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Real Time Number Plate Recognition Using Machine Learning

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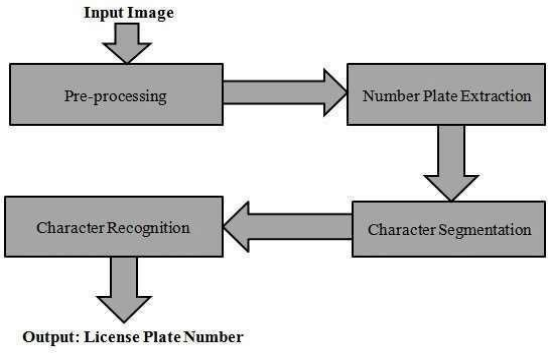
Abstract
This paper proposes a system that is used to detect and recognize Indian number platesusing the YOLOv3 architecture and CNN. This system is a digital image processing system that will be mainly used by government authorities to keep a check on vehicles that are not following traffic rules. Someof the major challenges faced by this system arethe speed of the vehicle, lack of proper lighting at the time of capture, and the number plate format. These factors affect the overall accuracy of the model. There are 3 steps inthis system: recognition, detection, and segmentation. Before applying CNN we should apply some prerequisite steps so that we can receive the greyscale image of the number plate which can be then used to differentiate it into uppercase characters, lowercase characters, and numbers. To get greater accuracy we will try to apply multiple CNN models instead of a single CNN model.

I. Introduction

Since vehicles are everywhere. So to detect the vehicles, the most efficient way is to detect the number plate of that vehicle as it uniquely identifies a particular vehicle. As, we notice, the number of vehicles are increasing day by day and frauds like stealing cars , bikes, over-speeding, crime at tolls, etc. are being frequently recorded by the government. So to stop this kind of crime, it is necessary to detect the identity of the vehicle. Once we get the identity of the vehicle we can trace the vehicle and then we try to stop it from crossing the borders of the particular state and inform all the government authorities about it. That is why this system is useful.

There are many challenges with this system but we will divide this into two categories: technical factors and environmental factors. Firstly, Technical factors include the size of thenumber plate, the font used in the number plate or any abnormality in number plates. Secondly, Environmental factors include bad lighting conditions, rain, different camera angles, different orientation of the number plate and having an unclear environment background. There are many techniques to solve these types of problems. Some conventional approaches are edge detection, character based approaches, and text-based approaches.

Earlier techniques used by the developers was the KNN algorithm where the first step was to use a camera to take a picture of the vehicle. The processing stage comes next. This stage will involve converting the RGB image into a grayscale version.



Finally, it utilizes the adaptive thresholding approach to turn the grayscale image into a binary image after employing median filtering to remove the noise. The subsequent step, Extraction of the license plate region from the thresholded image. The following step, which is crucial to the entire procedure, is to separate each character from the license plate. The possibility of receiving erroneous findings exists if the segmentation is not done correctly. The KNN algorithmis used to distinguish each character. It will first use several character sets to train the system, and the KNN algorithm will then be used to recognize the characters.

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After the inaccuracy of the KNN models, they have used Deep learning to achieve the highest accuracy. They first captured the images of the number plate from different angles. After capturing, these images are sent to multiple data warehouses. For a particular number plate at least 200 unlabelled images are sent to the data warehouse. As the number of cases increases the efficiency of the system will increase. Most of the images should be from the frontal view because if we rely on the side view pictures, it would be difficult for us to clearly identify the number plate.

So ,in the Deep learning method the correct detection of the character in the output layer depends on the input which was received from the previous layer. There are many chances of misclassification in the intermediate layers. Deep learning has made object detection and image classification tasks easier than the previously used methods like K-MEANS, SVM, etc. CNN consists of the majorly 3 layers: First layer is input layer which is used to take the input from the yolov3 modules. In the second layer the size of the input is reduced with the help of some functions. In the third step we will get the output. These layers are used to convert the raw data into multiple- level absorption. Earlier scientists have been using OCR techniques for the detection of characters from the number plates.

Since this technique was used for all the characters and numbers in the number plate which decreased the efficiency of the system. After a few years of research, scientists have found a solution of creating a separate OCR for the characters and numbers. Now it is much easier for us to detect the characters and numbers in the number plate.

After the detection of the characters and numbers the conventional Deep learning and CNN methods can be applied which will help us detect and uniquely identify the number plates in the complex background and multi- orientation images.

