Automated Region Extraction and License Plate Detection using Deep Learning

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Abstract – This paper proposes a robust system to recognize vehicle license plate by Deep Learning. Achieving good recognition results for license plates is challenging due to multiple adverse factors. A new License Plate Detection method for challenging environment is proposed. Normally Background clutters are common in road scenes and license plate detection is considered as difficult problem. To address this problem, a two-step approach is developed in which first the car is detected by removing the background clutters and then localizing the license plate in each vehicle region. To be precise, faster region based convolutional neural network algorithm for vehicle region detection is adopted and license plates are generated using hierarchical sampling method. Finally the result is filters out by deep convolutional neural network.

Index Terms: Surveillance, RNN, CNN, License plate, ANN, Candidate region

I. INTRODUCTION

Surveillance cameras are widely spread in most cities, being an important tool for monitoring traffics. License plate detection is an important task for many practical applications like traffic management, surveillance, speed measurement, vehicle recognition and automatic vehicle ticketing. The difficulties included in this are cluttered backgrounds and small area of license plate. However there is a lack of research for license plate detection in complex scenes. Here the detection of license plate is considered as a difficult problem due to 1) Strong background clutters and 2) relatively small area of License plate regions. Moreover, an increasing awareness of security has made the need for vehicle-based authentication technologies very strong, with the idea that license plate detection systems may be used as access control systems for monitoring of unauthorized vehicles that intrude into private areas.

The traditional method involves hand crafted features such as color, edge and morphology which are primarily confined by stringent conditions. For example, some of these systems

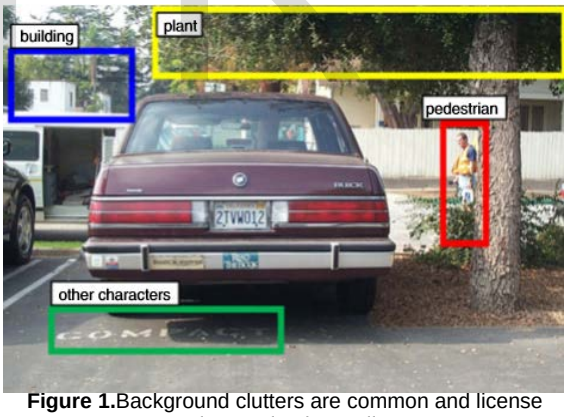

Figure 1. Background clutters are common and license plate region is small.

need high resolution images as input, the acquisition of which requires expensive equipment, while others require strict device mounting free from translation and rotation. However, real-world scenarios are quite different where car license plate detection becomes very challenging. Thus under the complex situation, it is difficult to propose a robust method with hand-crafted features. To alleviate this problem, CNN-

based methods have been devised which automatically learn features from the acquired data .In this method, we address these problems by developing two-step approach. This approach seems to be sub-optimal because we do not detect license plate directly. First, we detect the vehicle region with the R-CNN algorithm and then from that we localize the license plate in each vehicle region. Second, we have at most one license plate for each vehicle and this allows us to handle false positives very effectively.

II. RELATED WORK

Over the last two decades, impressive research works have been carried out by the computer vision community to address the problem of vehicle license plate detection and recognition. This task of license plate detection is broadly categorized into three approaches; 1) Region-based approach, 2) pixel to pixel approach and 3) color image approach.

Over the couple of last few years, many computer vision problems are addressed by using convolutional neural networks (CNN). In line with that many researches tried to solve the problems of license plate detection and recognition using CNN. CNNs have already exhibited remarkable performance on text and optical character recognition and object detection. But for the removal of background clutters, the CNN based model may not be used directly to achieve good enough performance.

