An Ensemble Based Car Number Plate Detection System

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***Abstract*—Automatic Number Plate Recognition (APNR) system has a number of applications related to car monitoring, ownership and movement. One of the key components in APNR is the number plate detection module. A large number of detection algorithms have been proposed with little or unspecified accuracy. This paper proposes an ensemble technique for number plate detection. Ensemble technique has always been used for the classification problem; however we propose this scheme for the detection problem. We developed five detection models and combined them to form an ensemble. The output of each of these models is combined using a fusion function. The experimental results show that our model obtains better detection accuracy. Also other methods are designed such that they are inherently limited to extracting exactly one number plate in an image. Our model would also work on images with multiple cars and multiple number plates.**

Keywords—number plate detection; ensemble;

I. INTRODUCTION

Automatic Number Plate Detection (ANPD) system is the first step for an Automatic Number Plate Recognition (APNR) system. This technology is highly needed in Pakistan because of the rapid increase of vehicles in the country and it is very difficult for a human to monitor them. This system can be used for finding stolen cars, access control and red light violation enforcement, parking toll, border control and traffic monitoring [3].

The development process presents many challenges because of the diversity of number plate sizes and the different colors. Also, the angle of the number plate makes its detection difficult. Another challenge was to differentiate between the stickers text on the car from the plate text, which is done by edge detection.

Furthermore, ensembles of classifiers are commonly used in the field of machine learning to enhance classification accuracy as compared to a single classifier [5]. The ensemble consists of a number of basic classifiers, and is an efficient classification technique that has shown its effectiveness in many applications.

The aim of the paper is to develop an efficient ensemble based system which detects the number plate from an image.

II. LITERATURE REVIEW

This section presents some proposed solutions in ANPD. Furthermore, we also examine how ensembles are used to enhance classification accuracy, and how the concepts of ensembles can be combined with the detection problem, instead of the classification problem.

A. ANPD

Lot of work has been done on automatic number plate detection (ANPD) and extraction algorithms. Generally, any algorithm will utilize some or all of the basic methods such as edge detection, contrast enhancement, and morphological opening and closing operators [1][2][3]. For edge detection, the most commonly used operator for ANPD is the Sobel operator. Typically it is used to find the approximate absolute gradient magnitude at each point in an input gray scale image. This becomes easier once the image goes through contrast enhancement. The morphological operators are used to detect candidate plate area in the image. There can be more than one candidate for a number plate so further processing is needed to extract the best one [2].

References [1] and [3] first perform morphological opening and image subtraction operations. This is followed by edge detection using the Sobel operator. Finally the candidate plate area is detection by the morphological closing operation. A slightly modified algorithm, given in [2] and [4], first calculates the edge density followed by edge detection itself. Then the long and short edges are filtered out using a threshold value, followed by candidate regions extraction using morphological filtering.

B. Ensemble of Classifiers

Using ensembles to enhance classification accuracy is becoming very common in machine learning. Ensemble based classifiers are used for character recognition [6], classifiers for decoding fMRI data [7], automatic music genre classification [8], gait recognition [9] and texture classification [10].

III. PROPOSED SOLUTION

We propose an ensemble for ANPD. Internally, the ensemble is composed of five different algorithms. The four algorithms were taken from [1], [2], [3] and [4] which we refer to as algorithm 1, algorithm 2 etc. in Fig. 1. The fifth algorithm is proposed and is discussed below. When an image is received it is passed to all the five algorithms. The result i.e. the location of the candidate region of the number plate is combined using a fusion functions. The fusion function is an OR operation .

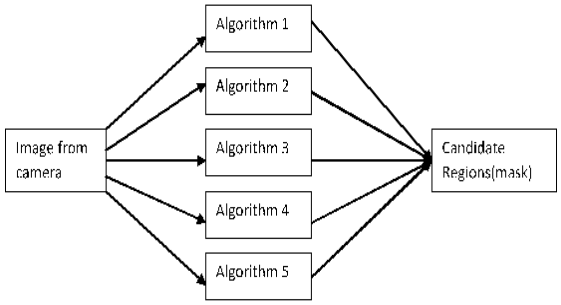

Fig. 1. Ensemble of Number Plate Detection Models

In addition to using four algorithms, we also propose our own. After we get the input image, it will be sent to detection module where it will be pre-processed. After that, it will create a mask containing candidate regions of number plate and which may contain garbage. This mask is then sent to the extraction module where these regions are filtered with aspect ratio and area checks giving us the plate region. The different modules of our proposed model are discussed briefly here.

A. Preprocessing

The image acquired via various means is affected by many factors including lack of exposure, Noise, distortion in optical system, or moving camera or vehicle etc. Here preprocessing is used to deal with these factors. The process mainly involves:

- Greyscale conversion
- Noise Removal by applying median filter
- Border enhancement for brightness
- Thresholding and Histogram Equalization

B. Morphological Operations and Convolution

For classifying the plate area the local variance and gradient magnitude in the vehicle number plate image are calculated. This process is based on the concept that the brightness variation in the number plate region is different from elsewhere.
Convolution is performed to preserve the image brightness.

C. Edge enhancement and detection

The edges are enhanced using various functions during preprocessing. In this case Sobel operator is used. It deals with vertical and horizontal edges. The vertical and horizontal edges of an image are highlighted and the background noise is removed. A rectangular window is used to find the plate region.

D. Region Of Interest detection by erosion and dilation

At first the image is dilated to enhance the boundaries and to make the holes smaller. In the end Erosion is used to further shrink the image and to make the holes larger. In case of multiple Regions of Interest (ROI), we consider some features such as area, aspect ratio (height per width) and edge density in order to discard wrong candidate regions.

E. Mask Generation

In the end a mask is generated which contains a number plate.

IV. RESULTS

The number plate dataset was taken from https://data.gov.uk/dataset. Before a number plate is be detected, the image is first preprocessed. The result of preprocessing an image is shown in Fig. 2. below.

Fig. 2. Result after Pre-processing

The result for edge detection and enhancement using a monotone image is given in Fig. 3.

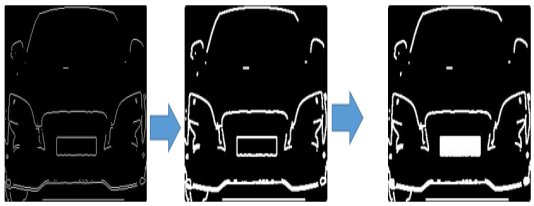

Fig. 3. Edge Detection

The next step is ROI detection. The results of ROI detection are shown in Fig. 4.

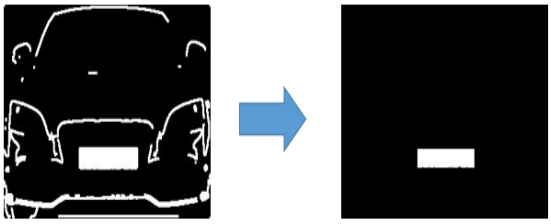

Fig. 4. Region of Interest

The detection accuracy of our ensemble model is more than 95%.

V. Concluding Remarks

The paper presents an ensemble for detecting the license plate from an image of a car regardless of the color of car and plate. At first, the plate was detected using Edge Detection method; since the edges of number plate are sharp, it can be distinguished from rest of the image content. While using the aspect ratio check we came across a certain problem involving headlights of the car. The headlights of the car were also detected in addition to number plate as they had the same aspect ratio. The solution that we came up with for this problem was to detect the head lights as well and then to pass it to the segmentation function which instead of retuning letters returned junk as there are no letters in headlights. This spared us the trouble of narrowing the aspect ratio rang further which would have resulted in a smaller success rate of detection.

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