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END-TO-END CAR LICENCE PLATE DETECTION AND RECOGNITION WITH DEEP LEARNING.

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Abstract: An exponential growth in many vehicles necessitates the use of automated schemes to preserve vehicle information. The evidence is extremely required for both management of traffic as well as reduction of crime. Number plate recognition is an actual way of automatic vehicle identification. Some of the current algorithms based on the standard of learning take a lot of time and proficiency before delivering satisfactory results but even then, lacks accuracy. In the planned algorithm an effective technique for recognition of vehicle number plates has been devised. This project presents a novel convolutional neural network (CNN) -based method for high-accuracy real-time car license plate detection. Various contemporary procedures for car license plate detection are reasonably effective under specific circumstances or strong assumptions only. Though, they exhibit poor presentation when the evaluated car license plate images have a degree of revolution, as a result of manual detention by traffic police or deviation of the camera. Therefore, we propose the CNN-Model, ImageNet, VGG-16, and RNN framework and for more accuracy, we used Faster R-CNN and CRNN for car license plate detection. Using perfect rotation angle estimates and a fast intersection-over-union valuation strategy, our projected approach can elegantly manage rotational problems in actual-time circumstances. The algorithm goals at addressing the difficulties of scaling and recognizing the situation of characters with a decent accuracy rate.

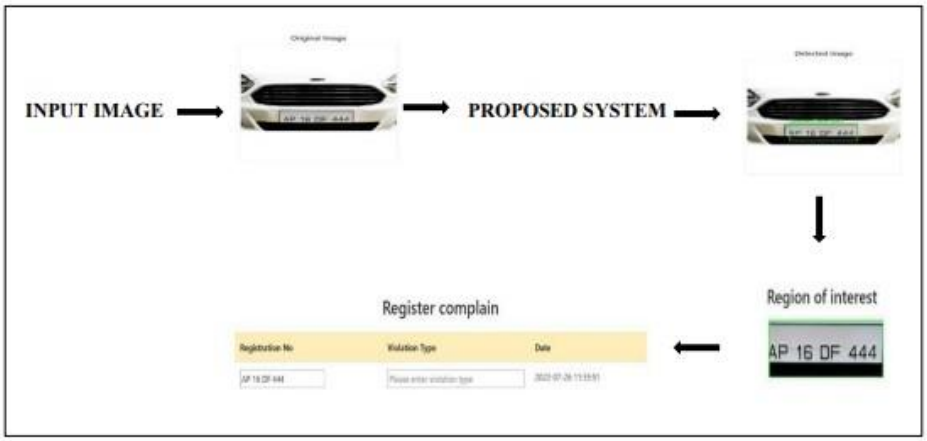
Index Terms – Deep Learning, Vehicle Detection, Convolutional Neural Network, Pattern Recognition.

1. INTRODUCTION

Vehicle number plate recognition is the most sensational and exciting research subject in the previous few years. Number plates are of altered shape, and size and also have altered colors in different countries. In India, the main common vehicle number plate used consumer yellow or white as background and black as foreground color. In this paper, we suggested a scheme for the localization of number plates for vehicles in India and segmented the numbers to detect each number independently. In tradition, a common recognition scheme of supervisory vehicle devices usually uses humans to identify the license number monitored by a camera. Mainly, using humans to identify vehicle license numbers in this way may explain the problems. But using people to do the recognition continues time and needs numerous workers to prepare for this work. Hence, NPR is established for vehicle identification to help human operators and improve the examination or work excellence. Some presentations of an NPR system are automated high-way toll collection systems, automation of petrol stations, and journey time observing. The task of recognizing number plates in conditions becomes a bit difficult as many Indian vehicles do not follow the standard format of the number plates. Number plates can have only one row or dual row.

The key objective here is to design an effective automatic vehicle identification technique by using a vehicle number plate. The scheme first would capture the vehicle's image as quickly as the vehicle touches the security examination area. The taken images are then extracted by using the separation process. Optical character recognition is used to detect the characters. The achieved data is then matched with the data stored in their databank. In our modern-day to day life, the use of data to offer insights and significance to the data has grown on a big scale this generation of insights happens with different methodologies where machine learning is one of it where the data is comprehensive from various sets of samples. One of the methodologies used is the procedure of ANN (Artificial Neural Network) which challenges mimicking the biological counterparts one of the approaches in it is the CNN (Convolutional Neural Network) which works on mimicking computer vision to identify, discover and classify the objects or entities in the specified field of view.