In the same way, we also present a review on License plate recognition using deep learning in the following. Yang *e*t al. [6] proposed Chinese vehicle number plate detection using kernel-based extreme learning machine with deep convolutional neural networks. The method uses CNN for feature extraction and then kernel based extreme learning machines for recognition. The main objective of this method is Chinese License plate recognition. But this method does not remove the clutters in the road scenes. Then many researches tried to detect license plate using deep learning and many other methods. For example, Abedin *et* al. [7] proposed a license plate recognition system based on contour properties and deep learning model. The method segments characters for recognition. Polishetty *et al.* [9] proposed a next generation secured cloud based deep learning license plate recognition method that involves Edge detection and Binarisation for achieving results. But it is noted that edge detection and binarisation are sensitive to complex background and distortions. Montazzolli and Jung [10] proposed real-time Brazilian License plate detection and recognition using deep CNNs. The method uses CNN for character segmentation and recognition. This method is proposed for high resolution and quality images. Bulan *et al.* [11] proposed segmentation and annotation free license plate recognition with deep localization and failure identification. However, it is not clear that how the method takes care of distortion effects and poor quality images. Selmi *et al*. proposed a deep learning automatic license plate detection and recognition. The method performs many pre-processing before applying CNNs. Li *et al*. proposed reading car license plate using deep neural networks. This method explores the combination of RNN and CNN for license plate detection and recognition. However, it is not clear that how the method works well for images affected for multiple adverse factors.

Finally, the review of License plate detection using Deep learning shows that most of the types of method focus on peculiar type of images and designed for different countries. None of these methods addresses the issues of background clutters and relatively small area of license plate region.

III. PROPOSED METHODOLOGY

The work presented in this paper focuses on the fast and accurate detection of License Plate. This method used to detect the License Plate by removing the background clutters and finding the License plate in relatively small areas. Background clutters are most common in road scenes so it is difficult and important task to detect the license plate by removing the clutters. Thus the idea to solve this problem is done using deep learning. The method works on neural network to train the images and classify them. Deep learning works much faster and produces accurate result. The proposed system consists of mainly three parts namely 1) Vehicle region detection, 2) Candidate region generation and 3) License plate localization.

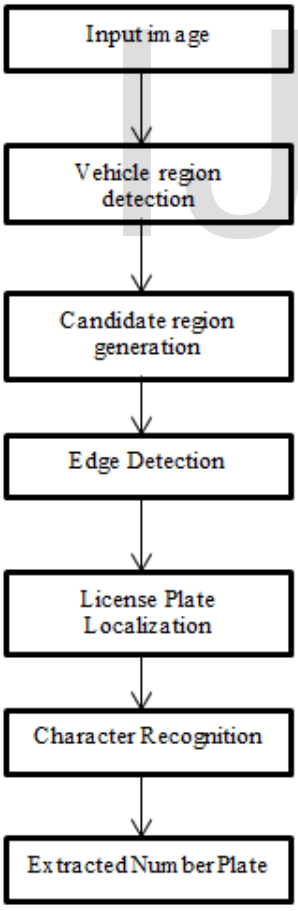

Figure 2 . Block Diagram

Background: Convolutional License Plate can be classified into four categories: edge, color, region and character-based methods. Edge based methods exploited repeated vertical edge patterns from characters in license plates. These methods are efficient but sensitive to background clutters and image blurs. Second, color-based methods divided a given image into color-homogenous regions and selected license plate regions among them by using the geometrical properties of license plates. Third, region-based method extracted texture features and performed the classification of candidate

