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License Number Plate-Based Smart Surveillance System for Smart City using Image Processing Toolbox

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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. 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.

KEYWORDS : Smart car parking systems, LPR, connected component analysis, template matching, image processing etc

I.INTRODUCTION

Vehicle Number Plate Recognition (VNPR) is an exoteric and effective research modality in the field of computer vision [1]. As there are an increasing number of vehicles on the road, it is highly challenging to monitor and control the vehicles using existing systems (such as manual monitoring and monitoring by traffic police). An intelligent system can be used to overcome this problem in a convenient and efficient way. Real time detection of number plates from moving vehicles is needed, not only for monitoring traffic systems, but also for traffic law enforcement. However, development in this area is slow and very challenging to implement from a practical point of view [2].

Recognizing vehicle number plates can help with authorization (for example, when a vehicle enters into an impervious premise). VNPR can develop a security policy while the issues are more crucial. This research work aims to detect and recognize number plates in an intelligent way. The tests were carried out on vehicles in Dhaka city, in Bangladesh, although the work can be extended to any country. Dhaka is a densely populated city with huge amounts of traffic and people frequently break the traffic rules. In Bangladesh, Bangladesh Road Transport Authority (BRTA) has the authority to register vehicles. According to the annual report of BRTA [3], the number of vehicles are increasing rapidly every year in Bangladesh (Figure 1). This could be accounted for the increasing road traffic accidents and related deaths. Bengali alphabet and Bengali numerals are used in Bangladeshi vehicle number plates. The international vehicle registration code for Bangladesh is BD.

