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Automatic Number Plate Recognition System Using KNN

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Abstract - Automatic Number Plate Recognition (ANPR) is a surveillance system that captures the image of vehicles and helps in License plate recognition. ANPR can be assisted in the detection of stolen vehicles, collection of toll taxes, parking system, Border crossings, Traffic control etc. The detection of stolen vehicles can be done in an efficient manner by using the ANPR systems located in parking lots. This paper presents an automatic number plate recognition system using KNN in which the vehicle plate image is given as an input and the image is processed to get the number plate information. There are numerous ANPR systems available today. These systems are based on different methodologies but still it is really challenging task like non-uniform vehicle number plate, language of vehicle number and different lighting conditions can affect a lot in the overall recognition rate. Most of the systems work under these limitations. So, we have tried to overcome such limitations.

***Key Words*:** ANPR, License plate recognition, KNN.

1. INTRODUCTION

1.1 Automatic Number Plate Recognition

The Automatic Number Plate Recognition (ANPR) was invented in 1976 at the Police Scientific Development Branch in the UK. However, it gained much popularity during the last decade along with the improvement of digital camera and the increase in processing speed. ANPR is an image processing technology which enables to extract vehicle license plate number form digital images. It consists of a camera that has the capability to capture an image, finds the location of the number plate in the image and then extracts the characters using character recognition tool that translate the pixels into alphanumerically readable character or string. ANPR can be used in many areas from speed enforcement and tool collection to management of parking lots, etc. [7] at present, in ANPR there are several techniques used for the recognition plate's number such as pattern matching [8], neural network character recognition [1], and image processing technology [2].

Which are computationally expensive or use artificial neural network which involves complex mathematics. [3] ANPR algorithms are generally divided in four steps:

1. Vehicle image capture
2. Number plate detection
3. Character segmentation and
4. Character recognition

1.1.1 Vehicle Image Capture

The first step is the acquisition of an image i.e. getting an image. These captured images are in RGB format so it can be further process for the number plate extraction.

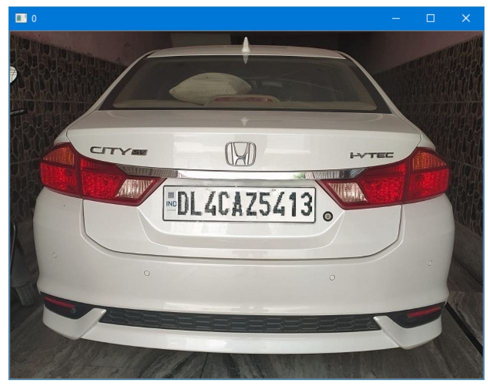

Figure 1: Vehicle image capture

1.1.2 Number Plate Detection

Most of the number plate detection algorithms fall in more than one category based on different techniques. To detect vehicle number plate following factors should be considered:

- **Plate size:** A plate can be of different size in a vehicle image.
- **Plate location:** A plate can be located anywhere in the vehicle.
- **Plate background:** A plate can have different background colours based on vehicle type. For example, a government vehicle number plate might have different background than other public vehicles.
- **Screw:** A plate may have screw and that could be considered as a character. A number plate can be extracted by using image segmentation method. There are numerous image segmentation methods available in various literatures. In most of the methods image binarization to convert colour image to grey scale image. Some plate segmentation algorithms are based on colour segmentation. [4]

1.1.3 Image Processing

Pre-Processing: The pre-processing is the first step in number plate recognition. It consists the following major stages:

a) Binarization.
b) Noise Removal

Binarization: The input image is initially processed to improve its quality and prepare it to next stages of the system. First, the system will convert RGB images to grey-level images.