Here the methodologies land with the generalization of examples by performing N layer treating on the data. CNN also has various methods to look forward to. This methodology as being highly accurate and able to outperform multiple approaches its features of real-time analysis of data make it suitable for various dissimilar applications such as real-time vehicle detection. As vehicles are increasing there is additionally a need to maintain and record and analyze the health of the transportation system. Thus, analyzing the vehicles or roads can give various key points in making adjustments to improve the efficiency of traffic, maintain the flow, securing people from non-rule followers. This paper gives a summary of several different methodologies current in the vehicle detection scheme. In this paper, we will see not the same methods used by different authors and their results.



2. LITERATURE SURVEY

Vehicle Recognition

As the need for processing the data increased authors have approached the task in multiple and diverse ways. In the case of detecting patterns in the vehicles, the approaches utilized by different authors give a glimpse of the scalability, performance, and reliability of available methods one such method is the use of RPN (Regional Proposal Network) which helps enables the extraction of characteristics of the object using the convolutional network which in turn uses area proposals. [4] Praveen Ravirathinam, with the use of region proposals, tried to predict the object's confidence scores and bounds. Here while doing training of the area proposal network to generate regions of interest the features and required dimensions are extracted which are then given to a fast convolution neural network for detection.

Number Plate Detection

Number Plate Detection revolves around the capability of the methods to generate and extract the features related to digits and the number plate associated with them. Here is one of the approaches authors [5] Shyang-Lih Chang, using a non-intrusive detection system the type of the vehicle is detected, there are various components used to measure the system type, here vehicles are detected along with text detection is done for recognizing the text of a numbered metal. Using this system certain features are tracked and selected on a license plate and tracked features are used across multiple frames and any rectification for the tracked features is performed using the convolutional network.

Hui Li, [1] proposed the method in two steps. First, several candidates based on texture information similar to the number plate are extracted. In the second step, an auto-correlation-based binary image and projection algorithm is used to verify the true candidate plate.

In Korean license plate extraction, Abbas M. Al-Ghaili [2] first used Sobel vertical edge detection on the image. Next, vertical projection analysis was used to locate the plate area. Fake candidates were deleted using a compact factor, which evaluated the densest vertical edge area declaring the true number plate. Every character on detected number plates is segmented in the character segmentation step. Segmentation techniques based on projection analysis and region growth are proposed in the literature. They developed a number plate detection algorithm using a group of lines forming a rectangle at the plate boundary. Observed by this step is the vertical edge density algorithm to find out the plate area.

Haifei Zhang [3] proposed vertical edge detection followed by size, shape filter for edge area, and edge matching technique based on plate model and used horizontal and vertical projection analysis for character segmentation. In this, horizontal edges of the plate area were decided initially, which helped to segment the characters with the large rotation. Characters were segmented using vertical projection analysis based on prior knowledge of the plate model and used connected component analysis for character segmentation. Avinash Bhujbal and Deepak Mane [7] this paper devised a smearing algorithm to locate the number plate. Zied Selmi [6] developed a region-growing algorithm for character segmentation.

3. PROBLEM STATEMENT

In the existing system of number plate detection, the interpretation of the captured image will be done either by human interface/system analysis but there is no reliability in the outcomes of the image processed and there are high chances of errors and misinterpretations in the number plate extraction.

How to overcome this challenge for a better interpretation and accurate results of the image?

Researchers have to face various problems while detecting and recognizing license plates. Here we have explored a few major problems**.** The first problem is the non-uniformity of the license number plate models for different cities. It may also vary from one state to another and thus from vehicle to vehicle. The length of the number plates may also vary. The second prime difficulty is the low resolution of the number plates for vehicles in video frames under typical surveillance systems.

The expected answers to these problems are to develop the sequential coordination of image processing tasks. This processing sequence may include, algorithms i.e, object tracking and segmentation, locating the license plate area, and detecting the number and its color.

