Automatic license plate recognition using Image Enhancement technique With Hidden Markov Model

G. Angel, J. Rethna virgil Jeny, J. Albert Simon

Abstract— Huge number of vehicles in modern cities makes the Traffic Surveillance a complex one. Therefore, it's essential to establish an efficient Automatic License Plate Recognition (ALPR) system for Traffic scheduling and Management. In this paper we propose an Automatic License Plate Recognition System for Recognizing the License plate Number. To deals with the illumination problem, good pre-processing methods (Image Enhancement) are used to remove the influence of lighting and to make the license plate salient. Our proposed System contains three main modules: Vehicle License Plate detection (VLPD), Segmentation and Plate number Recognition. The query image is enhanced to support over bright images by using Image Enhancement technique. The speed and accuracy of the image in enhanced by using Contour algorithm (CA) and Hough transform (HT). Horizontal and Vertical projection techniques are used to separate the character from license plate image. Finally the plate numbers are recognized by Hidden Markov Model (HMM) and Optical Character Recognition (OCR) Technique.

Index Terms—ALPR, VLPD, LPR, OCR, HMM, CA, HT.

1.AUTOMATIC LICENSE PLATE RECOGNITION

ALPR is a special form of Optical Character Recognition. License Plate Recognition is a type of technology, which enables computer systems to read automatically the registration number (License Number) on vehicles from digital pictures. Reading automatically the registration number means transforming the pixels of the digital image into the ASCII text of the number plate. Capturing of fast moving vehicles needs special technique to avoid motion blur which can decrease the recognition accuracy dramatically. To ensure the right image quality short shutter time need to be used with the combination of high-power illumination. The retro reflective plates reflect this kind of light very well and it is undetectable for the human eye. This combination works fine during day and night and provides constant good image quality.

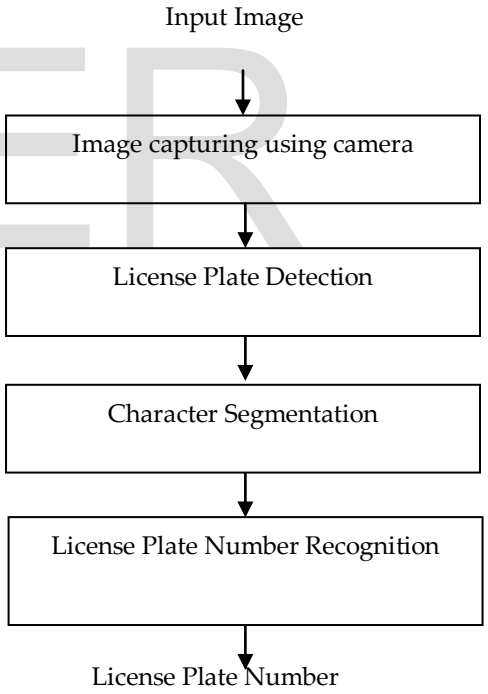

Fig. 1 Phases of ALPR System

The OCR system that extracts the License Plate number from a given image has four stages. First stage: Capture the car image by using camera. The parameters of the camera, such as shutter speed, orientation, camera resolution, type of camera and light has to be considered. Second stage: Image is given as input and the extracted license plate is the output. Third stage:

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License Plate is the input; characters of the License Plate are taken as segmented output, by projecting their Positions with templates. Final Stage: Input is segmented character. Output is plate number in a standard form by using template matching or using classifiers (Hidden Markov Model). The OCR system performance relies on the robustness of individual stage. Fig1 represents the phases of the ALPR system. The License Plate detection module receives images which have been processed by the pre-processing module – the first input module of this system. The resulted images of this module are sent to the segmentation module. The segmentation module segments plate-images into separate character- images. These character-images are then recognized by the OCR module and the final results are ASCII characters and numbers in plates.

2. LICENSE PLATE DETECTION

The license plate detection stage influences the accuracy of an ALPR system. The input to this stage is a car image, and the output is a portion of the image containing the potential license plate. The license plate can exist anywhere in the image. Instead of processing every pixel in the image, which increases the processing time, the license plate can be distinguished by its features, and therefore the system processes only the pixels that have these features. The features are derived from the license plate format and the characters constituting it. License plate color is one of the features since jurisdictions such as countries, states or provinces have certain colors for their license plates. The rectangular shape of the license plate boundary is another feature that is used to extract the license plate. The color change between the characters and the license plate background (texture) is used to extract the license plate region from the image.