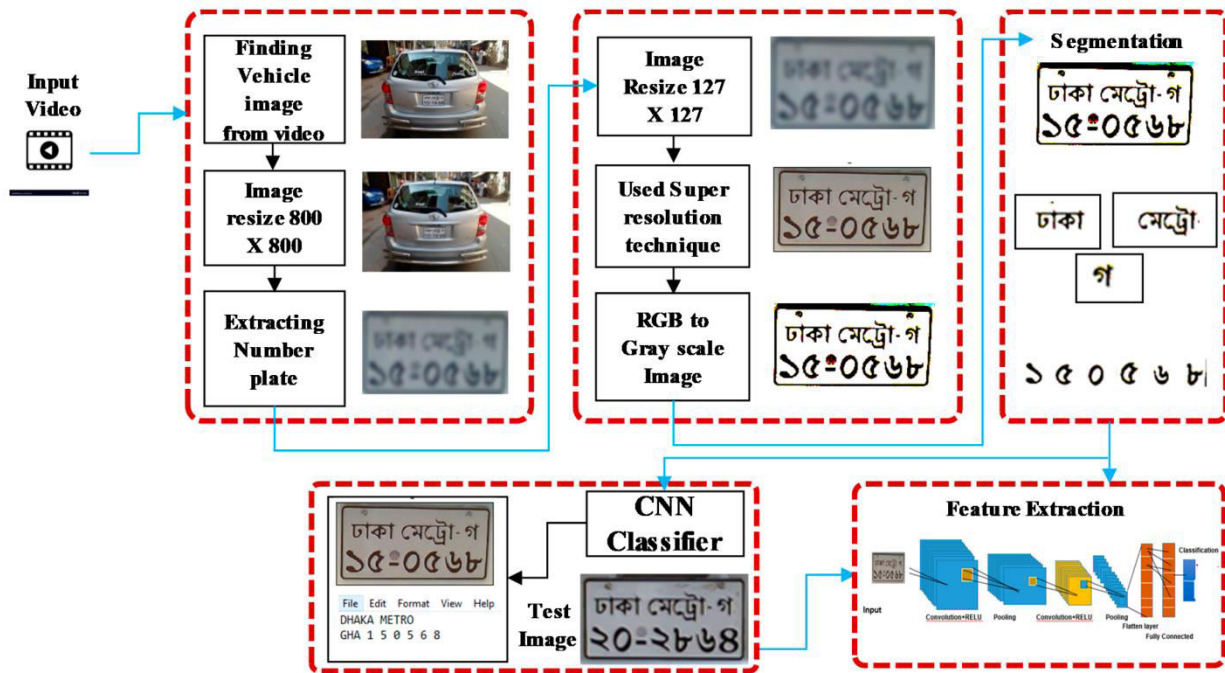


Fig 1: Vehicles Number Plate Detection

This research work developed an intelligent system that is efficient to recognize vehicle number plates using Convolutional Neural Networks (CNN). The recognition system consists of five major steps: image pre-processing, detection of the number plate from the captured image, learning based super resolution technique to produce a high-resolution image, segmentation, and recognition of each character. Segmentation is the most important task as it provides the result of the entire number plate analysis. The main objective of segmentation is to determine each region according to vehicle city, type, and number. However, segmentation of blurred number plates was more challenging, and this was overcome by using the super resolution method that transformed the blurred number plate image into a clear image.

II.RELATED WORKS

In the literature, a large number of systems were proposed and applied for vehicle number plate recognition: digital image enhancement, detection of the number plate area from the captured image, segmentation of each character, and recognition of the character form the core steps in the recognition systems.

Cheokman et al. [4] showed morphological operators to pre-process the image. After preprocessing, the template matching approach was used for recognition of each character. It was issued for the vehicle registration plate (Macao-style). In [5], scaling and cross-validation was applied for removing outliers and finding the clear parameters, using the Support Vector Machine (SVM) method. Recognizing characters via the SVM method, the rate of accuracy was higher from the Neural Network (NN) system.

Prabhakar et al. [6] proposed a webcam for capturing images. This system can localize several sizes of number plates from the captured images. After localizing the plate, characters are segmented and recognized using several NNs.

Sobel color detector for detecting vertical edges was used in [7], where the ineffective edge was removed. The plate region was discovered by using the template matching approach. Mathematical morphology and connected component analysis were used for segmentation. Chirag Patel [8] proposed mathematical morphology and connected component analysis for segmentation and recognition of characters using the radial basis function of the neural network.

The number plate detection system in [9] used plate background and character color to find the plate location. For segmentation, the column sum vector was adopted. Artificial Neural Network (ANN) was used for character recognition. literature and are categorised based on the features, such as edge detection, global image information, texture, colour, and character features they use. Edge detection algorithms find a rectangular shaped region with a known aspect ratio and extract all rectangles from within the image. This technique examines the changes in pixel amplitudes to transform the greyscale image into an edge image. The Sobel operator algorithm is a filter used for edge detection to define the boundary between two regions in a twodimensional image, with its kernel scanning in both vertical and horizontal axes [5] [6]. The Canny operator uses a Gaussian filter for smoothing or convolution and can work with images of varying environmental conditions, distances, and angles [7]. Unfortunately, since Sobel and Canny are based on matrix multiplication, they are reliant on powerful processing power, which is costly, and suffer performance lag when used on low-cost devices. Morphological detection systems, such as that of Zhai et al. [8], eliminate nonplate regions thereby selecting the license plate and are faster than other edge methods. However, there are several drawbacks in Zhai's system in that it did not use complex images which challenge the algorithm, and second, was not tested in a low-cost device.

III. PROPOSED METHODOLOGY

This proposed system has the capability of detecting and recognizing vehicle number plates in any language. To detect each character of a number plate, this system trains all alphabetic letters from the plate using machine learning. Number plate characters for the majority countries across the world are from A to Z and 0 to 9, so that it can easily be detected, whereas Bangla number plate detection and recognition is very challenging, due to the complex alphanumeric characters. Therefore, Bangla number plates have been considered as a case study in this research.

