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Morphology Based Number Plate Localization for Vehicular Surveillance System

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ABSTRACT

Number Plate Recognition systems are used to track and monitor the moving vehicles by automatically extracting the number plates. The objective of this system is to recognize vehicles based on license plate information. The images of passing vehicles are taken at surveillance system and those images will be processed. Proposed method uses simple morphological open and close operations using different structuring elements and Global Thresholding for plate localization. Connected component labeling is used for plate recognition from all other candidates. We have proposed a method to locate number plate using efficient algorithm for plate feature extraction, Labeling & searching plate region. By overcoming the difficulties in existing methods, proposed method results in high detection rate.

Keywords: **- Morphological operations, Labeling Global Thresholding, Number plate localization**.

I. INTRODUCTION

The license plate recognition of vehicle is an important part of the **Intelligence Traffic Control System**. Number Plate recognition system have wide range of applications like traffic surveillance, tracing of stolen cars, identification of dangerous drivers and Automatic Electronic Toll Collection system [2][3] [4]. The objective is to extract and recognize License plate information from car images without any human intervention. One of its main advantages is the ability to capture information in the plates, at high traffic flow and speeds, and when it is difficult to manually record [1].The Number Plate recognition

System has mainly three components. They are image Acquisition system, image processing system and display unit. In this paper we have proposed a method for Plate Localization. Plate localization requires two major tasks. The first one is to separate Number Plate area from Non-Number Plate area and second one is plate adjustment.

The most commonly used method for license plate Recognition is the combination of **edge detection and mathematical morphology** [5] [6]. In this method detection rate is affected by the quality of the image. **Color based image processing** methods are not suitable for cases where the background has the same color of the plate or in countries where multiple colors are used (e.g. China). In Texture based feature extraction methods like **SVM and Gabor Transformation**, the computation complexity will limit its usability [2]. Many plate localization algorithms have been developed using the above mentioned methods. However, these algorithms are either having low detection rate or high computation complexity.

We are proposing an efficient algorithm based on the mathematical morphology which produces high detection rate than existing methods. This paper presents a method based on the open and close morphological operations with different structuring elements for number plate localization. This method utilizes open and close morphological operation and Global Thresholding to enhance plate region and eliminate non-plate region. Finally the plate region is obtained based on Connected Component Labeling and geometrical relationship of numbers on plate.

II. SYSTEM OVERVIEW:

License plate is a pattern with high variations of contrast. This feature is useful to locate the plate and is robust to the changes of lighting conditions and orientation of image taken. The open and close morphological operations are used to extract the contrast features within the plate. This is a relatively stable method when subjected to different image alterations or conditions [2] [6].

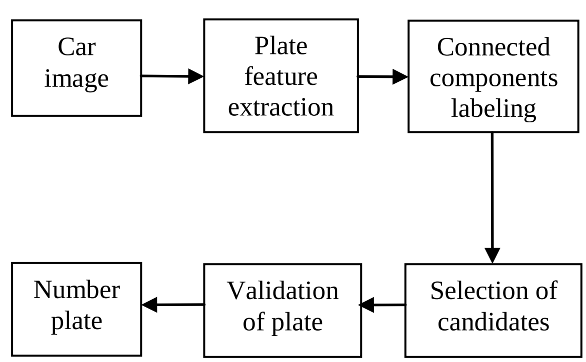

Fig. 1: Block Diagram of System

The license plate localization consists of three major stages:

- Morphological operations for extracting plate features
- Labeling the connected components
- Selection of candidate regions
- Validation of plate region.

Fig. 1 shows the block diagram of the Plate Localization. Each stage is explained further in the next sub unit.

III. PLATE LOCALIZATION:

The Car image is passed through two open & one close morphological operations and Global Thresholding in order to maximize the elimination of non-plate regions.

3.1. Plate Feature Extraction:

Fig. 2 illustrates the plate feature extraction stage. The original RGB image is given to system and it will be converted into gray scale image which is passed to first Opening operation. Morphological Opening is erosion followed by a dilation used to eliminate small and narrow parts of an image [2] [7]. Rectangular structuring element (SE) is used for opening operation and this step is used to smooth the background illumination.