2.1 Gray scale Conversion and Adaptive Histogram Equalization

Images taken from camera were processed by the first stage. The purpose of this stage is to enrich the edge features. Because our detection method is based on the boundary features, it will improve the successful rate of the VLP detection module. The algorithms sequentially used in this module are graying, normalizing and histogram equalization. After having obtained a grey- scale image, we use Sobel filters to extract the edging image, and then thresholds the image to a binary one. We used the local adaptive thresholding algorithm [2] for the binarization step. Especially, we develop an algorithm based on dynamic programming to optimize its speed and make it suitable to real-time applications [1]. The resulted images are used as inputs for the VLP detection module. In this paper we use an Adaptive histogram equalization algorithm for illumination images. Adaptive Local Thresholding Method is used for preprocessing the image rather than using the global thresholding method, In this approach we compute an independent threshold for each pixel over a local window whose centre is the pixel being binarizing (M window size). Each algorithm following this approach has a different method of determining threshold values on local window. In [3], each pixel is assigned to a background or foreground level (using global threshold), then the threshold value is determined by the average of two background/foreground clusters.

2.2 Hough Transform and Contour Algorithm

In boundary-based approach, the most important step is to detect boundary lines. One of most efficient algorithms is Hough transform. Hough Transform is applied to the binary image to extract lines from object-images. However, the drawback of this approach is that the execution time of the Hough transform requires too much computation when being applied to a binary image with great number of pixels. The speed of the algorithm may be improved by thinning image before applying the Hough transform. Nevertheless, the thinning algorithm [5] is also slow. This limitation makes the approach unsuitable for real time traffic management systems. The algorithm we used in this system is the combination of the Hough Transform and Contour algorithm which produces higher accuracy and faster speed so that it can be applied to real time systems. The functions of Hough Transform and Contour algorithms are, 1) Combine Hough Transform and Contour Algorithm [4] for Detecting VLP Our approach is

as follows: from the extracted edging image, we use the contour algorithm to detect closed boundaries of objects. These contour lines are transformed to Hough coordinate to find two interacted parallel lines (one of 2-parallel lines holds back the other 2-parallel lines and establishes a parallelogram-form object) that are considered as a plate-candidate. Since there are quite few (black) pixels in the contour lines, the transformation of these points to Hough coordinate required much less computation. Hence, the speed of the algorithm is improved significantly without the loss of accuracy. However, some plates may be covered by glasses or decorated with headlights. These objects may also have the shape of two interacted 2-parallel lines, and therefore, are also falsely detected as plate-candidates. To reject such incorrect candidates, we implement a module for evaluating whether a candidate is a plate or not. 2) Plate-Candidates Verification From the two horizontal lines of a candidate, we can calculate exactly how inclined it was from horizontal coordinate [4]. Then we apply a rotate transformation to adjust it to straight angle. After processed, these straight binary plate-candidate regions were passed to a number of heuristics and algorithms for evaluating. Our evaluating plate-candidates algorithm is based on two main steps: (a) Evaluate the ratios between the heights and the widths of the candidates, (b) Use horizontal crosscuts to count the number of cut-objects in the candidates.

3. CHARACTER SEGMENTATION

3.1 Horizontal Projection

The common algorithm for this task is applying projections. However, in some cases, it does not work correctly. We will now describe our approach in segmentation by adding some enhancements to this method. We use a horizontal projection to detect and segment rows in 2 row plates. The result of row segmentation is nearly perfect. The positions with minimum values of horizontal projection [6] are the start or the end of a row in plate. After labelling, a set of potential license plates can be extracted from the images. However many incorrect license plates may be extracted from the cluttered environment. For instances, frames of windows, trees, edges among a set of books, etc. are frequently segmented as license-plate-analogue pixels. Therefore, some geometries and texture information are used first at this stage to remove these unwanted regions.

Fig. 2 Results of row segmentation by horizontal projection

3.2 Vertical Projection

Vertical Projection is different from row segmentation, character segmentation is more difficult due to many reasons such as stuck characters, screws, and mud covered in plates. These noise things cause the character segmentation algorithm using vertical projection [6]. In some worst cases of bad quality plate images, a character can be segmented into two pieces. We apply several constraints of ratio of the height to the width of a character. We search for the minimum values in the vertical projection and only the minimum positions which give cut pieces satisfied all predefined constraints are considered as the points for character segmentation. By this enhancement, we have achieved better results in this task. After this step, we have a list of character candidates. Not all of the candidates are actually images of characters. The final plate candidates, together with their list of characters are passed to the OCR module for recognizing.

4. LICENSE PLATE NUMBER RECOGNITION

The segmented characters are then recognized and the output is the license plate number. Character recognition in ALPR systems may have some difficulties. Due to the camera zoom factor, the extracted characters do not have the same size and the same thickness [7]. Resizing the characters into one size before

recognition helps overcome this problem. The characters font is not the same all the time since different countries license plates use different fonts. Segmented character may have some noise or they may be broken. License Plate Number recognition use Hidden Markov Model Technique for Optical Character Recognition.

