Multinational Automatic Vehicle License Plate Recognition System

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Abstract

Automatic Vehicle Number Plate Recognition is a key technique in most traffic-related applications and is an active research topic in the domain of image processing. Deep Multinational Automatic Vehicle Number Plate Recognition System is designed to be applicable to multinational license plates. Automatic number-plate recognition (ANPR) is a technology that uses optical character recognition (OCR) on images to read vehicle registration plates to create vehicle location data as well as time at that location. The process of identifying particular objects in an image plays a crucial part in the fields of Deep learning and computer vision or digital image processing. Vehicle plate detection and recognition appear in vast variety of applications from including travel time estimation, car counting on highways, traffic violations detection, speed calculation and surveillance applications. Also, the vehicle's license plate is the only trustworthy identity of a vehicle in Intelligent Transportation Systems (ITS) and correct vehicle identification depends highly on the accuracy of such ANPR systems. Because of recent developments of highway and the increased utilization of vehicles, significant interest has been paid towards the latest, effective, and precise intelligent transportation system (ITS).

Keywords: automatic license plate recognition; image processing; computervision; deep learning; machine learning; vehicle identification; neural networks; intelligent transportation system; object detection and tracking; recognition; optical character recognition, surveillance applications.

1. INTRODUCTION

Because of the mass integration of information technology in all aspects of modern life, there is a growing demand for information systems for data processing in different domains. Automatic Vehicle Number Plate Recognition isa key technique in most traffic related surveillance applications and is an active research topic in the domain of image processing. So as a result, various techniques and algorithms have been developed for license plate detection and recognition. In most of the cases, vehicles are identified by their number plate, which are easily readable by humans but not by the machines. For machines, a

registration number plate is just like a dark spot that is within a region of an imagewith a certain intensity and luminosity. Because of this, it is necessary to design a robust mathematical system able to perceive and extract what we want from the captured image like in this system we want to capture the vehicle's license plate.The design of these systems is one of the areas of research in areas such as Artificial Intelligence, Computer Vision, Pattern Recognition and Deep Learning's Neural Networks.

These systems require data to be captured or archived or by a human which is able to recognize vehicles by their number plates in real-time environment and reflect the realityin the information system. In this system we have manually made datasets to train the system. But in real time hardware will be used while it's application. The basic hardwareof these systems is a camera. We have relied on images of cars in which we can see theirnumber plates. The license plate recognition systems have two main points that are must to be considered that is the quality of license plate recognition software with recognition algorithms used and the quality of imaging technology, including camera and lighting.

The traffic monitoring cameras are mounted over 4 to 7 meters above the street level. Plate recognition range, where the cameras are able to capture the vehicles plates withsufficient resolution, starts from 20 to more than 50 meters away from the camera location.

The system's transformation between the real environment is perceived and information systems need to store and manage all that information. We have considered the maximumrecognition accuracy, to achieve faster processing speed, handling as many types of platesfrom different countries, manage the broadest range of image qualities and achieve maximum distortion tolerance of input data. In most countries, they use Arabic and English letters, plus their national logo. Thus, it makes the localization of plate number, the differentiation between Arabic and English letters and logos object and finally, the recognition of those characters become more challenging research task. The use of the artificial neural network has proved itself beneficial for plate recognition, but it has not been applied for plate detection. We have tried to build a solution that recognizes many places with uttermost clarity in any circumstances. With a varying distance and color combination of the license plates, it should work on vehicle.

In this system we have used Image preprocessing algorithm using Neural Network Tensorflow Object Detection (TFOD) zoo model i.e ssd_mobilenet_v2_coco for detectionof vehicle license plate, after that the number plate is located and extracted from the image. Segmentation of individual characters is present in plate and then Optical Character Recognition (OCR) for each image we segmented individual character. The output of the recognition of each character is processed as ASCII code associated with image of the character. This is achieved through Deep learning which segregates vehicles based on certain patterns found in the dataset. Once the data is classified, labelled groups will be created. The application will have a GUI interface to check the number of vehiclesviolating different traffic rules. By recognizing all successive images of the characters arecompletely read the license plate and save the result information in the form of document.

2. RELATED WORK

Automatic Number plate recognition (ANPR) is generally considered a solved problem inthe computer vision and image processing community. But most of the current works on ANPR are designed to work on license plates for specific country and use country specificinformation which limits their practical applicability. Such ANPR systems require changes in the algorithm to work on other countries license plates. Previous works on multinational license plates recognition are tested on datasets from various countries that share the same license plate layouts [2]. To overcome this issue, this study presents a deepMultinational Automatic Vehicle Number Plate Recognition System is designed to be

applicable to multinational license plates. The main reason is that the ANPR system recognizes the registered number plate with no additional transponder requirements, as compared to the Ultra High Frequency—Radio Frequency Identification (UHF-RFID) systems.[8]. The studies in [9] considered LPR as a sequence labeling problem making the character segmentation step unnecessary. The study in [9] proposed the use of a recurrent neural network (RNN) with long short-term memory (LSTM) and ConnectionistTemporal Classification (CTC) for LPR.

MOTIVATION

The main idea is to automate the whole system which reduces manual work. Law- enforcement agencies are increasingly looking out for Real-time technology Automated Number Plate System technologies so to enhance the enforcement and investigate the capabilities. Expansion of the relevant information and expedite the tedious and time - consuming process of manually comparing the vehicle license plate's number with the stolen vehicle's license plate numbers list. Not only stolen vehicle's but also scans license plates to detect high-risk offenders or organized criminal groups is one of a rangeof measures being considered to keep police safe. With everyday increase in number of vehicles on roads, the problems faced like identification of stolen cars, invalid license plates, usage of cars in illegal activities. The system captures the LP's, track the location,time, keep the images for future references without any human interval.

3 SYSTEM ARCHITECTURE

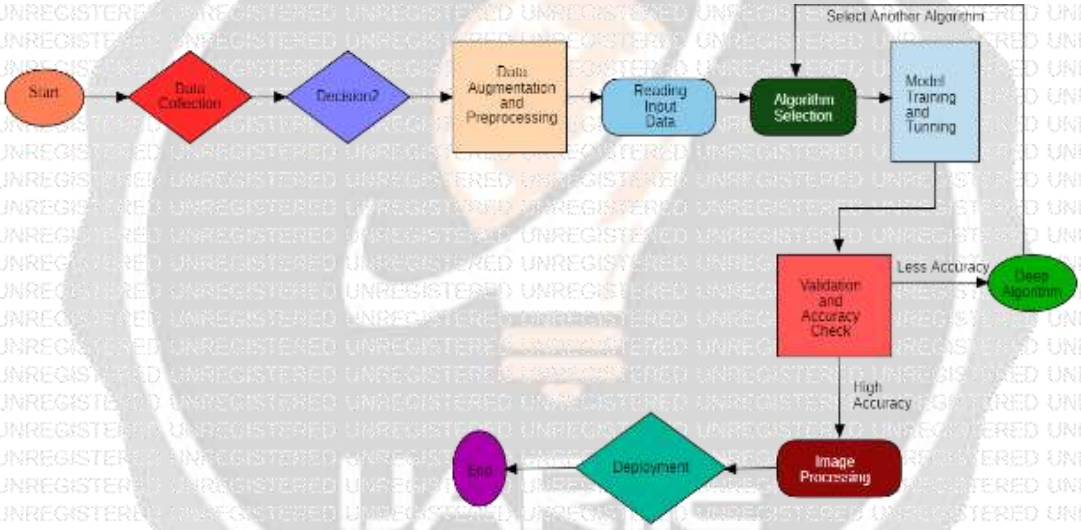

Fig 1: System Architecture

Text represented in figure 1:

1. Start
2. Data collection
3. Decision 2
4. Data augmentation and preprocessing
5. Reading input data
6. Algorithm selection
7. Model training and tuning
8. Validation and accuracy check
9. Deep algorithm
10. Image processing
11. Deployment
12. End