In this system, there are two parts: one part is for number plate detection of moving vehicles and another part is for number plate recognition. The first part extracts the number plate region from the captured image of the vehicle by using the template matching technique. The number plate recognition part consists of three activities. (1) The super resolution method is used in the number plate region for converting a low-resolution image to a high-resolution image. Then it converts RGB into a gray image. (2) The bounding box method is used for segmenting characters. (3) Finally, features from the authorized alphabets and numbers are extracted using CNN. The CNN model provides 4096 features for recognizing each character.

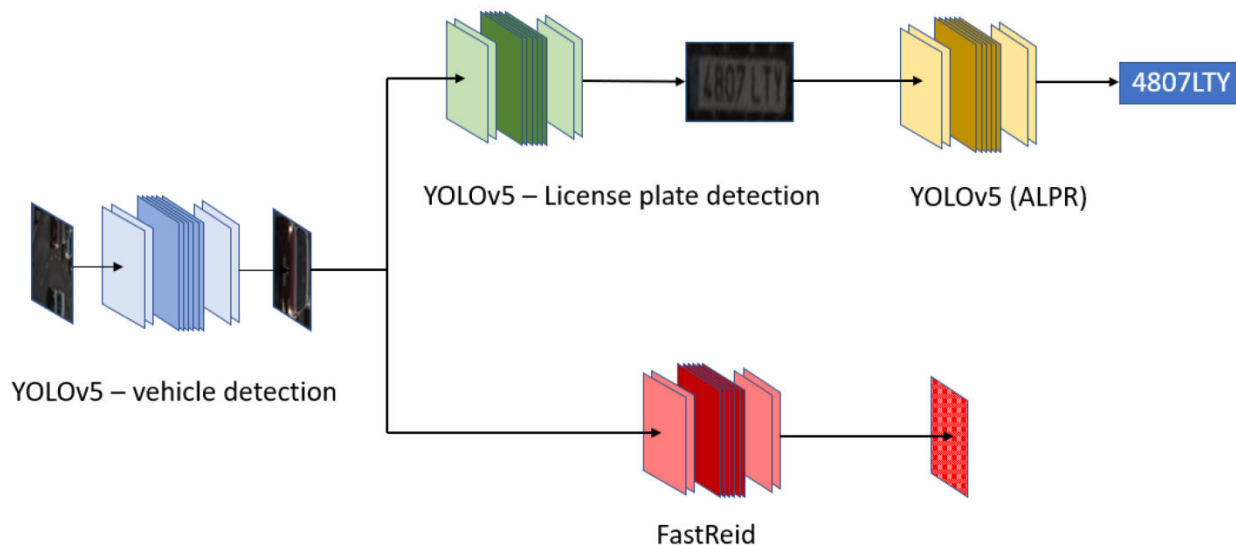


Fig 2: Intelligent Video Surveillance Systems

The imaging chips and optical components are highly expensive and, practically, not used in surveillance cameras. The quality of the surveillance camera and the configuration of the hardware components limit the captured image resolution. It



cannot detect character of the number plate from the vagueness plate region. In this research, a spatial super resolution (SR) technique is used to overcome the limitation successfully.

The SR techniques construct the high-resolution images from various accomplished low-resolution images. The concept of SR is to organize the non-redundant data contained in abundant low-resolution frames to produce a high-resolution image. The main objective of super resolution is to acquire the high-resolution image from the multiscale low-resolution image through the spatial resolution approach. The spatial super resolution is applied to get a high-resolution number plate image. First, the system used the downsampling approach and converted the image samples, such as local gradient, alignment vector, and local statistics.

IV.RESULT ANALYSIS

A system presented in [38] might have failed if the texture of the plate was not clear and the number plate region was short of the threshold of the projection operation. To solve this problem, this proposed system brought novelty in employing the super resolution technique to organize the non-redundant data contained in abundant low-resolution frames, and to produce a high-resolution image. The technique converted blur images to clear images to recognize the texts correctly. A vehicle number plate detection system presented in [39] was unable to properly recognize some characters and numbers, such as 2, 0, 7, and more, due to having a lower recognition rate compared to the other characters. In this system, the machine learning based CNN model was employed to recognize all characters and numbers correctly. Thus, the recognition rate was higher than the other techniques reported in the literature. Capturing images by directly pointing the camera towards the number plates was not feasible for real-world usage due to complex background and environment