In previous research, the most prevalent technique is the methods based on edge statistics, which are based on the principle that the change of brightness in the license plate region is more remarkable and more frequent than elsewhere. But they hardly can be applied to complex images due to their sensitivity to unwanted edges. Combined edge statistics with morphological steps to eliminate undesirable edges in the processed images. On the different hand, some approaches take advantage of color features. The following three key sections are involved in this proposed algorithm. Firstly, the Sobel operator is used to extract the vertical edges of the vehicle image. Finally connected component analysis is used to locate the license number plate accurately. Similarly, uses a color-based method, but in which the color information from the colored image is reasonably utilized to greatly decrease the edge points. This method, also eliminates the disturbances of the fake plate's region whose structure and texture are similar to the vehicle number plate but do not match the number plate's fixed color collocation.

In addition to recognizing the plate, the vehicle's license plate recognition system also has to recognize the character on the plate. This step is a larger part that involves a great amount of calculation. It could verify the accuracy of the whole system. When the vehicle's license plate is viewed in a dark or rainy environment or a complicated environment, it is difficult to distinguish the license plate clearly. To recognize the character, it is, therefore, necessary to use the technique. Adjusting the light, separating the characters, and modifying the integrality using gray level values. Finally, they used a neural network to recognize each character. There are three layers, which are the input layer, hidden layer, and output layer, in this design. This method could improve the accuracy and training speed. Moreover, another important advantage is to avoid falling into local minimum points. One database should exist. For instance, for the recognition of English and digital letters, there are 26 letters and 10 digital letters in the database. Then they used the calculation to match the template and judged whether it matches or not.

Detection of vehicle licenses is a huge challenge in image processing. The reason can be concluded in the following aspects. Firstly, the shape of the car plate license plate may be various in different countries. A license plate is combined with English characters and numbers. Secondly, in real life, the license plate may be distorted as well. As a final point, the luminance condition in car images taken by auto cameras may vary greatly; either too bright or too dark luminance may impact accuracy and complicate plate detection. The level of difficulty in detecting license plates increases with each of these factors. On the other hand, as the application environments of license plate recognition are different, the technical requirements for license plate recognition are also different. For instance, the system of license plate recognition must take into consideration of the higher requirements on vehicle speed factors on the highway, compared with that in the standard way. In the system of license plate recognition, it is very hard to improve both the accuracy and speed of recognition concurrently. The reasons for this cannot be exclusively attributed to the imperfection of the recognition techniques, but also the limitations of the hardware. In addition to plates with clear letters and numbers, we also limit ourselves to plates with clear numbers. By doing this, we leave out plates that have a lot of dirt or are fuzzy due to the high speed.

To recognize the vehicle, type the challenges are the diversity of the type of vehicles of each category along with the quality of information that is used to train the model and how well balanced the dataset is to train the model. As the depth and granularity of the training increase, the data needs to be as rich as in the case of number plate detection where the number plate data needs to be precisely modeled. Some other challenges are in terms of type, color, the shape of the number plate, and vehicle type were based on the different categories the variations of the features. There are also issues related to the occultation of vehicles in the given frame of relevance, whereas the vehicle in a given frame becomes smaller the model doesn't recognize it.

4. PROPOSED METHODS

The block diagram of license plate recognition system implementation is shown in Fig.1. There are various steps in this approach and these are implementations. A number plate is a pattern with very high disparities of contrast. If the number plate is very similar to the background it's challenging to identify the location. Illumination and contrast change as light falls changes to it. The morphological operations are used to eliminate the contrast feature within the plate.

We input an image of a car that goes through the image pre-processing stages that enhances the image quality for better results in later stages. Then it converts the RGB image into grayscale and further binarization is done to restrict the color shades to 2 colors only (viz. Black & White). Then with the help of Sobel's edge detection algorithm or Smearing algorithm, we extract the license plate from the binarized image. After getting the license plate now, the system will segment the character on the license plate by horizontally scanning the image. Then with the help of CNN, we recognize the characters. After recognizing the characters, we can

use them for verification of license numbers or extracting information about the vehicle owner based on the license plate number. The whole process is shown in Fig. 1.