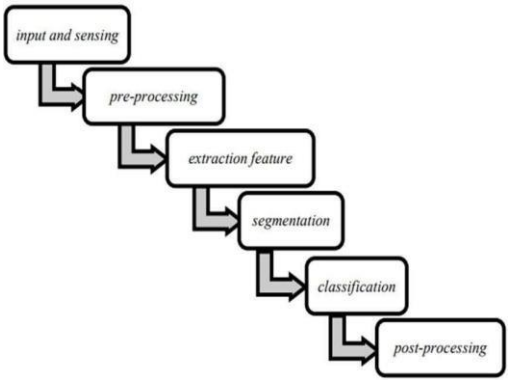
These input layers are connected to extract the features from the previous layer. Hidden layers have a pooling function in them which is used to merge similar features into a single unit and reduce the size of the input data. After that, a fully connected layer will perform the various techniques to predict the output. This CNN system is usually embedded in high- processingsystems.

Our work usually consists of deep learning techniques which are suitable and can be encapsulated in our system to detect and recognize the images in real-time. Our methodology consists ofthe CNN networks which can be used to attain the highest accuracy in an unclear environment. We will use mobile phones, cameras, or YOLO v3 compatible devices for real-time objectdetection.

We will also use the combination of the multiple models to get strong evidence about the accuracy and performance. The final system will be customised to achieve the best accuracy using an inbuilt microprocessor which is having similar performance to other CPUs, with least energy requirement .

Related Work

The paper [1], they have used the Otsu method and K Nearest Neighbour . Otsu method was developed to convert RGB image to binary image which includes a process that first converts the RGB image into Grayscale Image and finally to Binary image. This was done because Binary Images are easier to process and extract the required properties from the image while requiring less processing power and time. ANN which stands for Artificial Neural Network algorithm was used for the purpose of classification. Also, this algorithm can withstand any noise. Otsu method is used for feature extraction while for comparing proximity test and training data, ANN is incorporated. Various deep learning algorithms and classification processes (to classify the test data) were implemented to determine the test data. Pattern recognition is the main process used in the Otsu method which uses Binary Vectors without disturbing the threshold at all. The pixel value distribution across the image is adjusted for better results and better binary segmentation. His ANN classification in this study proved to be of great benefit to vehicle license plate recognition.



The paper [2], they have used asupervised ML (Machine Learning)

algorithm called K-Means which is used to create subsets by splitting characters into smaller sets. The

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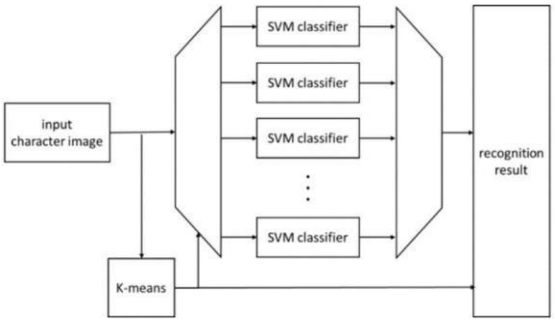
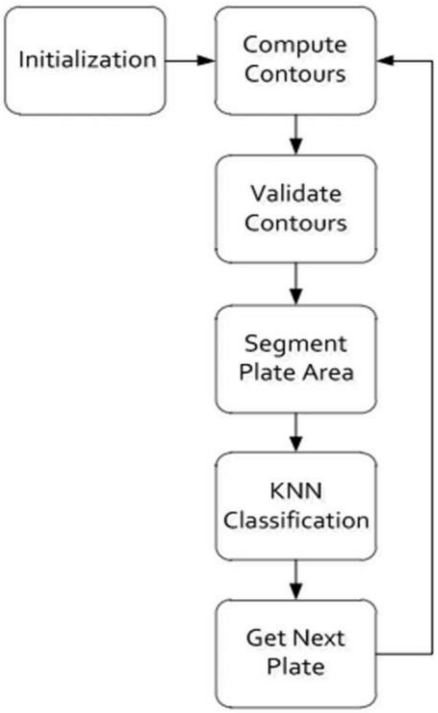
subsets obtained are classified further by Support VM's(Vector Machines) which Improves accuracy of the system. This method uses character recognition to identify obstacles based on the camera angle, vehicle speed, and brightness of the surroundings. The camera captures images of faint, unrecognizable characters. Support VM's are highly accurate and provide good performance . This is why they are widely used for classification problems and regression problems. Multiple Classification includes various SVM classifiers which should be able to classify samples belonging to various classes. If the number of samples is huge, it would ultimately increase the workload on the SVM and hence lead to a reduction in accuracy of the whole system.

SVMs make it easy to classify hard- to- recognize characters. SVMs are also used to classify subsets of characters and reduce character classes. This leads to reduction in the number of SVM's required.



The paper [3], they have used KNN classifiers which are used to classify characters from license plates. A vision camera installed on the highway analyses the feed it receives and captures images of vehicles along the highway. Contours within the license plate are calculated along with their size as if they were valid characters, and the license plate is segmented from the recognized contours. KNN Algorithm is used to classify each contour separately.



Then, the ANN algorithm is used which is trained using various sets of training data each containing 36 characters in total. Specifically, it consisted of 10 digits and 26 alphabets. The final algorithm was tested on characters which were segmented previously and then compared to methods for character recognition such as Artificial NN.

The paper [4], they have K Nearest Neighbour for recognizing license plate characters and uploading license plate details to a server. Firstly an image of the vehicle is captured by the camera and processed to remove noise. Obstacles encountered in this process are blurry or fuzzy images.

They are separated from the rest of the image to extract the specific image of the license plate from the rest of the image.

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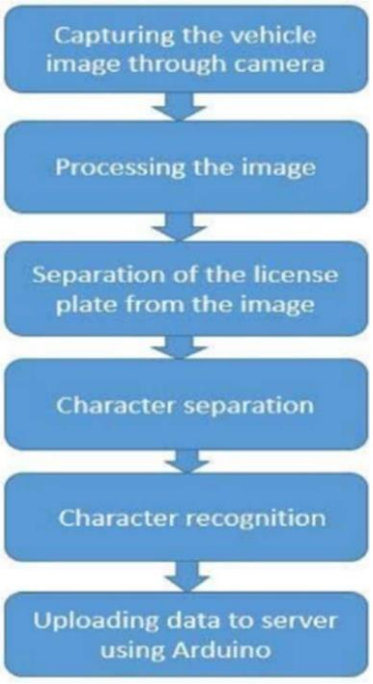
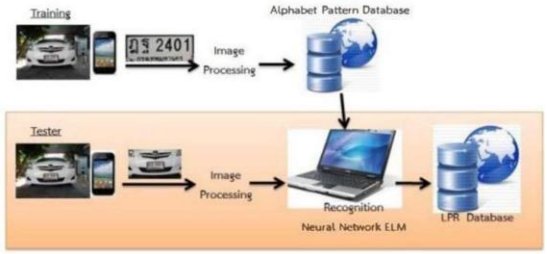


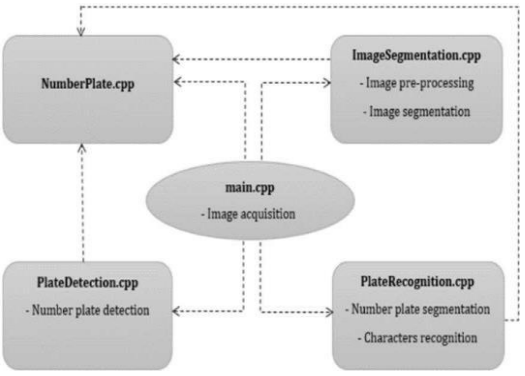
In the next step, the extraction of the license plate from the rest of the image is completed. After this, separation of the characters from the license plate is done and K Nearest Neighbour Algorithm is applied to recognize the individual characters. This process ,firstly splits the image and obtains the individual characters and then uses K Nearest Neighbour to extract the individual characters . At Last, the license plate is recognized to feed to the Arduino Server which is programmed on the Arduino IDE . Also, it provides query options. At last, it outputs the recognized characters.

The article [5], they have used deep learning methods for the training purpose. Extreme Machine Learning (EML) is implemented which Accurately Classifies the NumberPlates.

There are 2 parts in this system. The first part is using HOG (Histogram Oriented Gradients) which is used for feature extraction after preprocessing results are obtained. The second part is used for the classification of individual digits and alphabets so as to individually analyze the letters and digits that are present on the number plate. Extreme Learning Machine (ELM) which is a learning algorithm operating which is supervised and uses a single hidden layer feedforward network with the performance almost equal to SVM. ELM does the classification part and HOG (Histogram of Oriented Gradients) is designed to extract key features from license plates in order to recognize Thai language characters on license plates. This system was used because it was fast .



This article [6], they have used a technology for Recognition of Indian License Plates, presents a ton of problems. Reasons for this include the variety of font sizes, the variety of colors, and the two-line license plate system. The issues are addressed in real Indian road conditions. The implementation uses ANN to recognize characters and SVM which is used for contour detection. A variety of algorithms were used to remove the noise and improve plate recognition coupled with neural networks to obtain the best results while relaxing many camera constraints.