Noise Removal: In this noise removal stage we are going to remove the noise of the image i.e., while preserving the sharpness of the image. After the successful Localization of the Number Plate, we go on with Optical Character Recognition which involves the Segmentation, Feature extraction and Number plate Recognition. [5]

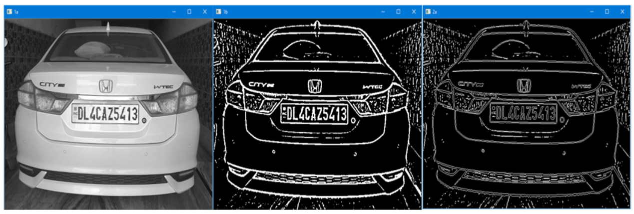

Figure 2: Image Processing

1.1.4 Character Segmentation

A precise binary image is got after the license plate localization. In order to recognize the vehicle number plate characters afterwards, each character must be divided respectively. That is task of character segmentation. The individual characters have to be distinguished (segmented) from each other. In this step, the characters & digits of the plate are segmented and each is saved as different image. Number Plate segmentation plays an important role in ANPR system. To obtain segmented characters in number plate, first plate image is converted into binary image. Then 'Lines' Function is used to divide text on the number plate into lines, which uses "clip" function. "Clip" function crops black letter with white background. After cropping image, resizing is done and same operation is repeated for each and every character on the cropped image. Because the images contain some noise it is further filtered and normalized. To make the final image to match up the standard template uniform that contains only two grey values of black and white. [3]

Figure 3: Character Segmentation

1.1.5 Character Recognition

This is the most important and critical stage of the ANPR system. Character recognition step will be identifying the characteristics of the character input image. In this stage, the segmented characters are rescaled to match the characters into a window. For this purpose, each character is normalized to the proper size of binary image and then follows by reshape to standard dimension before further processing. Fitting approach is also necessary for template matching.

Finish the identification by calculating the similarity of features. For the similar characters, make the second identification with the method of feature point matching Another approach is that Once the lines in an extracted vehicle number plate are separated, the line separation process is now applied column wise so that individual character can be separated. The separated individual characters are then stored in separate variables. The extracted characters taken from number plate and the characters on database which we have stored are now matched. The next phase is template matching. Template matching is an efficient algorithm for character recognition. The characters image is match up to our given database and the best resembling is considered. [3]

In another method of neural network, it is very important to expand the training database size for Neural Network. By increasing the database size, the accuracy for the network will be increased. KNN is used to classify the characters of number plate. However, they do not provide hardware. Therefore, statistical feature extraction has been used. [6]

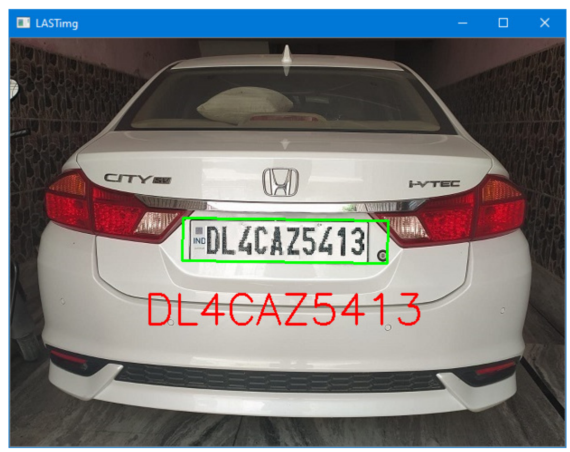

Figure 4: Character Recognition

2. RELATED WORK

Junaid Ali Khan, et.al (2017) proposed an improved car number plate recognition (ECNPR) system [9]. The proposed system could identify various designs and font styles of the number plates of the cars. This study made a threefold attempt. At first, numerous templates matching was utilized to recognize the characters. The recognized characters were of different fonts and sizes. In the second step, the noise was removed animatedly through the adjustment of pixel value. In the final step, a more demanding dataset was created and utilized. This dataset includes various font styles and designs of number plates. The tested outcomes depicted that the modification of CNPR proposed approach showed superior results in terms of some parameters such as false positive and false negative values. [12]

Isaias Tesfu Negassi, et.al (2018) proposed a novel and intelligent car plate recognition system [10]. The proposed interface behaved as a primary stage of a scheme by transforming the major entry of the ability to a completely automatic car entry control system. The proposed approach reduced the intensity of staff watching at the major entrance points. This database created the major processing border and simulated the controller as man aid system. This system utilized a graphical user interface to process and handled the entrée to the car. [12]

Madhusree Mondal, et.al (2017) stated that an effort had been made for recognizing the states of a vehicle using number plate [11]. The preliminary outcomes achieved from this work were extremely inspired. These results very efficient even with an extremely less amount of training patterns. However, the implemented research showed a capable prospect of CNN approach for this type of automation applications. On the other hand, the real concerns lied on the real time execution of CNN approach. [12]

3. THE ALGORITHM

The k-nearest neighbors (KNN) algorithm is a simple, easy-to-implement supervised machine learning algorithm that can be used to solve both classification and regression problems.