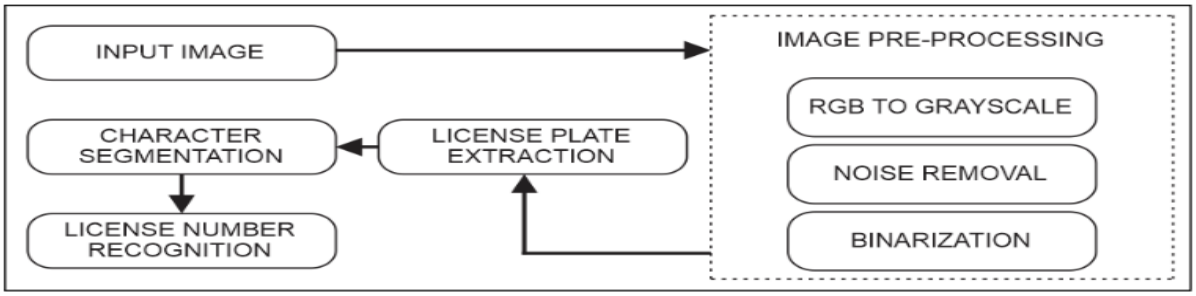


Fig.1

Currently, there is a lot of research on license plate recognition in the recognition area. Usually, license plate recognition is divided into five parts: input image, image preprocessing, license plate extraction, character segmentation, and license number recognition. In the first two parts, some common methods are usually used, such as Grayscale image, and Intensity Transformation Image. The function of the first two steps is to help search for the license plate more accurate way. Indeed, the first and most important step of a vehicle's license plate recognition system is to search and localizes the license plate. This detection step could greatly affect the speed and accuracy of the whole automatic license plate recognition system.

The proposed system for license plate recognition is presented in this section. Input to the system is a vehicle image that has been acquired through an image acquisition device and output is the editable form of the license number the flowchart of the proposed system is shown in Fig. 1. Which consists of the following main steps:

1. Acquired Input Image
2. Image Pre-processing
   a. RGB to grayscale conversion
   b. Noise removal by Iterative Bilateral Filtering
   c. Image binarization
3. License plate extraction using Sobel's edge detection algorithm/Smearing algorithm
4. Character Segmentation
5. Recognition of License number using convolution neural network

A. Input image:

B. Image Pre-Processing:

1. RGB to Grayscale conversion:

From the input RGB image, it has to be converted to grayscale, and the 8-bit gray value is calculated.

2. Noise reduction:

We used the median filtering technique to reduce the paper and salt noise. We have used 3x 3 masks to get eight neighbors of a pixel and their corresponding gray value.

3. Image binarization:

Image pixels are separated into a dual collection of pixels i.e., black and white.

C. License plate extraction:

The basic step in the recognition of a vehicle number plate is to detect the plate size. In general numbers, plates are rectangular. Hence, we have to detect the edges of the rectangular plate. Mathematical morphology will be used to detect that area. Using the Sobel edge detector, we used high light regions with a high edge magnitude and high edge variance identified. Depending upon the threshold percentage edge will be detected from the input image.

D. Character Segmentation:

It measures a set of properties for each labeled region in the label matrix. We use a bounding box to measure the properties of the image region. After labeling the connecting components, the region will be extracted from the input image.

E. Recognition of License number:

License plate detection is identifying the part of the car that is predicted to be the number plate. Recognition is identifying the values that make up the license number plate. License plate detection and recognition is the technology that uses computer vision to detect and recognize a license number plate from an input image of a car.

From the above mention, the problem statement can be achieved by implementing a deep learning technique called convolution neural network concept where the image capture will be processed in 3 different stages such that the extraction of the license plate details will be more accurate and there is also very high chance getting the desired results even though there are many distractions in the image captured so, in the project I am going to demonstrate the same how to capture the image and extract the data by using convolution neural networks for quick processing and accurate details of the license plate.

In the proposed software, the administrator defines both a "white list" for authorized vehicles that can access the site and a "black list" for unauthorized vehicles which are denied entry to that site. The system consequently would allow only the authorized (predefined) vehicles to enter the parking zone, and, meanwhile, prepares reviews of the parking zone in terms of the number of current vehicles, time of entry and departure, number of vehicles exiting the area, duration of each vehicle's stay in the area, vehicles which have been denied entry, unidentified vehicles, etc. Implementing the proposed system can provide a higher level of security and safety in the controlled area for the vehicles. The system can be connected to some gates to provide automatic and intelligent opening/closing operations for authorized vehicles. If connected to alarm lights, traffic lights, or smart boards, the system can show predefined messages for specific vehicles. The user interface of the system is designed for speedy access to system events and can facilitate utilization through issuing audio alarms.