4.1 Hidden Markov Model

HMM technique plays an important role in numerous real life applications such as automatic tool collection, traffic law enforcement, parking lot access control and road traffic monitoring. HMM technique [7] gives the standard output for the vehicle's license plate (LP) number from an image or images. The input images can be taken by using infrared camera. HMM technique obtains standard output by using many techniques such as object detection, image processing and pattern recognition. HMM of OCR is known for automatic vehicle identification, car plate recognition and number plate recognition for cars. Detection and recognition of license plates method challenges the several plate types and environmental changes.

In this model, all images used for training and images to deal with after well trained is the same size of 50×50 pixels. Hence, all character images are scaled into the size of 50×50 pixels by the centre point. 1) Features extracting: In this system, we use the HMM model for character recognition. The features which we used in this model are the ratio of foreground pixels in a window. Scanning a window in an image and overlapped windows 2) Training model: In the recognition module, we need to classify a character image into one of 36 classes (26 alphabet letters: A, B, C… and 10 numeric characters: 0, 1, 2…). To train our model, we use training sets which were extracted from images of VLPs. The number of samples for every class is about 60.These samples were extracted from real VLP images with a little noise, so after well trained, the model can recognize exactly plates with the similar types of noise. In the last step, we use some specific rules of Vietnamese VLPs to improve accuracy. We learned that the third character in plate must be a letter, the fourth is sometimes a letter but usually a number and the other positions are surely numbers.

5. RESULTS AND DISCUSSION

Our system is evaluated for some vehicles plates. Images were taken from web and Sony DC350 digital camera, with size of 800x 6000 pixels, in different places and times. Fig3 shows the input image of this process. Fig4 shows the License Plate Detection result of our method. Fig5 shows the Character segmentation results of our method. Fig6 shows the final license plate number recognition of our method.

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Fig. 3. Image Acquisition

Fig. 4. License Plate Detection

Fig. 5. Character Segmentation

Fig. 6. License Plate Number Recognition

6. CONCLUSIONS AND FUTURE WORK

6.1 Conclusions

The purpose of this paper is to investigate the possibility of automatic

recognition of a vehicle license plate. We can improve quality of the license plate image using Adaptive Histogram Equalization. The algorithm is very effective for binary images and has also proved to be effective for reconstructing gray-scale and color images. The system performs well on various types of Vietnamese VLP images, even on scratched, scaled plate images. In addition, it can deal with the occlusion and inclination images. It specially removes the illumination problem in images.

6.2 Future work

We are working on a number of algorithms used to recognize the multiple license plates in the image. The purpose is to detect regions that are likely plate regions first and thus to reduce the computation cost of the VLP detection algorithm. In addition, we intend to combine a number of texture-based approaches, and machine learning methods to evaluate plate-candidates. We believe these will improve the accuracy and the speed of the algorithm furthermore.

REFERENCES

[1] A. Rahman, Ahmad Radmanesh, "A Real Time Vehicle's License Plate Recognition", Proceedings of the IEEE on Advanced Video and Signal Based Surveillance, AVSS'03, 2003.

[2] D. A. Duc, T. L. Du, T. D. Duan, Optimizing Speed for Adaptive Local Thresholding by using Dynamic Programming, The 7th International Conference on Electronics, Information, and Communications, pp438-441, Vol 1, 2004.

[3] Jun-Wei Hsieh, Shih-Hao Yu, Yung-Sheng Chen, "Morphology- based License Plate Detection from Complex Scenes", 16th International Conference on Pattern Recognition (ICPR'02) Vol 3, 2002.

[4] Kwang In Kim, Keechul Jung and Jin Hyung Kim, "Color Texture- based Object Detection: an Application to License Plate Localization", Lecture Notes in Computer Science, pp. 293-309, Springer, 2002.

[5] Kamat, Varsha, and Ganesan, "An Efficient Implementation of the Hough Transform for Detecting Vehicle License Plates Using DSP'S", Proceedings of Real-Time Technology and Applications, pp58-59, 1995.

[6] K. Kanayama, Y. Fujikawa, K.Fujimoto, and M.Horino, "Development of Vehicle-License Number Recognition System Using Real-Time Image Processing and Its Application to Tracal-time measurement", In Proceedings of IEEE Vehicular Technology Conference, pp798-804, 1991.

[7] Yasuharu Yanamura, Masahiro Goto, Daisuke Nishiyama, "Extraction and Tracking of the License Plate Using Hough Transform and Voted Block Matching", IEEE IV2003 Intelligent Vehicles Symposium Conference, 2003.

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