SE is a matrix containing 1's and the centre of the matrix is called 'Origin'. The size of SE is based on the resolution of the original image, plate region and it should be related to size of character. We have taken SE size as 4×30.This opening operation can effectively erase plate region and keep non-plate region from grayscale image. Background of image will be obtained in this step. The next step is to subtract the background image from the grayscale image of car and the result is Highlighted Plate region. Fig. 3 shows the Highlighted Plate region.

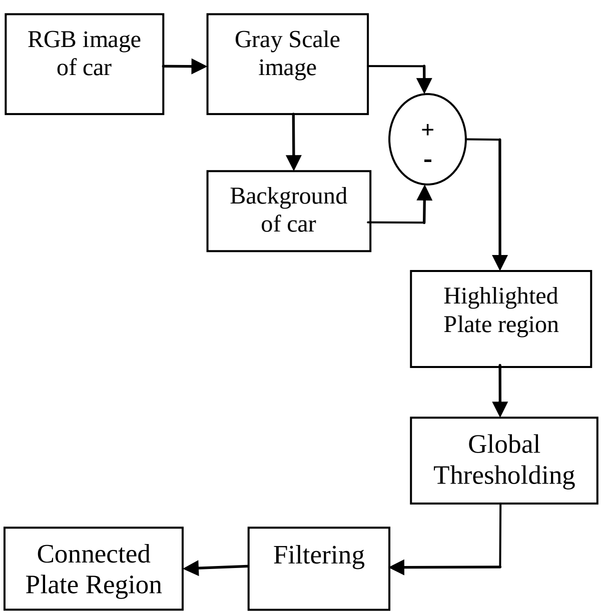

Fig. 2: Block Diagram Plate Feature Extraction

Fig. 3: Highlighted Plate Region

The output of this stage is converted to binary using Global **Thresholding**. This operation will further eliminate non-plate regions. The algorithm for Global Thresholding is given below [8]

1. An initial threshold (T) is chosen (any random value).
2. The image is segmented into object and background pixels, creating two sets:
   a) $G_1 = \{f(i,j) > T\}$ (object pixels)
   b) $G_2 = \{f(i,j) < T\}$ (background pixels)
3. The average of each set is computed.
   a. m_1 = average of G_1
   b. m_2 = average of G_2
4. A new threshold is created that is the average of m_1 and m_2
   $T' = (m_1 + m_2)/2$
5. Repeat the steps two to four using new threshold value, until the new threshold equal to previous one.

Fig. 4: Binary image

Still some unnecessary information would remain in the binary image. To eliminate the rest of non-plate regions other two Morphological operations are used. The first one is another opening operation which is performed to filter the small and narrow elements.

Here 'diamond' shaped Structuring Element is used for removing such small elements. The SE used is a 'diamond' shaped matrix that has a radius R=2, where inside the 'diamond' all 1's will be present and outside of it all 0's will be present. When this diamond shaped structure is used during the opening operation only diamond-shaped regions containing 1's will remain and other elements will be removed. If radius is greater than 2, plate region may get damaged. This operation is very useful to erase net shaped and narrow lines that are surrounding the plate area [2] [4]. Fig. 6 shows the resulting image.

Fig. 6: Filtered image

The above operation can efficiently erase most of the unwanted elements but some pixels in the plate region can also be eliminated. Therefore closing operation is used to completely fill the plate region thereby to connect the pixels. The morphological close operation is a dilation followed by erosion, which is normally used for fusing small holes and filling narrow aperture [2]. In this step, a 4×12 'rectangle' shaped SE is used for the closing operation. The result obtained after performing the close operation is shown in Fig. 7. The size of the SE depends on the size of the plate region and resolution of image.

Fig. 7: Connected Plate Region

From Fig. 7 we can observe that, the plate region is a group of connected pixels which can be easily extracted using some known geometrical conditions like Width/Length ratio and their ranges.