Algorithm:

1. Start.
2. Take an input image.
3. Convert the image RGB to Grayscale.
   a. Load the image.
   b. Retrieve the properties of an image like width, height, and channels.
   c. Get the pointer to access image data (i=0 to height, j=0 to width).
   d. For each height and each width of the image, convert the image to grayscale by calculating an average of RGB channels of the image converted to grayscale manually.
4. Convert the grayscale image to noise removal by using Iterative Bilateral Filtering.
5. Convert the image to Binarization.
   a. Load the image.
   b. Setup threshold, max value (threshold=threshold_otsu(grey_ image)).
   c. Convert grey image to binary image.
6. Extract the license plate using optical character recognition.
7. Segmentation of characters and numbers.
8. License plate recognition.
   a. Load the image.
   b. Verify license plate characters.
   c. Is the license plate recognized go to step e.
   d. Otherwise, if a license plate is not recognized go to step 7.
   e. Display the output.
9. Stop.

5. EXPERIMENTAL METHODS

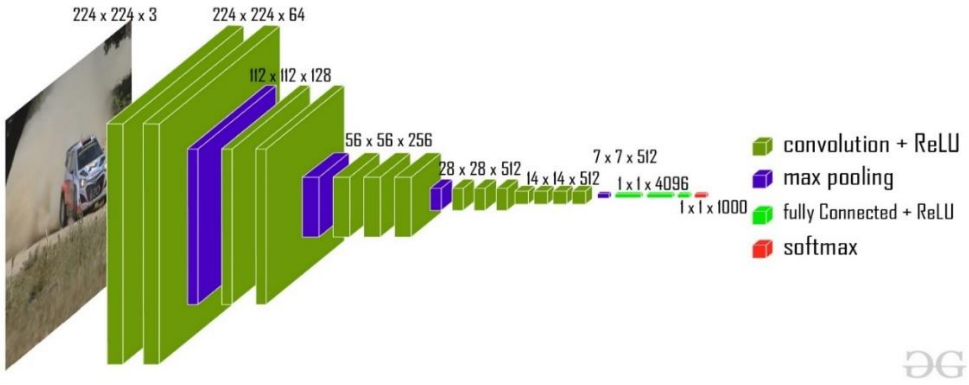
ImageNet

ImageNet is an image database organized according to the WordNet hierarchy (currently only the nouns), in which every node of the hierarchy is depicted by hundreds and thousands of images. The paper has been instrumental in advancing computer vision and deep learning research. The information is available for free to researchers for non-commercial use.

VGG16

In 2014, VGG16 won ILSVR (Imagenet Large Scale Visual Recognition) competition using a convolution neural network (CNN). It is considered to be one of the most brilliant vision model architectures of all time. With VGG16, instead of having several hyper-parameters, they focused on having convolution layers of 3x3 filters with step 1 and the same padding and max pool layers of 2x2 filters with step 2. This arrangement of convolution layers and max pool layers is followed throughout the entire architecture. As a result, it has 2 FC (fully connected layers) followed by a softmax. The sixteen in VGG16 refers to the sixteen layers with weights. A computer visual perception competition called ImageNet Large Scale Visual Recognition Challenges is organized every year and it has about 138 million (approximately) parameters. Two tasks are assigned to teams each year. The first procedure is to detect objects within an image from 200 classes, which is known as object localization. Second, image classification involves labeling each image with one of 1000 categories. As recently as 2014, the Visual Geometry Group Lab at Oxford University proposed VERY

DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION. In the 2014 ILSVRC challenge, this model won first and second place in the above categories.

