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Automatic Number Plate Recognition using YOLO for Indian Conditions

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Abstract—*Automatic Number Plate Recognition Solution (ANPR) is being used from very old days but the technology behind it remains unevolved. Previous systems which are used by the Government of India [1] do not provide a real time solution for the problem. Latest advancements in the field of computer vision and decline in the prices of GPU's make real time processing of such applications possible. Therefore it is possible to develop a real time Automatic Number Plate Recognition Solution.*

Keywords—Automatic Number Plate Recognition (ANPR), Optical Character Recognition (OCR), Template matching, Yolo algorithm, Deep Learning.

A. INTRODUCTION :

Even though now that we know that Automatic Number Plate Recognition(ANPR) is widely known but not used because of its usage of the old technology, we are proposing to develop an application to manage the visitors in the residential areas using the same technology with GPU centric algorithms. Now to train the system we are going to use GPU centric algorithms like YOLO to compete with different challenges we face while working with ANPR in countries like India. In India we face challenges like, the cameras used are mostly used for surveillance purposes and not for training and testing of deep learning models, the second challenge we face is that the number plate sizes and character patterns vary from different vehicles which really makes things complicated. But, by using GPU centric algorithms and using some good camera handling techniques we can achieve good accuracy to implement different applications like visitor management systems using computer vision technologies like Automatic Number Plate Recognition.

Visitor Management Systems helps the admin or the front desk officer to manage all the visitors visiting in that particular area in a day. For such applications, we can not actually manage the visitors but all the vehicles of the visitors with their number plate. Admin or the person working with the application can look for all the visitors stored at the end of the day.

B. EXISTING SYSTEMS:

To create a society without human intervention cars can be used as a Proof of Identity(PoI) and the unique registration plate number provides the opportunity to track the movement of cars in turn tracing humans that are associated with that car. This was identified in the past that is why tracing of cars is being used from as early as the 1980s. Advancements in computer vision techniques now allow us to do that automatically without human intervention.

'Feature based number plate localization' [2] is a technique that is used for number plate localization. This approach consists of a number of algorithms developed on the basis of general features of both, characters and number plate. For pre-processing, the input gray-scale image is adaptively converted into binary image using Ostu's method. A mask having the shape of inverted 'L' and size equal to maximum possible character dimensions is rolled throughout the binary image. At every increment a position is shortlisted as possible character location if there is at least a single white pixel in the region and there is at least a single white pixel on the immediate next row and column of the region. Size of each shortlisted character calculated. If it is less than half of the maximum possible character size that location discarded. Subsequently multiple detected portions are discarded using filters such as white pixel density, height and width and one final region is decided to recognise characters. If cases where the number plate script is not in english language or the number plate is barely visible are excluded then, 82% of the plates were recognized correctly which means in ideal conditions it was able to predict correct outcome only 82% times. The performances of individual sections are 87% for number plate localization and 85% for character recognition and 95% for character segmentation.

A SVM (Support Vector Machine) [1] which has been trained on a chosen data set for most of Indian number Plates. A detailed analysis has been done before making these SVM which is the first step to finalize if any of the regions in the video frame has a number plate or not and if it has it will select the exact plate which is containing the number. In this an image is first preprocessed i.e. it is converted from RGB to grayscale. After that segmentation is applied for detecting number plate location in the image. For that image is passed through a sobel edge detection filter to detect horizontal edges. Now the image applied to Otsu's threshold and binarised. After that morphological operations are performed on the image to detect probable number plate regions. All rectangular contours are selected and characters are segmented and recognised.

Most of the algorithms use features of number plates to localise the area of number but none them treats number plate as an object. We are trying to use object

detection algorithms which perform better on low end GPUs and provide less response time which will allow us to detect in real time.

C. PROPOSED SYSTEM

In other approaches images are first preprocessed and then number plate area is detected [5]. But in this case as we are using object detection algorithms to detect the number plate there is no need to use binarization and median filtering instead they will be used in character recognition step. The measure steps that are going to be followed are :

1. Number Plate Localization.
2. Character Recognition.

1. Number Plate Localization:

The very first step in the system we are trying to propose is to detect the number plates from the image we are passing. Consider the Number plate as an object and to recognise it we have to use different object detection algorithms. There are two different concepts which come into picture which are object classification and localization. Classification is nothing but classifying the type of object like a car, bike or a person and localization is locating where the particular object is in the image by drawing lets say a bounding box over it. Object detection is a combination of both classification and localization of the object in the image. The GPU centric, efficient algorithm we are proposing to use to detect the object area from the image is the YOLO algorithm(You Only Look Once) [3].

What is the YOLO algorithm ?

When YOLO came into the picture of Deep Learning Object detection algorithms, many algorithms were proposed to detect the object from the image but YOLO took a completely different approach. It was not the old classifier again produced to be an object detector. The fact that YOLO actually looked only once which the name shows and detected the object attracted many new deep learning developers. It actually looked only once but in a clever way.

The first version of YOLO was proposed in 2016 and the latest version of YOLO which is YOLOv4 was proposed in 2020 which we are going to talk about in this research paper.

