified and improved to have a good result. For the detection phase, we used three different color spaces whose intensity and chromaticity components are concatenated. The image produced further passed through Gabor filters which assists in edge enhancement of the image along with removal of noise. To decrease the computation area in the image, binary image is used on which rectangular blocks are found first and only those are taken which have height/width ranges in the license plate size. Further connected component analysis is used from the thresholded binary image produced after Gabor filtering in which centroid, area, bounding box region properties are used to sort out characters in the image. Some noise removal method is also added to remove objects that were considered impossible to be a character based on their size. This resulted in segmented character image which is used for template matching in order to recognize the characters. In the recognition phase, we used the template matching algorithm whose accuracy was improved using English license plate font and format. Experimental results shows that proposed algorithm can effectively localize the characters and template matching process successfully recognize the alphabets in the frames. Experimental results shows 90% accuracy in localization of license plate in the video frames tested.
References:


