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Detection of Deformed Number Plates in Natural Scene Images

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***Abstract*—**Automatic license plate detection is one of the most common video analytics. Existing system fails if the license plate is deformed (broken or blurred). The main cause for the deformation of the number plate is when the vehicle met with an accident or whenever car robbery takes place. Recognizing various disfigured numbers on deformed number plates has been one of the challenging issue in the field of research. This paper concentrates on deformed number plate detection and recognition. Here MATLAB software is used to extract the alphanumeric values which is deformed. Template matching being the oldest method has been used to recognize the alphanumeric values. Our algorithm has been applied on various types of number plates and achieved an accuracy of 78% for the deformed number plates. This study has importance in various real world applications like traffic control, toll control or parking lot access.

***Keywords*—** MATLAB, preprocessing, character reconstruction and segmentation, character recognition, Template matching

I. INTRODUCTION

There are increasing cases of stolen vehicles now a days, government had been familiar with different type of processes for capturing the characters of number plates of variety of cars. The technology of vehicle plate detection and recognition of character can be called as Automatic license Plate Recognition (ANPR).Automatic license Plate Recognition is an essential technique.

The main purpose of the system is to properly detect the number plate and detect the character and rejoin the broken number or character to original number or character. The main objective of this system is to work quickly and perform under distinct environmental circumstances like either day or night time. In the same way different countries number plates should be summarized. With an outlook to the increasing amount of population and human needs, vehicle usage also increased. As such, vehicle control is a major problem.

The ANPR is one of the main technique used for controlling these vehicles. This system also used in other areas like automatic toll collection, traffic checking, Parking lot access, security control of restricted areas. By using ANPR system it will reduce the man power. There are some challenges to perform ANPR process. For example, number plate with broken character, tilted image, plate may be covered by mud or dust, in a dim light etc. these number plates are called deformed number plate. These problems may occur during the recognition. Therefore, this study help to solve the problems using ANPR.

In this paper techniques involved are Preprocessing, Character Reconstruction and segmentation, Character Recognition. Here Preprocessing phase is used for resizing and noise removal, Character Reconstruction and segmentation phase undergoes dilation and erosion process and in Character Recognition phase, template matching method is used.

II. RELATED WORK

Suhaila Abd Halim and Mohd Syazreen Zulkifli [1] proposed a methodology to develop a tool to detect the broken character on car number plate. In this methodology broken character of the number plate is segmented using connected component labelling. Then character relocation is completed using template matching. GUI interface has been developed using MATLAB that takes image as an input and produces message whether the image consists of broken or non-broken characters.

R. Azad et. al.[2], developed an application to find plates that are tilt and has poor quality. Proposed methodology converts the image into binary mode with the use of adaptive threshold. Edge detection and morphology operations are used to remove the tilt. Then KNN is used to for character recognition and achieved an accuracy of 99.12%.

In [3] image processing methods to control the entrance of smart parking has been discussed. It includes pre-processing, and color filters are used to detect the plate region. Later character segmentation is done to convert the image to binary, by filtering the binary image using morphological operation, the objects are determined as

segmented plate characters. Correlation method was used to recognize segmented characters. The proposed methodology achieved an accuracy of 97% recognition rate.

In addition, study of broken characters on different areas such as printed documents and handwritten scripts[4] used a method of re-join the broken character from the original character. Although it differs from the focus of this study on broken car plate, the research on broken car plate is very limited so, this paper is also considered.

Monika Arora et. al. [5] proposed a methodology that uses ANN and KNN for character recognition in OCR technology. Initially licensed number plate is detected from the given image. Further character segmentation and recognition is done. Random moving and standing vehicles with license number plates have been included as an input image. 87% accuracy has been achieved for clear plates and 47% for the skewed plates.

Divya Rastogi et. al.[6] describes a methodology to detect a licence plate using YOLO(You Only Look One) which is a deep learning object detection architecture based on convolution neural networks. They proposed a real-time vehicle number plate recognition(RVNPR) system for the recognition of number plate It makes use of high definition cameras, which captures the pictures of passing vehicle and send it for processing by RVNPR software. It has a high accuracy in detection and recognition.

S´ergio Montazzolli Silva et. al.[7] presented a complete deep learning Automatic License Plate Recognition (ALPR) system for unconstrained scenarios. This paper focuses on unconstrained capture scenarios, in which license plate might be considerably distorted due to oblique views. Convolutional Neural Network (CNN) is used to detect and rectify multiple distorted license plates in a single image, which are fed to an Optical Character Recognition (OCR) method to obtain the final result. As an additional contribution, manual annotations for a license plate images from different regions and acquisition conditions are also presented.

Cheng-Hung Lin et. al. [8] proposed a three-stage license plate recognition system based on Mask R-CNN that can be used for various shooting angles and more oblique images. Proposed architecture can identify license plates with bevel angles over 0~60 degrees and achieve mAP rates of up to 91%. Compared with the approach using YOLOv2 model, the proposed method with Mask R-CNN has made significant progress in identifying characters that are inclined above 45 degrees

III. METHODOLOGY

The proposed approach is composed by four main steps as shown in Fig.1: Image acquisition, preprocessing, character reconstruction and segmentation and character recognition. Given the license number plate as input image, it undergoes preprocessing steps. This preprocessed image is subjected to character reconstruction and character segmentation where the deformed alphanumeric value is reconstructed in this step. As a next step, the reconstructed image is fed to character recognition step where template matching method is used.

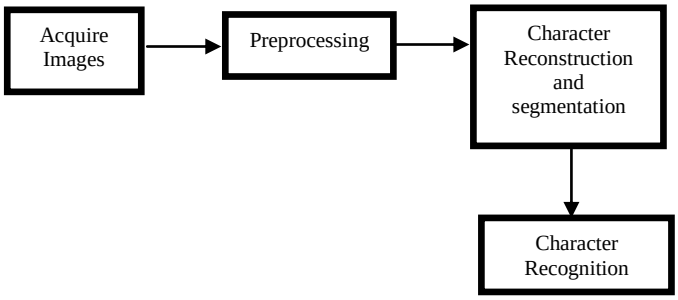

Fig: 1 Block diagram for detecting deformed number plates

The algorithm for proposed methodology is as follows:

- **Image Acquisition**: This step includes, acquiring the image and resized to obtain the number plate assuming it is taken from a particular distance.
- **Preprocessing**: In preprocessing, the first step is to convert the RGB image to Grayscale. After the Grayscale conversion the image undergoes median filtering and a set of morphological operations is performed to remove noise. The edges are then enhanced using gradient subtraction and convolution, and the intensity is adjusted using the histogram method. In order to eliminate possible horizontal lines that is resulted from the previous processes, erode function is being used.
- **Character Reconstruction**: Preprocessed image is fed into character reconstruction phase where it undergoes dilation to extract the character edges. Filling the connected regions of the image and thinning is performed in order to isolate the characters. Further, noise removal is done to eliminate all the regions that are of pixel area more than 100 and displaying the reconstructed character.
- **Character Recognition**: Reconstructed character is treated as input for the character recognition phase. In character recognition, template matching technique is used in order to concatenate all the characters in the number plate. In template matching, knowledge base is loaded which contains binary input images and correlation method is performed to store the score and index. This step is done for all the characters in the number plate in order to find the maximum score and its index. SVM, ANN can also be used in place of template matching but SVM and ANN cannot produce good result as that of template matching because in SVM and ANN input image is compared with grayscale images which leads to intake of more input images. Fig.2 represents the template matching technique.

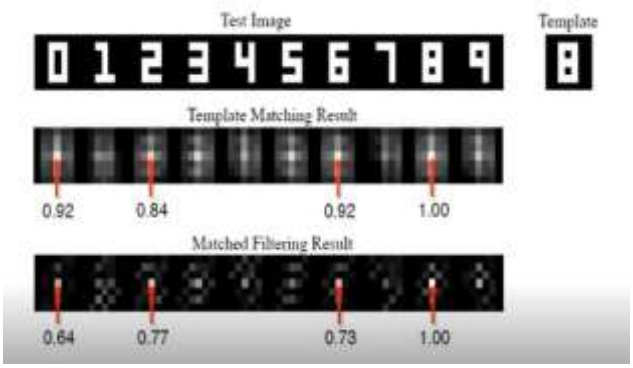

Fig 2: Template matching technique

Here 8 is an input that is being tested with all the digits in test image and particular scores is obtained for each match. As knowledge base contains binary input images, 0 is treated as minimum score and 1 is treated as maximum score. At position 9 the obtained score is 1.00 so result obtained will be 8. Suppose if the score has same value then, the score which has occurred first will be treated as output.

IV. RESULTS AND DISCUSSION

Preprocessing

- **Input**: A deformed number plate is taken as an input.
- **Output**: A Preprocessed image is obtained as an output.

Fig 3: Deformed Number Plate

Fig 4: Preprocessed image

Character reconstruction

- **Input**: A preprocessed image is chosen as an input.
- **Output**: Reconstructed character will be displayed as an output.

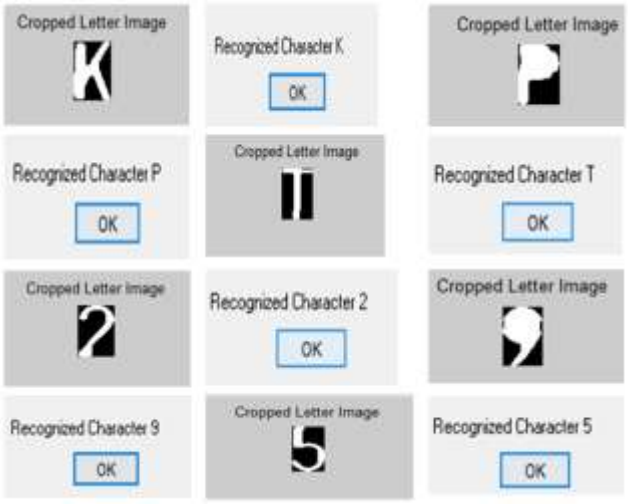

Fig 5: Output images of character reconstruction

Character recognition

- **Input**: Reconstructed image is taken as input.
- **Output**: Recognized character will be displayed as an output.

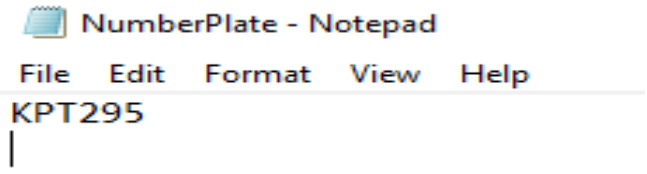

Fig 6: Reconstructed Number Plate

Table 1 shows character recognition of various number plates tested. Results shows 83% of accuracy for clear plates, 78% for the deformed plates.

Table 1: Character recognition of various plates

Plate Type	*Data set Size*	*Accuracy*
Deformed License Plate	986	78%
Clear License Plate	2408	83%
Skewed License Plate	357	47%

V. CONCLUSION AND FUTURE SCOPE

This paper contributes to detection and recognition of deformed number plates which can be helpful for traffic control, toll control or parking lot access. Proposed methodology mainly concentrate on image acquisition, pre-processing and character reconstruction and recognition using template matching technique is used in order to concatenate all the characters in the number plate. The main work is carried out using MATLAB software which helped to detect and recognize the deformed images. Our results indicate 78% accuracy of deformed license plates and 83% accuracy of clear license plates and 47% of skewed license plates. For future work, we want to extend our solution to improvise the accuracy of skewed license plate by using deep learning techniques.

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