3.1 K-Nearest Neighbors

The KNN algorithm assumes that similar things exist in close proximity. In other words, similar things are near to each other.

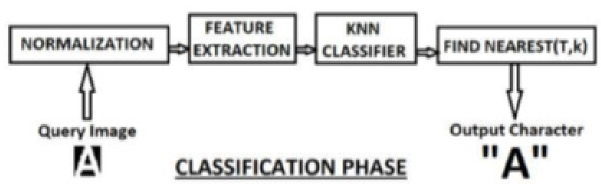

Figure.5 KNN-based Character Classifier [13]

The KNN Algorithm

1. Load the data.
2. Initialize K to your chosen number of neighbors.
3. For each example in the data.
   a. Calculate the distance between the query example and the current example from the data.
   b. Add the distance and the index of the example to an ordered collection
4. Sort the ordered collection of distances and indices from smallest to largest (in ascending order) by the distances.
5. Pick the first K entries from the sorted collection.
6. Get the labels of the selected K entries.
7. If regression, return the mean of the K labels.
8. If classification, return the mode of the K labels. [14]

3.2 Choosing the right value for K

To select the K that's right for your data, we run the KNN algorithm several times with different values of K and choose the K that reduces the number of errors we encounter while maintaining the algorithm's ability to accurately make predictions when it's given data it hasn't seen before.

Here are some things to keep in mind:

1. As we decrease the value of K to 1, our predictions become less stable. Just think for a minute, imagine K=1 and we have a query point surrounded by several reds and one, but the green is the single nearest neighbor. Reasonably, we would think the query point is most likely red, but because K=1, KNN incorrectly predicts that the query point is green.
2. Inversely, as we increase the value of K, our predictions become more stable due to majority voting / averaging, and thus, more likely to make more accurate. Eventually, we begin to witness an increasing number of errors. It is at this point we know we have pushed the value of K too far.
3. In cases where we are taking a majority vote (e.g. picking the mode in a classification problem) among labels, we usually make K an odd number to have a tiebreaker. [14]

3.3 Advantages

1. The algorithm is simple and easy to implement.
2. There's no need to build a model, tune several parameters, or make additional assumptions.
3. The algorithm is versatile. It can be used for classification, regression, and search. [14]

3.4 Disadvantages

1. The algorithm gets significantly slower as the number of examples and/or predictors/independent variables increase. [14]

RESULT

Experimental result of automatic number plate recognition system performed on various number plates.

Image Name	Image Size	Processing Time (in sec)	Detect(Y) or not(N)
1.png	1000x600	0.56	Y
2.png	1000x750	0.41	Y
3.png	1280x960	0.55	Y
4.png	1332x999	0.41	Y
5.png	1350x900	0.39	Y
6.png	720x701	0.33	Y
7.png	1024x768	0.33	Y
8.png	1024x768	0.39	Y
9.png	768x615	0.3	Y
10.png	665x410	0.22	N
11.png	1000x750	0.47	N
12.png	977x593	0.3	N
13.png	896x592	0.3	N
14.png	1224x784	0.48	N
15.png	768x696	0.39	N
16.png	999x749	0.67	N

Table.6 Result of test conducted on various number plates.

4. CONCLUSIONS

In this paper, the automatic number plate recognition system using vehicle license plate is shown. The system uses image processing techniques for identifying the vehicle number plate. The system works satisfactorily for wide variation of conditions and different types of number plates. The system is implemented and executed in python3 and performance is tested on genuine images. The system works quite well however, there is still room for improvement. At present there are certain limits on parameters like speed of the vehicle, script on the vehicle number plate, skew in the image which can be removed by enhancing the algorithms further.

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