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Number Plate Recognition System using MATLAB

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***Abstract*— With the ever-increasing population, increasing daily use of vehicles, increasing thefts, and traffic rule violations, maintaining a manual record of these vehicles is extremely difficult and impracticable. Today, we need sophisticated technologies to create a virtual network of law enforcement that can operate autonomously without human involvement. Gone are the days when tens of policemen were stationed every 10 km (miles) to monitor the traffic and enforce traffic restrictions. An automatic number plate detection system is designed in this paper in order to manage traffic, thefts, and toll collection. The designed system is cost-efficient and uses a widely used software named MATLAB. It involves three main phases: pre-processing, detection, and recognition. Character segmentation, Optical Character Recognition (OCR) techniques are used followed by an artificial neural network.**

***Index Terms*— Number Plate Detection, Neural Network, OCR.**

I. INTRODUCTION

Due to the immense growth of vehicles and transportation systems, which makes it impossible for humans to fully manage and monitor them, automatic recognition of license plate numbers has become increasingly important in our daily lives. It is impossible to manually keep track of every single car in the world today due to the growing quantity of them. It needs a person on duty every day of the week, 24 hours a day, to keep track of which cars are following the law and which should be penalized. As a car is identified by its number plate, an automatic detection system is needed to read those number plates and identify the vehicle. Automatic Number Plate Recognition systems (ANPR) is an image processing-based technology to identify the number plates and hence vehicles. These systems have gained high popularity in recent years owing to their wide applications and advantages, some of the major applications include traffic monitoring, toll management, tracking stolen vehicles, managing parking tolls, red-light violation enforcement, and crossing point and customs checkpoints. Moreover, this technique also aids in obtaining the right outcome compared to manual methods.

In Indian systems, there are mainly 2 types of number plates – black letters with a white background or black letters with a yellow background. There are ten characters in a number plate that uniquely identifies it. Two alphabets of state code, followed by 2 alphabets and 2 digits of district code. At last, there are four digits that define the actual registration number. From these 10 numbers, the complete information about the vehicle and its owner could be retrieved.

In this article, the system is designed to automatically identify a car breaking traffic laws, snap a photo of it, and then fine the offending owner to make the entire process autonomous. When parking, the system may be used to capture a picture of the car. This technology is significantly more efficient than people, reducing the need for tedious manual labor on a busy day and reducing labor expenses. Any car number can be shown once it has been converted to text.

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The government has invested millions of dollars in the research and development of a satellite-based toll collection system. With significant improvements, the system could prove to be an even stronger competitor than Satcom because there will be less time delay and it will use more accurate differential navigation and distance detection, where it can detect one entry point. In addition to traffic regulations, this system also targets the development of toll collection and security applications.

II. Literature Survey

Many methods are proposed related to the automatic number plate recognition system. Various types of software are used to detect license plates and few limitations are present in the proposed systems. Using MATLAB, Harshit Surya Koppisetti, and Archana Mangalagiri proposed a Number Plate Recognition System [1]. In this project, they have developed a prototype that can detect the number plate using MATLAB and image processing. It has been tested in various cases and has turned out to be successful. However, it can sometimes be unsuccessful when the image is not clear or the number plate is gaudy.

J M S V Ravi Kumar, B Sujatha, and N Leelavathi [2] have proposed an Automatic Vehicle Number Plate Recognition System Using Machine Learning. This research explained how machine learning and ANPR can be achieved. This research paper needs many modifications, including software and methodology, in an applicable way.