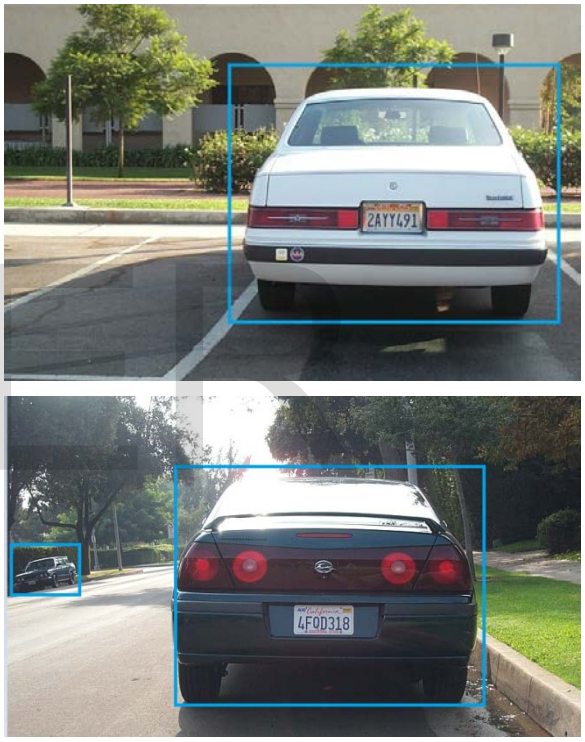

Figure 3. Blue boxes indicates the Vehicle region detection

regions. This approach is able to handle variety of road scenes. Lastly, character based method detected license plate using the character detectors. Due to recent advance in machine learning, this approach showed good performance, however it still suffered from false positives since there are many characters in road scene images.

Vehicle Region Detection: For the license plate detection, we first detect the vehicle region. This

reduces the background clutters and allows us to exploit scale information. Moreover vehicle regions are larger than the license plate region so we can exploit shape and texture features more effectively. In order to find the vehicle regions, many methods based on hand-crafted features and sliding scheme were proposed. However there performance degrades as targets are occluded and scenes are cluttered with other objects.Therefore, we adopt the faster R-CNN algorithm which is a deep learning based object detection method. This faster R-CNN is used to detect the vehicle region correctly and quickly than other methods.

Candidate Region Generation: After vehicle detection, we localize license plate in each region. For this, first we need to generate candidate region and apply CNN based classifier for each candidate. In order to generate candidate region, we adopt hierarchical sampling method that repeats greedy pairwise merging procedure until one global region remains. All regions that appeared in merging process are considered as candidate regions. The area of candidate region in the image is calculated as a feature extracted and it is given as total number of pixels in the candidate regions. The candidate region is generated and it overcomes the problem by avoiding the noise.

Figure 4. License Plate Detection

Edge Detection: This is a technique used to find the boundaries of object in image. It works by discontinuities in brightness. It is used for image segmentation and data extraction. The edge detecting an image significantly reduces the amount of data and filters out the useless information, while preserving the important structural properties in the image. There are several edge detection methods used for example error minimization, maximization object function, fuzzy logic, morphological, genetic algorithm, neural network and Bayesian approach.

Figure 5. Edge Detection

License Plate Localization: Localization of accurate License Plate regions from vehicle images is one of the most important and difficult tasks because each vehicular image differs in large variations in quantity, color, size, texture, font, shape, occlusions, patches and spatial orientations or inclinations of the License Plate regions within them. The variations of the environmental conditions also cause difficulties in the License Plate Localization. The main function of this module is to find the license plate of the vehicle in the image.

Character Recognition: Character recognition is an important stage in many license plate recognition systems. There are many factors that make the character recognition task difficult, such as image noise, plate frame, clinch and rotation and illumination variance. Optical character recognition technique is used to extract the characters obtained from the number plate. Classification stage is the decision making part of the recognition system.

Figure 6.Character Extraction

IV. EXPERIMENTAL RESULT

As shown in the figures, many images in the set shows challenging cases due to background clutters, different colors of license plate, occluded vehicle and various other capturing environments. In order to evaluate the proposed system we computed precision and recall values on the dataset and compared with conventional methods. We compared our approach with state-of-art license plate detector. The performance and average execution time varies. Our experiment indicates that proposed deep learning based license plate detector is faster and more robust.

V. CONCLUSION

The conclusion is the confirmation of the feasibility of license plate recognition based on a deep learning. The use of these networks creates a system really capable of "learning" the characteristics of the different digits and letters of the license plate, without complex mechanisms attribute extraction. The proposed approach achieved a very good result when compared to the previous system used. In this approach, unlike conventional methods, we exploited the properties of vehicle region by developing a two-step approach. The proposed method first detects the vehicle region by the deep learning based detecting method and extracts the license plate number. The proposed system was performed on widely used Caltech dataset. Experiment on Caltech dataset showed that the proposed system outperforms the conventional methods.

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