License Plate Localization, Segmentation and Recognition

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Abstract

The focus of this project is to develop a system for localization, segmentation and recognition of licence plates in images.

I. MOTIVATION

Automatic car identification systems based on localization and recognition of number plates from images, form a fundamental problem in computer vision.

Quick developments in Image Processing and need for faster, cheaper and more efficient systems in automotive security and steering systems has resulted in development of sophisticated solutions to this problem.

A solution to such problem can be applied in many areas and can form a basis of automatic systems providing access to protected areas, route traffic monitoring for offences and traffic system violations.

Most countries have an elaborate network of surveillance camera throughout cities and yet don't have systems to automatize car identifying process. Solutions are still expensive and not deployed at a very large scale.

II. PREVIOUS WORK DONE

License plate recognition has been of interest to researchers due its ability to uniquely identify vehicles. But license plates come in different makes and colors in different countries making its detection challenging. There are specific demands of such LCR systems:

- There should be robust and quick in identification of plates
- The system should be universal and detect license plates from different countries
- System should be resistant to weather conditions and disturbances that may occur while photo capturing or any mechanical tampering of the plate

Lot of research has gone into satisfying all the three aspects of a License Plate Recognition System. The problem has 3 main components: localization, segmentation and recognition.

For License Plate localization, a common approach is through horizontal and vertical projection on the image through a search window. The image is usually searched from the bottom since License Plates(LP) are located at the bottom of the image.

After segmentation, the edge features are extracted. Usually density based mapping is used to map
edges since it is presumed that denser regions are texts. There are various approaches towards LC detection through density such as *Connected Component Labelling(CCL)*[5, 6, 7], *fuzzy logic*[8], *vertical edge detection*[9]. However CCLs do not perform well for dark backgrounds and fuzzy logic is sensitive to color of LP. After this, we have to detect the LP area through row and column range detection. This can be achieved through a combination of Hough Transform and Counter Algorithm[10].

For character segmentation, previous approaches use gray-scale quantization and morphology analysis[1].

For character recognition sophisticated approaches such as *Artificial Neural Networks(ANN)*[8], *Probabilistic Neural Networks(PNN)*[6], *SVM*, etc are used.The major difference between these approaches is misclassification rate. It has been observed that SVM perform better than neural networks and PNN works better than ANN[2].

III. METHODOLOGY

A. PROBLEM STATEMENT

The problem addressed by this paper is the localization, segmentation and recognition of a licence plate in an image under any environmental conditions.

B. MAIN CONTRIBUTIONS

The paper presents an approach to license plate localization and recognition using connected components analysis and license plate signatures. The proposed method is designed to work under any environmental conditions.

C. SUMMARY

The license plate localization method must use a feature common among all the license plates. One such feature is relatively big differences in color and brightness of that of characters in license plates and their background. To localize a licence plate, two complementary approaches are discussed: using component analysis and licence plate "signatures".

Image Processing

Color space of the image is changed to YUV, but only luminance is recorded. The image is normalized with certain thresholding techniques to increase the contrast between license plate characters and their background.

Localization using connected component analysis

A filter is used to find areas where the contrast between neighbouring points exceed a certain threshold and binarizes the image. This helps in localizing a set of elements which can form a set of license plate characters. The neighbourhood is analyzed in form a 5x5 filter, when the contrast in neighbourhood exceeds a threshold, it is marked for possibility of a character element.

After labeling the black and white spots the process of elimination takes place. The aim of this stage is to leave in the picture only these spots which are most likely to be license plate characters, assuming that each spot represents a single character and isn't connected with any other object in the image.

The spot is eliminated if one of the below given conditions is fulfilled:

- the width of the spot is smaller than 3 points,
- the width of the spot is bigger than 1/4 of the input image width,
- the height of the spot is smaller than 8 points, you didn't receive my messages did you?
- the height of the spot is bigger than 1/3 of the input image height,
- the ratio of the spot's width to its height is smaller than 0,1,
- the ratio of the spot's width to its height is bigger than 4 (because of two or three joined characters),
- the ratio of the spots area to the spot's bounding box area is smaller than 0,15.