YOLO object detector is faster and more accurate when we compare it with other traditional object detectors, it is trained on COCO dataset for training purposes and has one stage detector which makes it faster. As we know the modern object detectors require more GPUs for training and also they train with large mini batched size, and this is what makes them slow when we actually use them to train our models. Sometimes the training time is so high that it becomes impractical to use such models. YOLOv4 proposed this issue by making object detection possible using a single GPU and smaller mini batched size. Which makes it superfast to train with a single 1080Ti or 2080Ti GPU.

When the algorithm is pretty efficient but with countries like in India we should also take care that the images we are using should be better and help our algorithm to some extent to make accuracy of the overall model more. Some of the ideas which we can focus on to improve camera performance is to focus on different camera settings like the iris size, shutter speed of the camera, what is the angle of the camera and the position of the camera?. Some more things on which we can focus are the lightning conditions and type and size of lens.[7]

How does YOLO work?

YOLO first divides the image in 13*13 of which each cell detects five bounding boxes (the bounding box is the rectangle which encloses the object). YOLO gives a confidence score which shows how confident the algorithm is that the object to detect exists in the bounding box. The score doesn't tell the type of object but tells the confidence score if it is in that bounding box or not. Now we know there are n*n grid cells and each detects 5 bounding boxes, so total bounding boxes will be n*n*5 that is 185. For example there are 13*13 grid cells and each cell detects 5 bounding boxes so total bounding boxes becomes 13*13*5 which makes 845 bounding boxes. Now the beauty of the algorithm is that these total 845 boxes were predicted all at once as the name suggests “You Only Look Once”.

How YOLO is better than R-CNN?

R-CNN takes the huge amount of time to train the model, however YOLO takes comparatively very less amount of time to train the same model.R-CNN can’t be used for real time implementation of object detection as it takes 47 seconds for each test image but YOLO can be used real time very efficiently.

2. Character Recognition :

After detecting the number plate area it needs to be cropped from the video frame and feed forward to a character recognition network. Before that the cropped number plates need to be preprocessed to get a more accurate output. The preprocessing steps that are carried out are :

Step 1:First the image is converted into a grayscale image and Gaussian blur is applied to smooth out the image.

Figure 1 : Image after Gaussian blur

Step 2: Then the image is binarized using Otsu’s Thresholding [6] to get a more distinguished foreground and the background.

Figure 2 : Output after Thresholding

Step 3 : The image is dilated to increase the boldness or brightness of the characters [8].

Figure 3 : Output after Dilation

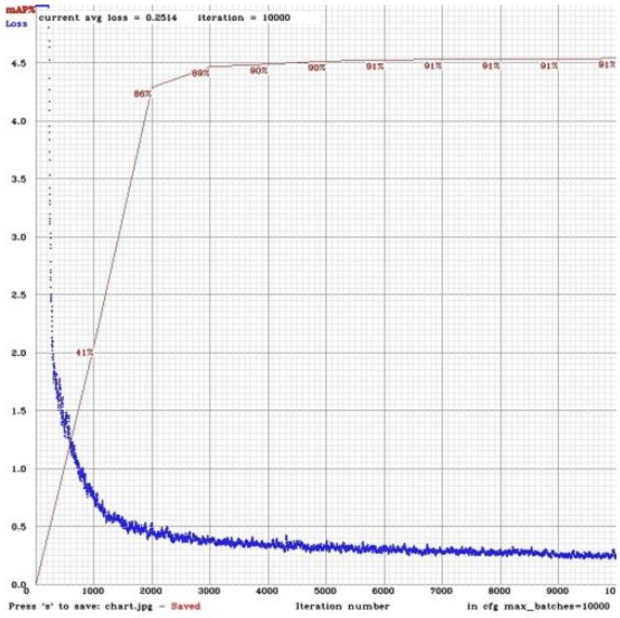
Step 4: Now the image is flipped and using OpenCV the contours are generated and characters are filtered on the basis of their height and area.

Figure 4

Step 5: The characters are now segmented and template matching or ANN is used to recognise the characters.

RESULTS

For training we collected the dataset from OpenImages and used Darknet YOLOv4 to train our custom object detection model for a single object i.e Number Plate. We trained the network for almost 18 hours on Google Colab's Tesla T4 GPU and here is the graph of loss and Mean Average Precision(mAP).



As you can see we got around 91% mAP which is comparable to the human eye. The accuracy of the model for normal conditions that we were testing was 98% to localize the number plate and it was detecting the number plate with more than 80% confidence that means. we can apply a threshold of 0.8 in applications to remove unwanted plates in frame.

Other than that what matters is the speed of the algorithm and we got astonishing results with that too. The model is detecting the number plate in around 30 - 40 milliseconds on images which is comparable to the latency of the human eye. While testing on videos we got around 12-13 FPS with the same mAP.

CONCLUSION

The Existing systems developed for ANPR do not make use of state of the art computer vision algorithms to detect plates that is why other technologies like RFID are being used on toll booths which require more investment than simply setting up a computer with GPU. These algorithms provide a very good accuracy which is comparable to RFID if cameras are placed in certain angles and right direction. We have tried this for YOLO but in future there will be other algorithms which will be better than it and can be used for real time surveillance and toll collection.

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