Hongliang Wang, Shuang He, Jiashan Yu, Luyao Wang, and Tao Liu March proposed a system of Implementation of Vehicle Target Detection and Information Recognition Technology Based on NI LABVIEW [3]. LABVIEW is used as software for extracting an alphanumerical text from an image in this proposed system. LABVIEW has the biggest disadvantage of lacking database communication and a lot of development is still needed on LABVIEW software including auto-resizing based on screen resolution and also has limitations on customization of the theme of UI and components. B Rajasekhar P Harsha Vardhini, Roshny J, V Lavanya, Professor from the Department of Electronics and Communication Engineering Anurag Group of Institutions, Telangana, India proposed a similar system using LABVIEW labeling Automatic number plate recognition using LABVIEW [4]. Similar issues are faced in this proposed system following limitations in UI and database communication. Seong-In Kang, Sang-Cheol Byun, Yeo-Han Yoon, and Youn Sub Park proposed a study on Single Camera Based ANPR System for the improvement of Vehicle Number Plate Recognition on Multi-Lane Roads. This research paper mainly focuses on vehicle number plate recognition on multi-lane roads[5]. Unlike the conventional method of detecting one lane with one camera, multi-lane ANPR the system recognizes vehicle markings on multi-lane roads. The limitations include the equipment installation interval and the equipment being expensive and not economically affordable in small cities.

Shally Gupta, Rajesh Shyam Singh, and H.L. Mandoria wrote a review Paper on the Automatic Number Plate Recognition System since this paper is a survey and review of how ANPR works, the authors didn't include any limitations [6]. This survey detailed a lot of research which can make things easy for researchers. Aniruddh Puranic, Deepak K, and Uma Devi [7] proposed a vehicle Number Plate Recognition System: An implementation using Template Matching. This system is very less accurate with 80% efficiency. The proposed system is aimed at solving two main problems prevailing in educational institutions, namely monitoring the number and type of vehicles currently on the premises and at the same time helping the owners with the exact time when their vehicle left the premises in case of theft.

Kartik Hosur, Lohith Jaganathan, Manjunath Ramesh, Nikita Parikh [8] proposed a system of Automatic Number Plate Recognition System. The system has been designed using a modular approach that allows for easy upgrades and/or by replacing various sub-modules, making it potentially suitable for a wide range of vision applications. The system can be more robust if high-precision cameras can be used to increase the overall accuracy if this system is implemented in real-time applications. Also, the sensor can be designed to allow the camera to capture an image only when needed to save power.

III. Methodology

The methods/procedures used in the project revolve mainly around the manipulation of an image. Various operations are performed on the input image to get the desired output for the specific operations needed. The proposed methodology consists of three major phases viz., pre-processing, detection, and recognition. Block diagram for the same is also shown in Fig. 1.

In Image acquisition, the image is taken as an input for processing the same for the final output. The system mainly focuses on acquiring images that are pre-captured and stored in a database. The stored image is pulled out by the

code for number plate recognition and various other processes are done before the extraction of the numbers that are the desired output. The first major step for this process is taking the images that are provided for the purpose of number plate detection and converting them into low-resolution images as the high-resolution images tend to take more processing time and the algorithms are slower to work with.

It is unnecessary to contemplate images of high resolution as only the output generated is a string. The basic function of the under-sampling feature is to reduce the image resolution if it crosses a predefined threshold by the algorithm. This step of the processing is also important for reducing the overall runtime of the algorithm in recognition of the characters i.e., the number plate. After the under-sampling has been done the image goes under another preprocessing stage. Here the image is converted from the RGB format to the HSV format, the HSV channel provides various advantages one of the foremost being they are much more efficient in separating the colors from the luminance. This helps the algorithm to better acquire the information needed as the range of illumination increases and the overall extraction quality of the image increases as well.

The HSV image is converted, or the grayscale part is extracted from the image, and this is better than the direct conversion of an RGB image as the luminosity of the image is more in the HSV channels. This step is important for the algorithm to easily read and differentiate the part of the image that is useful for the next step i.e., the number plate. These operations filters specifically are for improving the overall contrast of the desired image section. There are two major parts to this process. Top hat and black hat filters work together simultaneously to improve the bright objects of interest during a relatively darker background and enhance the darker objects of interest during a relatively brighter background respectively.