Points are then grouped together based on their size and neighbourhood. Similar points representing the same character are grouped together. The points in a group form a segment and an elimination process is applied to these segments. The segments remaining after elimination will represent the captions in the image. It is essential to perform grouping of neighbouring segments. A round of elimination is again performed and finally the remaining segments are considering candidates for license plates in the image.

Searching for signature of license plate

The second method of license plates localization is based on localization of theirs "signatures". The "signature" is a characteristic sequence of minimum and maximum in the brightness function calculated on a single row of input image which crosses a license plate.

To localize the license plate every row of the input image is checked. If there is a part of a row which looks like a "signature" this part is marked. A number of grouping and eliminating operations is applied to the spots created in this way.

Using affine transformations, the localized image is projected and binarized. One of the challenges is to get a horizontal image of the license plate

D. TECHNIQUE EVALUATION

To evaluate effectiveness of the method proposed in this paper a few tests were performed:

T1. Test of effectiveness of the connected component analysis method.

T2. Test of effectiveness of the "signature" searching method.

T3. Test of effectiveness of license plate localization process based on both presented methods.

T4. Test of effectiveness of character segmentation process.

T5. Test of effectiveness of character recognition process.

T6. Test of effectiveness of proposed license plate localization and recognition system.

E. SHORTCOMINGS

The final result of effectiveness of proposed license plate localization and recognition system isn't very impressive. That is caused by the poor effectiveness of the proposed character segmentation and recognition methods. One wrongly segmented or recognized character is enough to reject whole localized, segmented and recognized caption in the syntax analysis process.

IV. PROBLEM STATEMENT

The focus of this project is develop a system to locate a number plate in an image and segment it. Final step of the problem is perform Object Character Recognition on the segmented image to recognize the number plate.

V. APPROACH

Our approach towards solving the problem of License Plate Recognition shall be based on the following pipeline:

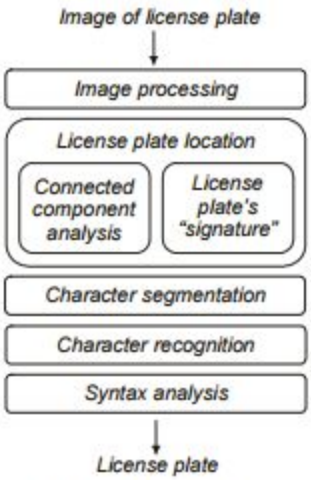

Fig. 1. Diagram of the proposed license plate recognition metho

(1) We shall perform first perform image pre-processing in order to remove noise, improve picture quality and remove shadows, etc. For image pre-processing we shall rely on the approach by [3] which involves:

$$gray(i, j) = 0.59 * R(i, j) + 0.30 * G(i, j) + 0.11 * B(i, j) \quad (1$$

[3]

(2) Median filtering

(3) Contrast enhancement

This shall be followed by LP localization. For this we will try to implement signature analysis[paper 1]. Some other approaches we will look into shall be [paper 4] and [paper 5].

For character segmentation we will use horizontal and vertical segmentation[7]. Through vertical scanning, the characters shall be extracted into arrays and through horizontal scanning extra upper and lower areas shall be eliminated. For character recognition we plan to use an open source OCR Tesseract [link]

VI. EXPERIMENTAL SETUP AND EVALUATION

Details of experimental setup.: What datasets are you going to use? What metrics are you going to use to evaluate your (or other) methods? Provide an intuition of what the metric is measuring.

The dataset we are going to use can be found here. We are going to start with number plate recognition using images containing one-two cars. We shall then test our system on images with multiple cars captured in both daylight and night. For evaluation we shall use the following two metrics:

- **True positive rate**: we shall reject those predictions where there is slight discrepancy between the actual label and the final outcome of our system.
- **Edit distance:** we will calculate the edit distance between the characters of the actual label and the predicted ones to understand the accuracy of our system.

VI. DIVISION OF LABOUR

Since, we are working in a team of two: we plan to divide the work equally for understanding research papers, programming, implementing and data collection.

For every part of the project, we would have equal number of hours spent from both the students.

VII. REFERENCES

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