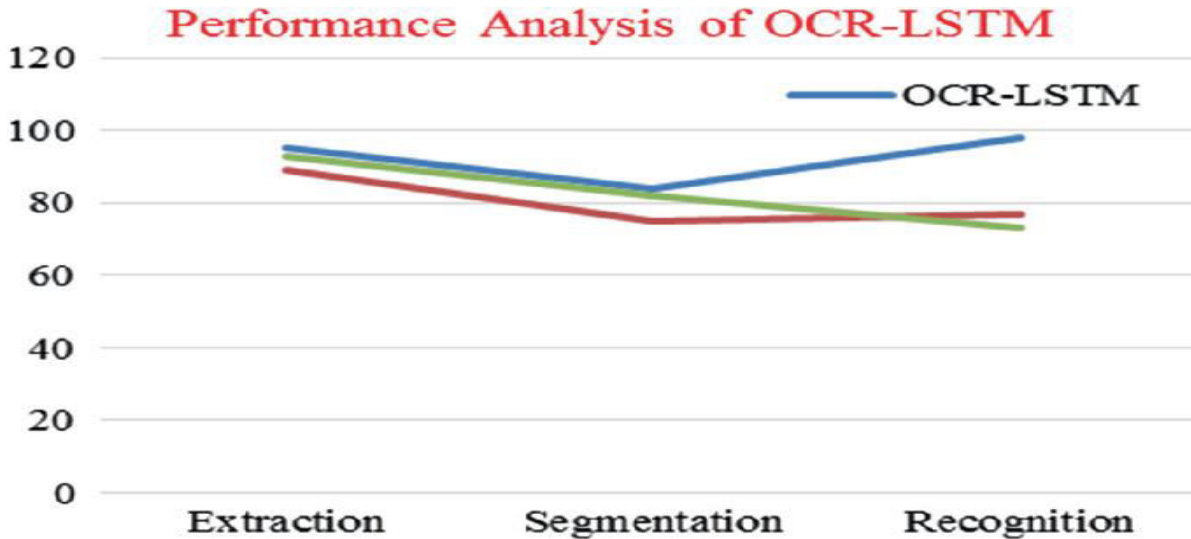


Fig 3: Result analysis

Vehicle number plate recognition system (VNPRS) can play a vital role in implementing technologies for smart cities, such as traffic control, smart parking, toll automation, driverless car, air quality monitoring, security. A conceptual framework for integrating VNPRS with the smart city systems is presented in. The key theme in the smart city is about collecting data from the individual systems by sensors and cameras, communicating within different systems, and taking action from the hidden information within the data. Automatic vehicle number identification could provide a base data to the network of the smart city. For example, in case of monitoring and managing security for a particular location within a city, VNPRS can serve as the tracking aid for the security authority. The VNPRS can be connected to a cloud-based system where all registered vehicle numbers will be stored. A vehicle number plate recognized by the system will be directed to the cloud system for matching with the database, and identifying the vehicle user information, for taking further action by the relevant authority.



V.CONCLUSIONS

In this research, a system is proposed for detecting and recognizing vehicle number plates in Bangladesh, which are written in the Bengali language. In this system, the images of the vehicles are captured and then the number plate regions are extracted using the template matching method. Then, the segmentation of each character is performed. Finally, a convolutional neural networks (CNN) is used for extracting features of each character that classifies the vehicle city, type, and number, to recognize the characters of the number plate. The CNN provides a large number of features to help with accurate recognition of characters from the number plate. This research used super resolution techniques to recognize characters with high resolution. In order to evaluate the experiment results, 700 vehicle images (with 70 iterations of each input set) were appointed. After training, the CNN acquired 98.2% accuracy based on the validation set, and attained 98.1% accuracy based on the testing set. This system can also be used for the number plates written in other languages in the same way.

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