Data Collection -It is the process of collecting images from multiple sources like Google's Open image dataset, Kaggle, Shutterstock
Data Labelling - It is the process of annotating the objects present in the image so we can trainour model accordingly eg. Cars, taxis, Ambulance, etc.
Data Augmentation & Pre-processing - It is the process of applying some augmentation andpre-processing techniques like rotation, cropping, saturation and others which makes the images more generalized and provide more variations in images.
Model Training and Tuning – It is the process of algorithms and tuning the parameters of algorithm for getting better result. In this case, tuned model such that model learned high-level features specific to the dataset. This is usually recommended when the training dataset is large and very similar to the original dataset that the pre-trained model was trained on.
Validation & Accuracy Check –In this process accuracy of the model obtained is checked andvalidated on validation images.
Image Processing –In this process after getting high accuracy on validation images, image processing is applied on images and videos for using it in different use cases.
Deployment –Deployment of the model means integration of model into production environment which will take input and provide us output that can be used in real- time scenarios
System needs to store every request into database and we need to store in such a way that if we want to retrain a model it should be easy to retrain model with new data as well.

4 System Implementation

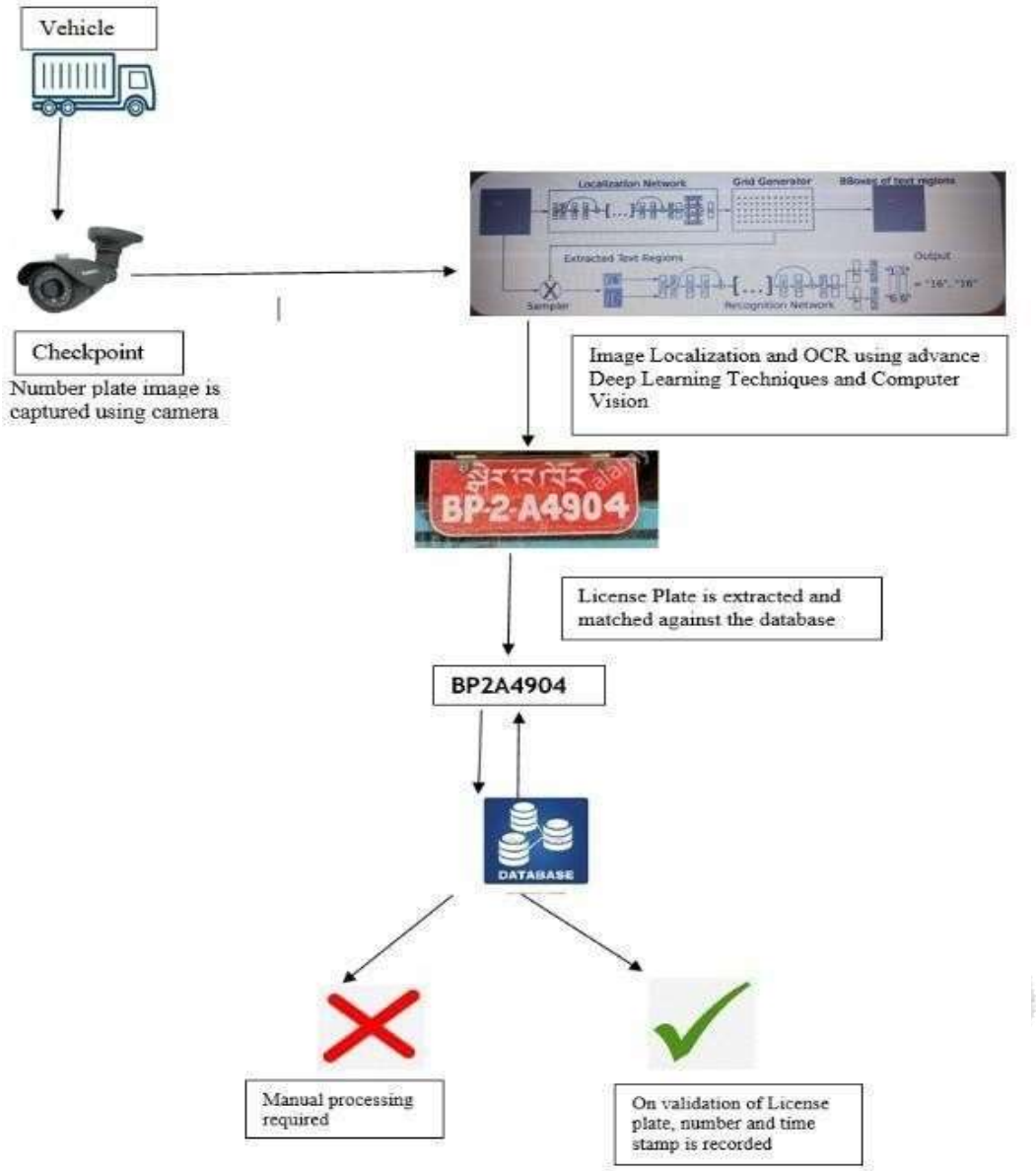

Fig 2: System Implementation

Text represented in figure 2:

1. Vehicle
2. Input through checkpoint captured using camera
3. Image localization and OCR using advance deep learning Technique andComputer Vision
4. License plate is extracted and matched against the database
5. Database
6. Manual Processing
7. On validation of license plate, number and time stamp is recorded.

4.1 SYSTEM IMPLEMENTATION EXPLANATION:

4.1.1 Dataset:

In this module, we discuss the dataset used for training and testing the model. Thedataset we used replicates the real-world scenarios. Images of License plates from different countries was collected. To make the model more robust to various input object sizes and shapes, each training image is randomly sampled by one of the following options: – Use the entire original input image, Sample a patch so that the minimum jaccard overlap with the objects is 0.1, 0.3, 0.5, 0.7, or 0.9., Randomly sample a patch

4.1.2 Data Preprocessing:

In this module, we discuss preprocessing of images. There are two types of preprocessing. First one is extracting frames from the video and the other one is the annotations of images. Image annotation means label the features we need the system torecognize. Image annotations is important step for datasets as it lets the training model know that important parts of images, then it uses that information and applies the same information to the testing images. Images of License plates from different countries wascollected. This is the data that feed into your custom object detection model later.

Models based on the TensorFlow object detection API need a special format for all input data, called TFRecord. Our goal at this step is to transform eachof your datasets (training, validation and testing) into the TFrecord format. And according to the images xml files were created for every license plate with dimensions. So Images are annotated in the xml file for object detection. These images were split intoTrain(80%) and test(20%) records.

A Label Map is a simple .txt file (.pbtxt to be exact). It links labels to some integer values. The TensorFlow Object Detection API needs this file for training anddetection purposes. Manually labelling the input data so that the deep learning algorithm can eventually learn to make the predictions on its own.

4.1.3 Model Selection, Configuration and Training:

Tensorflow 2 Detection Model Zoo which consist of set of different pretrained models on coco 2017 dataset. They are also useful for initializing your models whentraining on the novel dataset. From this SSD algorithm is used. For Model Configuration we have a different number of objects classes to detect, the objects wetry to detect might be completely different from what a pre- trained model was supposed to detect, probably have less computational power to train a model, and this also should be taken into account, so this is why we need to configure the model. Model configuration is a process that lets us tailor model-related artifacts e.g.

hyperparameters, loss function, etc so that it can be trained (fine- tuned) to tackle detection for the objects.

SSD (Single Shot MultiBox Detector) :

Popular algorithm in object detection. It's generally faster than Faster RCNN. The SSD architecture is a single convolution network that learns to predict bounding boxlocations and classify these locations within one pass. So for tracking the license plate of vehicles this algorithm is best suited as it can capture image of vehicle passing with single shot.
The SSD network consists of base architecture followed by several convolution layers. By using SSD, we only need to take one single shot to detect multiple objectswithin a image, while regional proposal network (RPN) based approaches such as R-CNN series that need to take two shots, one for generating region proposals, one for detecting the object of each proposal.
Thus, SSD is much faster compared with two-shot RPN-based approaches. Compared with Faster RCNN,it has a clear speed advantage and it it has YOLOobvious mAP advantage. Features of SSD algorithm:

1. Inherited the idea of converting detection to regression from YOLO and completed network training at one time.
2. Based on anchor in Faster RCNN,a similar priority box is proposed.
3. Adding a detection method based on the Pyramidal Feature Hierarchy, whichis equivalent to half a FPN idea