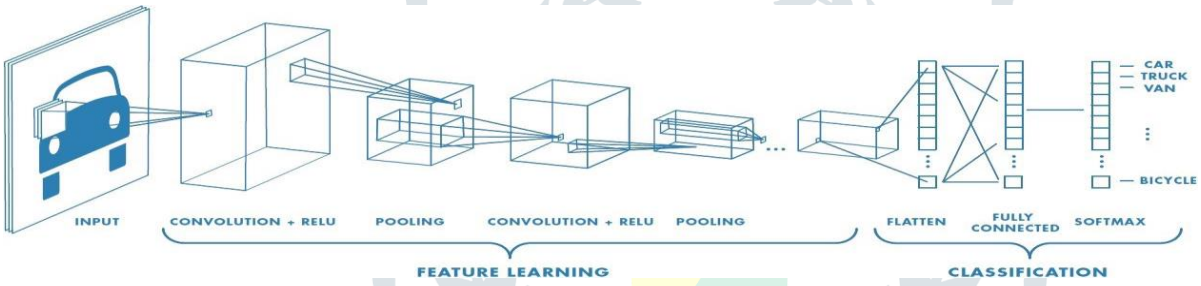


The architecture of the VGG-16

ImageNet contains 14 million images that belong to 1000 classes, and this model achieves 92.7% top-5 test accuracy on it.

Convolutional Neural Network (ConvNet/CNN)

The Convolutional Neural Network (CNN) is a Deep Learning algorithm that identifies differences between various aspects/objects in an image by assigning weights and biases to them. Pre-processing in a ConvNet is much less than in other classification algorithms. It is necessary to hand-engineer filters with primitive methods, but ConvNets can learn these filters with enough training. A ConvNets architecture is comparable to the patterns of connectivity of neurons in the brain, which is influenced by the organization of the visual cortex. An individual neuron is only able to respond to stimuli in a certain region of the visual field, known as the Receptive Field. The entire visual area is covered by a collection of such fields.



During the past few years, artificial intelligence has witnessed unprecedented growth in bridging the gap between humans and machines. It is a field where researchers, enthusiasts, and everyone in between work on many aspects to make amazing things happen. A great deal of attention is being paid to the field of Computer Vision.

As part of this area, machines will be able to experience the world similarly to humans, and even use their knowledge to accomplish a variety of tasks, including recognition of images and videos, image analysis and classification, media recreation, recommendation systems, and natural language processing. A Convolutional Neural Network is the most commonly used algorithm in Computer Vision with Deep Learning, and it has been developed and perfected over time.

Recurrent Neural Network (RNN)

An RNN is a type of Neural Network in which the output from the previous step is fed into the current step. Traditional neural networks have independent inputs and outputs, but in cases like predicting the next word of a sentence, past words are needed, so previous words must be remembered when predicting the next word. As a result, RNNs were developed, which utilized Hidden Layers to solve this problem. One of the most important features of RNN is the Hidden state, which remembers some information about the sequence.

The RNN has a "memory" which remembers all information about its calculations. Each input or hidden layer is treated with the same parameters, so the output is based on the same inputs or hidden layers. It reduces the complexity of parameters, unlike other neural networks.

Faster R-CNN for object detection

The most widely used state-of-the-art version of the R-CNN family — Faster R-CNN was first published in 2015. This article, the third and final one of a series to understand the fundamentals of current-day object detection elaborates on the technical details of the Faster R-CNN detection pipeline. For a review of its predecessors, check out these summaries: Regions with CNN (R-CNN) and Faster R-CNN.

In the R-CNN family of papers, the evolution among versions was sometimes in terms of procedure potency (integrating the various coaching stages), reduction in check time, and improved performance (MAP). These networks sometimes include —

a) a district proposal algorithmic rule to get "bounding boxes" or locations of attainable objects within the image;

b) A feature generation stage to get options of those objects, sometimes employing a CNN;

c) A categorification layer to predict that class this object belongs to; and

d) A regression layer to create the coordinates of the item bounding box additional precise.

The only complete portion of the network left in quick R-CNN was the region proposal algorithmic rule. each R-CNN and quick R-CNN use CPU-based region proposal algorithms, Ex- the Selective search algorithmic rule that takes around two seconds per image and runs on computer hardware computation. The quicker R-CNN paper fixes this by mistreatment another convolutional network (the RPN) to get the region proposals. This not solely brings down the region proposal time from 2s to 10ms per image however additionally permits the region proposal stage to share layers with the subsequent detection stages, inflicting associate degree overall improvement in feature illustration. within the remainder of the article, "Faster R-CNN" sometimes refers to a detection pipeline that uses the RPN as a district proposal algorithmic rule, and quicker R-CNN as a detector network.