3.2 Labeling the Connected Components:

In binary images analysis objects are usually extracted by means of the connected components labeling operation, which is assigning a unique label to each maximal connected region of foreground pixels. The classical sequential labeling algorithm relies on two subsequent scans of the image. In the first scan, a temporary label is assigned to each foreground pixel based on the values of its neighbors already visited by the scan. When a foreground pixel with two foreground neighbors carrying different labels is found, the labels associated with the pixels in the neighborhood are registered as being equivalent. After completion of the first scan equivalences are processed to determine equivalence classes. Then, a second scan is run over the image so as to replace each temporary label by the identifier of its corresponding equivalence class.

Here we have used a **Two-scan labeling algorithm** unlike the classical approach, where equivalences are processed during the first pass in order to determine the correct state of equivalence classes at each time of the scan. This is obtained by **merging** classes as soon as a new equivalence is found, the data structure used to support the merging being a simple 1D array. This approach allows the check for a conflict to be carried out on class identifiers rather than on labels.

TWO- SCAN Labeling Algorithm:

```
1. First scan is started and check for pixel value,
   If  l (i, j) =0, go to next pixel.
2. Else If l (i, j) =1 then check following
     a. If l (i-1, j) =l (i, j-1) =0 then assign new label.
     b. If l (i-1, j) =0 or l (i, j-1) =0 then assign label
        related to  non zero pixel.
     c. If both are equal then assign any value.
     d. If labels of two neighbors are not equal, mark
       as equivalence and go for merging
3. Repeat step 1 and step 2 for all pixels
4. In second scan label values are changed according
   to their corresponding class identifier
```

3.3 Selection of Potential Candidates:

Labeled image is taken as input to this stage. Two geometrical conditions are used to select potential candidates from all the labeled elements. Assume the extracted plate region is of size W×L .The first criterion is the ratio r between the width and length of plate and it must matches with ratio specified. The second criterion is the ranges of W and L; they must be within given range. For this, the given ranges of W and L must be large enough to cover most of the possible sizes of the plate region. These two steps in selection of potential candidates can effectively reduce the number of candidate regions. However, there may arise some Candidates that are other than the actual plate. These fake candidates need to be eliminated using validation criteria.

```
For each Label
   {
     [r c] = Region with Label K
     pwidth=max(c)-min(c);
     pheight=max(r)-min(r) ;
     If width and height satisfies selection criteria
      {
         % validation
```

```
    Compute complementary binary of selected
    Candidate
    Label the connected components in selected
    Candidate
   For each Label
    {
        [ro co] = Region with Label K1
        cwidth =max (co)-min (co);
        cheight =max (ro)-min (ro);
     If W/H of k1th label is within given range
        Increment ccnum by one
     }
     If ((ccnum<=15) && (ccnum>=2))
        Display the region having kth label
  }
}
```

Fig. 8: Selection and Validation Procedure

3.4 Validation of Selected Candidates:

The validation criterion is based on counting the number of connected component from each potential candidate. For this purpose the complemented binary image of potential candidate is taken. After this connected components present in the complementary binary image will be Labeled. The connected components that meet the geometrical conditions of the character on the plate (i.e width/length ratio of the character) will be taken into consideration. In general, in an original plate region this connected components count must be in between 2 to 15 and for fake regions this count is less than 2 or greater than 15. Therefore, using this process all the non number plate regions can be filtered out. So at this stage actual plate region can be obtained.

Once the plate region coordinates obtained, the final number plate can be extracted from the original binary image.

IV. RESULTS:

V. CONCLUSION & FUTURE SCOPE

In this paper, we have presented an efficient algorithm based on Morphological operations and Geometrical relationship for Number Plate Localization. This method has low computation complexity and also detection rate is improved than existing methods. This work can be extended to detect all kinds of vehicles and this can be applied to design a real time system for Tracking vehicles, tracing stolen cars and Automatic Gate Control System.

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