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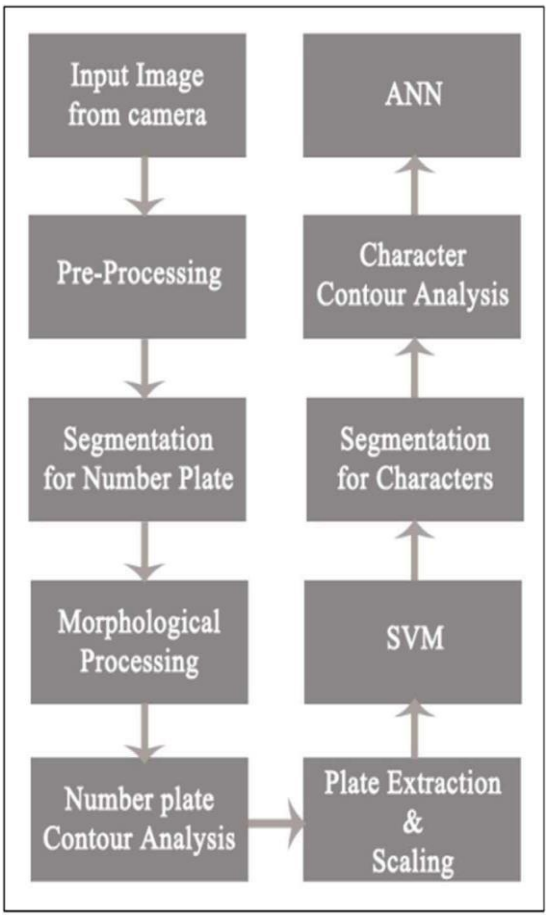
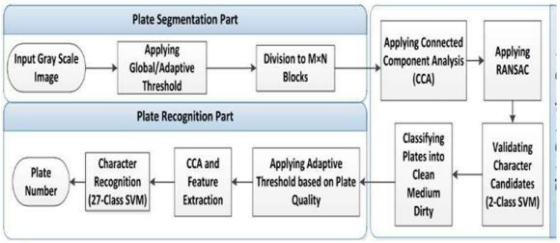


In this paper [7], they have developed an ANPR system that utilizes two machine learning techniques, SVM and ANN. System receives an image of a car, processes it, analyzes it using multiple machine vision techniques and the two machine learning algorithms mentioned above, and finally identifies the license plate of the vehicle.
The entire process can be broadly classified into three phases: image acquisition, image preprocessing, image segmentation, Recognition of License Plate, Segmentation of individual parts of License Plate, and finally recognition of individual characters.

In this paper [8], The system which is used in this paper is used to detect the number plate of the vehicle which is at a high speed or when the environmental conditions are not good for the camera to detect the picture of the vehicle. In this system, they have used the grayscale algorithm to correctly identify the vehicle. This involves some steps: Firstly, we will click the whole image of the vehicle. Then, we will convert the image into a grayscale image. So, after this, we will get the points as 0's and 1's which are the output of the binary image. Then, in the third step, we will segment the number plate of the binary image. Then we will classify the characters using the SVM technique. The main advantage of this method is that we will be able to predict the number plate even when it is covered with dust because the gray scale helps us to identify the number plate.



In this article [9], This framework is based on LP detection, segmentation, and masked region convolutional neural networks used for detection. This, we use the DELP-DAR system for the recognition of the license plate. This system allows us to scan the license plate in tough conditions. It has 3 steps:The first step is LP detection in this they will detect the LP from the input image. Then comes the segmentation and recognition of each character after which the LP recognition is completed.
In this system, we will make use of the Mask R-CNN as our core component. RCNN is already fast and can recognize the text with greater accuracy. So we will take it to another level by detecting the regions which have the characters in them and which are blank. We will mark the region as "empty" or "object-y". As this system will have a large number of inaccuracies because of the empty and texted regions. In fact, four sets of data were tested with images taken from multiple scenes under different conditions, such as different orientations, poor quality images, blurry images, and complex surrounding background.