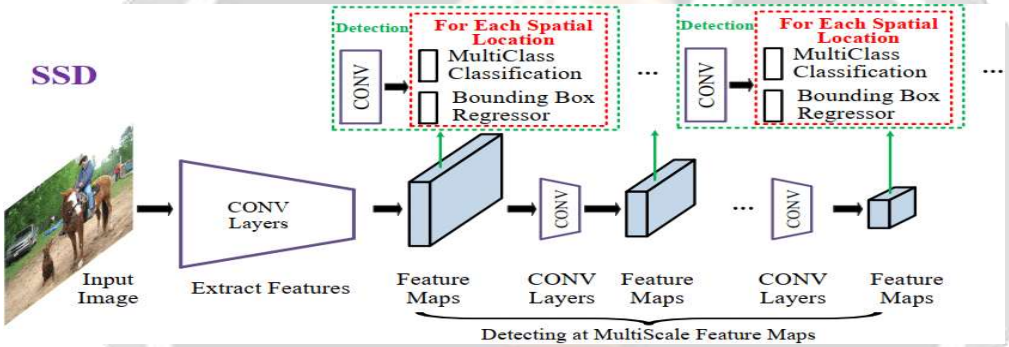

Fig 3: SSD Architecture

4.1.4 Localization of license plate:

License Plate image varies as the rule of a plate and the impact of the lighting platform.As the binary model which has global threshold is not capable of producing convinced outcome from adaptive local binary technique has been employed. The local binary techniques are referred to as an image would be classified into m × n blocks, and everyblock is computed using binary model.
The SSD training objective is derived from the MultiBox objective but is extended to handle multiple object categories. Let x^p ij= {1, 0} be an indicator for matching the i-th default box to the j-th ground truth box of category p. In the matching strategy above, we can have summation of i x^ p ij
≥ 1. The overall objective loss function is a weighted sum of the localization loss (loc)and the confidence loss (conf):

$$L(x, c, l, g) = \frac{1}{N}(L_{conf}(x, c) + \alpha L_{loc}(x, l, g))$$

where N is the number of matched default boxes. If N = 0, wet set the loss to 0. The localization loss is a Smooth L1 loss between the predicted box (l) and the ground truthbox (g) parameters.

4.1.5 Text Detection:

Here EasyOCR is used which is actually a python package that holds PyTorch as a backend handler. It is the most straightforward way to detect text from images also when high end deep learning library (PyTorch) is supporting it in the backend which makes it accuracy more credible. EasyOCR supports 42+ languages fordetection purposes.

4.1.6 KPI's (Key Performance Indicators):

1. Time and workload reduction using the UGV based surveillance,
2. On time alert to nearest hospital on medical emergency (accident),
3. Get the exact location of vehicle

5 APPLICATION AREAS

1. Identifying the vehicles which violate the traffic rules.
2. Identifying Emergency Response vehicles and doing special provisions
3. Restricting the parking in offices and homes to only registered vehicles.
4. Automatic toll deduction on toll booths.
5. Identifying and logging the vehicles moving in and out of factories and warehouses.

6 CONCLUSION AND FUTURE SCOPE

6.1 Conclusion:

Intelligence caters to machine learning and deep learning solutions and Vision caters to image and video analytic solution. In this project we have proposed the end- to-end delivery of AI solution for multinational vehicle plate recognition. This can further be used to analyze the number of vehicles crossing above speed limit and fall under vehiclesto be fined. A good image preprocessing almost guarantees a successful recognition. Our main aim is to focuses on Cropping of the images as per ids and store them temporarily instack. Through the stored images we used Google-Optical Character Recognition (OCR) technique to read each and every number of the no. plate and keep it in a Proper database with respective current time-stamp. The System will analyze the incident based on the data trained using our algorithm. We can identify the incident and transmit the information, so that concerned authority can take necessary action in order to control the situation.

6.2 Future scope:

1. Future work may include improving the robustness. By using the highly qualifiedcamera, they operate the operation to urge more accurate results.
2. Speed Detection: It Can detect speed of a vehicle. Will be able to recognize betweennormal speed and overspeed of vehicle.

3. Various Character Detection It can detect various characters and symbols of differentstyles and fonts number plate.
4. Alert System: A message or alert will be sent to admin and registered mobile number ofthe vehicle owner for over-speeding or for use of inappropriate design and characters of number plate. Such kind of data will be added to the record and will be stored in database for future references.
5. KPI's (Key Performance Indicators) can be improved to show more details.

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