This is a very important and essential step in the processing of the image there are various factors that affect an image and the quality of the image that in turn gives A bad quality image after having all the information that is needed but is hindered by some entity some entities in the image called as noise there are various types of noise but the two major types are the Gaussian noise and the salt and pepper noise. The code is designed on a mathematical process in order to Apply various filters on the image to remove such noises and give the output a clearer image that is easier for the algorithms to read the characters from. Applying contour tracing also called border following it's an algorithm that generates an extracted part of the image based on the intensity values that are presented in the algorithm. For example, in MATLAB finding contours is finding a white object from a black background and vice versa. The image goes through various processes like segmentation and filtering and grouping contours which allows the program to detect specific changes and the intensity of the pixels which in turn gives the algorithm the desired output which is the distinguished image of the number played from the image presented which can also be termed as number played extraction from the given or the provided image.

The final step in the program is to extract the and present them out ask the output. One of the most complex processes is to make the process efficient as well as Pre size well Accurate in itself. As the model must be trained through database learning to recognize what A character looks like based on predefined and fed data. The major challenge for the learning algorithm is to detect the newer presented that is unprecedented characters that are provided in the number plate each time a new photo is generated because for the human eye, it is easy to detect A character based on its shape regardless of its fawn but for the algorithm to understand completely the model has to be fairly adjusted in terms of efficiency versus accuracy as we'll struggle to provide any relevant data if either of the two parameters set is not balanced.

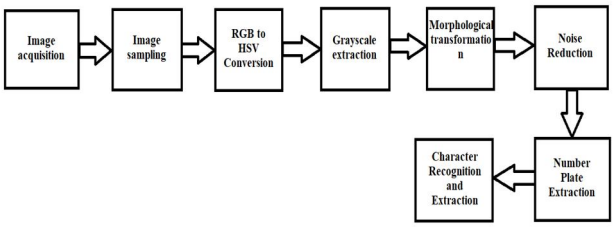

Figure 1. Steps Involved in Image Processing

The model is trained with 26 characters of the English alphabet and 10 numerical inputs as shown in Fig. 2. The program recognizes the pre-fed characters, and the algorithm tries, with an iterative code, to match each character of the number plate that is provided from the image. The code works in such a manner That it does not confuse

and mix all the characters that are provided in the image, so it uses the leftmost character first against all the pre-fed characters and then moves on to the next one when a match is found from the database. The result is shown as the string or the characteristics of the number plate and then is further sent for the desired processing of what the number is being used for. After performing all these operations we were able to extract the number plate information of various types of images.

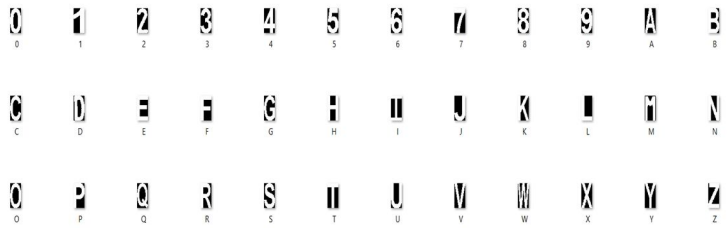

Figure 2. Images used to train the model to recognize various characters and numbers

At a glance, the physical model can be iterated as Hardware and Software. A microcontroller is used as the primary piece of hardware in this software-based architecture to operate the entire NPR. The data on the image and procedure, which includes the automobile number, are sent to the computer's algorithm. The image is then contrasted with the lovely database, which activates the microcontroller and causes it to start producing the output that was supported by the input. Smoothing with Gaussian A linear Gaussian function is used in 42 NUMBER43e PLATE DETECTION USING MATLAB Gaussian filtering or smoothing. Reducing noise and detail is the goal of Gaussian filtering. The major role and important part of this technique is software, as this uses image processing technology. This image processing tool is employed from MATLAB, where it uses many toolboxes. Even now this algorithm is split into two parts initially, we have got to capture this image and dump it into MATLAB software using the 'imread' keyword, and net this software is employed to pre-process the given data, next segmentation of characters and resize the image, display of recognized character.