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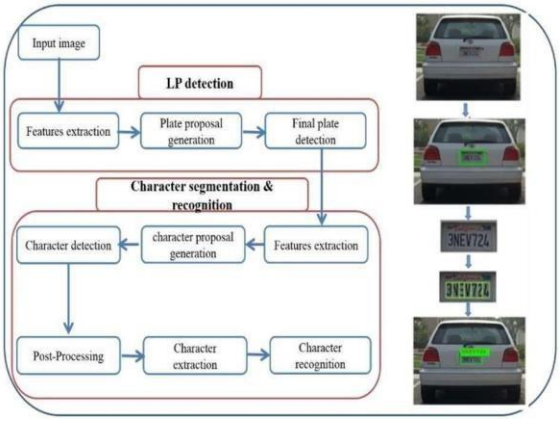
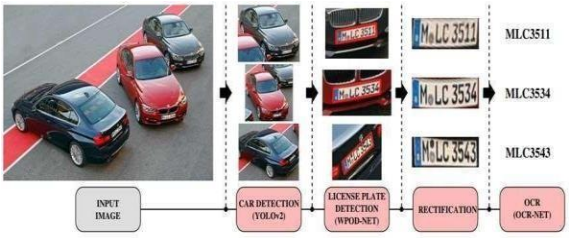


In the paper [10], the process can be broadly classified into 3 main steps: detection of vehicles followed by detecting License Plates and finally OCR . When an input image is captured or received , the first module analyzes the scene to detect the vehicle. During this process the WPOD-NET (Warped Planar Object Detection Network) is used for searching for LPs in the given detection region and for each LP it detects, it returns an affine transform so that the LP region can be rectified and confined in a rectangle. These obtained data are saved and passed on to the OCR network for the processing that gives the final output.



II. LIMITATIONS

The algorithm used in the earlier to detect the number plate have some drawbacks in them. Like in KNN which has some obstacles in recognizing license plates, such as those used to recognize characters, predict spaces and characters. If other parts of the license plate have dust or text such as names, numbers, etc., these sounds will also be detected as part of the license plate, which is highly inaccurate. These are sent to the system and the system cannot track the license plate during template matching.

Limitations of using of SVMs in ANPR include designing and implementing LPR on the Android mobile phone platform using NNs, building an LPR system capable of recognition of license plate in real time, and implementing an Android-based system capable of recognizing license plates in real time. It includes building a LPR system using robots.

One of the challenges is scanning the license plate which was earlier done by the cameras and mobile devices were inaccurate because it only detects the exact area of the number plate. This may fail due to different sizes of the number plate. A future extension of this work is the development of character recognition using template matching algorithms. Detection of license plate characters at night works efficiently, but is less efficient during sunny hours.

Another Limitation is the use of ANPR cameras raises privacy concerns for many people who are reluctant to store their data for months. Storing of information may lead to identity theft , data breaches or identity misuse. Everyone hates that their location is always known. However, ANPR is not particularly considered as an individual privacy violation and data should always be securely kept and access should only be given to authorized officials. In Extreme Situations, ANPR can be actively used in parking areas. ANPR cameras may not be very effective if the license plate is obscured or distorted in bad weather such as heavy rain or snow. These cameras also rely on smart driving of the car. For example, if a car gets too close to the other car in front while exiting the parking area and you can't see the license plate, the camera won't know you're out of the lot and could overcharge.

Additionally, some ANPR cameras are not sophisticated enough to detect non- standard license plates such as Third Party License Plates. In such situations, it makes sense to mix human and automated systems.

Another drawback of the ANPR parking system is that human error and human behavior are rarely considered. The ANPR system usually does not consider grace periods when entering parking lots. This means that drivers who enter the parking lot and are unable to find a space may be charged because they saw a camera drive in and out of the parking lot but could not find a suitable ticket.

III. CONCLUSION

The current era is witnessing a massive increase in population growth, resulting in more vehicles roaming the streets. This ever-increasing number of vehicles poses various major challenges including: Increased traffic violations, theft, terrorist activity, parking problems, and accidents. Addressing these issues is important. To solve these

problems, an ALPR system was designed that can effectively identify vehicle license plate data. This work presented an ALPR system using deep learning (CNN) techniques for character recognition. The proposed ALPR system consists of four main phases: data acquisition and pre-processing, feature extraction, region of interest (ROI) selection, and classification . In this the data acquisition is done by the YOLOv3 compatible devices which overcomes various limitations of the traditional ANPR system built using KNN and SVMs. In this system of the ALPR we are trying to use the OCR method for the feature extraction and region of interest classification. This OCR will be different for the character and numbers as this will provide a greater efficiency in our system. Pre-processing techniques like (grayscale, median filtering, thresholding and masking) are applied next to the CNN masking layer and are used to further improve the image quality, followed by CNN training. Finally, the system uses CNN to recognize the license plate data.

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