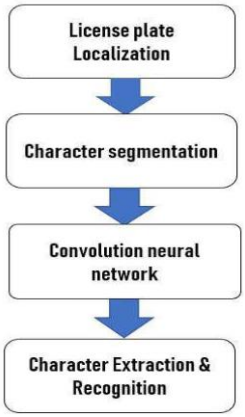
CRNN

The Convolutional Recurrent Neural Network is the combination of two of the most prominent neural networks. The CRNN (convolutional recurrent neural network) includes CNN (convolutional neural network) followed by the RNN (Recurrent neural networks). The proposed network is similar to the CRNN but generates better or optimal results, especially in audio signal processing.

6. RESULT AND DISCUSSION

All the experiments are performed on which python-3 is installed; the experimental training sets supervisory more than ten thousand copies of artificial approximate real scenarios license plate data sets. For convenience, the data set is made by taking foreign license plates as an example, namely the combination of English and Numbers, and the style of the data set. The proposed license plate recognition framework. The input of this stage is the license plate image patch and its four corner coordinates generated by the previous stage. We first perform license patch registration to obtain a rectified license plate of resolution 48×120. The unsupervised STN (spatial transformer networks) implicitly performs character segmentation. Each of their attention to the pixels of each corresponding character. The output of the parallel STN are segments of the input license patch.

CNN FRAMEWORK



Finally, the recognizer recognizes each segment. Different from the state-of-the-art detector Faster R-CNN, our detector does not share CNN features between RPN and R-CNN. Besides, we use a new network structure for RPN and design our R-CNN base network. In this experiment, we compare our solution with Faster R-CNN, denoted as FR-CNN. The training settings of reference schemes are the same as ours. At the inference phase, 10 ROIs of RPN proposals after NMS are reserved. Compares several schemes in terms of detection performance. The AP (average precision) at different IOU thresholds are listed, e.g., AP0.7 means the AP value is calculated when the detected box is treated as true positive if the IOU overlap with the ground truth box is greater than 0.7. There is an interesting phenomenon that Faster R-CNN with VGG performs almost the same as that with ZF when the IOU threshold is 0.5. However, when the IOU threshold is increased, the advantage of VGG becomes visible. This suggests that shallow network structures can find the coarse location, but more powerful networks can localize more precisely. We also change the Faster R-CNN

feature stride from 16 to 8, and the performance dramatically improves. This shows that higher feature resolution is beneficial for license plate detection. Comparing ours and the FR-CNN series, we can easily find that our detector performs much better. The gain has three possible sources:

1) We use corner points as supervision while FR-CNN (or VGG) uses bounding boxes as supervision;
2) We use a new network as the RPN base network and
3) The R-CNN in our network does not share features with the RPN.

Fig.1

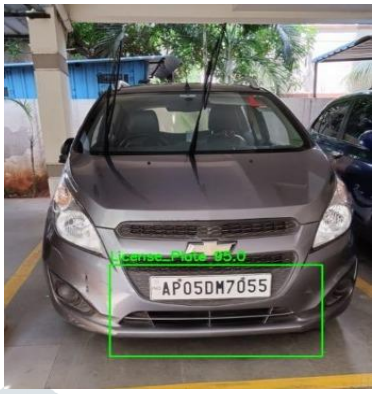


Fig.2

Fig.3

Fig.4

7. CONCLUSION

This paper gives information about the VNPD System algorithm based on template matching. The algorithm used improved Otsu's technique for threshold segregating. Measure modification between the characters was reduced by exploiting the correlation between the templates. A procedure is suggested to cope with measure modification by using template matching with Normalized Cross Correlation. It attained an accuracy of 98.07%. We have presented a new model for multi-directional car license plate detection. The suggested model can smartly solve the difficulty of multi-directional car license plate detection, and can also be organized easily in real-time circumstances, because of its reduced computational difficulty compared with previous CNN-based techniques. The introduction of an attention-like prepositive CNN model framework yields new state-of-the-art accuracy. In the future, a well-organized less time-consuming vehicle number plate detection technique is proposed which is executed on the multidimensional image. To eliminate the license plate, we remove connected mechanisms of less than 1000 pixels. Our anticipated algorithm is mainly based on the automobile number plate system. Abstraction of number plate accurateness may be improved for a low ambient light image. Our scheme could also integrate with other things like smart parking, retrieval of stolen cars, and inspecting drivers who over speed their vehicles on roads. There can be further development that can be done in the recognition phase by improving the dataset and also in the procedure of applying morphological procedures.

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