IV. RESULTS

In this imperfect environment, we can't expect an image to just contain a specific set of information that is needed for data extraction, we need to localize and extract the data from any type of image for that we need to find out the exact coordinates where the data is present in the image and that can prove to be a very difficult task when working on the color image because there is a presence of various colors which can make the task difficult, so to get the desired results we need to convert the image into a binary image, where we can differentiate the data easily and locate the presence of data that we are interested in.

After we have successfully converted our image into binary format, we will run it through a localization template where we have trained the model to locate and find the data that matches our training model data. Using this model we will be able to locate the data, the principle behind its working is that it has various characters which correspond to a particular data set, by comparing those data sets we can find out where our data is located and we can isolate that from the entire image

Figure 3a. Input image provided to the model

Fig. 2 shows the images used to train the model in order to identify the presence of data and localize segments. After a useful portion of the image is found then a particular region is separated from the rest of the image and this

process is called Segmentation. It is a process in which the image is separated from the rest of the data which is noise. Segmentation reduces the load on our processor for further steps as it removes all the unwanted data and now we can focus on our targeted portion. Fig. 3a and Fig. 3b show the input image and segmented image.
After the segmentation is done, we need to perform the process of Letter Detection. It is a process that is used again with the training model to find out the data set of intensities but this time a rather complicated approach is used to localize each character. Bitmapping is used to find out the particular character which is more commonly known as Optical Character Recognition (OCR). Each character is identified and assigned a corresponding ASCII value to make it readable by a computer. Fig. 4 shows the code for localization and identification of characters.

Figure 3b Segmented image formed by the image segmentation process

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```
function letter=readLetter(snap)

load NewTemplates
snap=imresize(snap,[42 24]);
rec=[ ];

for n=1:length(NewTemplates)
    cor=corr2(NewTemplates{1,n},snap);
    rec=[rec cor];
end

ind=find(rec==max(rec));
display(ind);

% Alphabets listings.
if ind==1 || ind==2
    letter='A';
elseif ind==3 || ind==4
```

Figure 4. Visual representation of the code

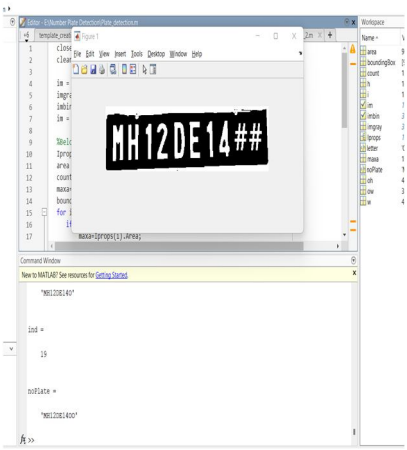

Figure 5. The final output returned both in picture and data format

After sub-processes are complete entire process in small functions is combined and finally, the entire process is called in one program performing all the processes in sequence and ultimately producing computer-readable data output of the entire process. Different localization algorithms are used for different kinds of images that vary in exposure, and color and have a highly irregular location of data. After meshing and combining the entire logic and processing techniques Finally the data is produced as output.
As shown in Fig. 5, a local image of specific data is produced for a user to read, at the same time text data is also generated for the computer to perform further processes, like online ticket generation, toll collection, parking violations detection, vehicle tracking, and many more.

V. Conclusion

In this article, sophisticated number plate detection systems are developed, which have an infinite number of applications and serve as proof-of-concept for additional MATLAB-based recognition features that can be implemented in a similar manner. Various complex image processing techniques combined with complex computational algorithms, a MATLAB model is developed that can read the number plate data of any image and extract the information required for a wide variety of tasks, and that too with faster processing, high stability, minimum error cases and robustness to different types of images.

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