Intelligent vehicle license plate recognition by deploying deep learning model for smart cities

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Abstract— According to surveys, almost 3.5 lakh road accidents have taken place in India within a year in 2020. Almost 1.4 lakh people have died due to road accidents. The major cause of road accidents in India is over speeding. The population of India makes it difficult for the police to monitor every single vehicle that breaches the traffic rules. Many solutions have been proposed to maintain traffic and make the drivers and pedestrians follow the traffic rules, especially the speed limit. Yet, the drivers don't seem to obey the rules and stay within the speed limit at the places which were not monitored by police or other humans. To resolve this issue, this research aims the development of a deep learning model which is capable of predicting the registration number of a certain vehicle in the road and this reach helps to turn the normal city into a smart city. By applying the model in real life, the vehicles which involve in traffic crimes a repeated number of times can be identified and the driving license of the driver can be blocked. This deep learning model is constructed using the convolutional neural network theory and is very easy to test and train. The model is then trained again and again to reach a higher precision. The efficiency of the model is also tested sometimes to ensure the efficiency is high. The efficiency of the model is monitored using three parameters named recall, precision, mean average precision.

Keywords— Image processing, number plate detection, YOLO algorithm, OCR, deep learning

I. INTRODUCTION

Computer vision is part of artificial intelligence which allows the users to extract important information or data from images without any human verification. The process of computer vision is achieved through deep learning and machine learning algorithms. Out of both techniques, deep learning is said to be the most efficient technique as it is more accurate, speeder and it can produce less error rate. There are multiple applications of computer vision. One of its applications is number plate recognition from the images of vehicles and even moving video. This research aims at the construction of a deep learning model using convolutional neural networking and the YOLO algorithm. This deep learning model is used to detect the number plate present in the image of the vehicle. The clipped image of the number plate is then given as an input to tesseract. A tesseract is software that is used for optical character recognition. This technique extracts the registration number from the image and converts it into text. In India, the number of road accidents keeps on increasing and it never reduces. This increases the pressure given to the police department. This method can be very useful for the police to maintain law and order in terms of vehicles. As the registration number of vehicles can be recognized on the go, it can be easier for the police department in identifying the vehicles that involve in malpractices.

II. LITERATURE SURVEY

According to the annual report of the National Crime Records Bureau (NCRB), India had 3,54,796 instances of road accidents in 2020, with 1,33,201 persons killed and 3,35,201 wounded. Over speeding was found to be the cause of more than 60% of road accidents, accounting for 75,333 deaths and 2,09,736 injuries, according to government data. According to the research, Uttar Pradesh had the most railway crossing incidents (380 out of 1,014 total), accounting for 37.5 percent of all such accidents. Bihar and Madhya Pradesh came in second and third, respectively, on this list [1]. Road traffic accidents are responsible for a significant portion of the world's deaths and diseases, particularly in developing and underdeveloped countries and regions. With the assistance of medical professionals and other like-minded social members of the community, advocates for efforts to prevent injuries following an accident can develop a formidable lobbying force. When the Indian Orthopedic Association filed a "Public Interest Litigation," or PIL, against the government of India in 2012, it brought this severe issue to the public's attention. On-road safety, according to the Indian Supreme Court, the country's current legislative framework is insufficient. Advocacy like this seeks to win support in a hostile environment to bring about the required change for the better [2].

The article discusses traffic infraction detection, which is a hot area in which existing systems are being automated. The traffic will be recorded using CCTV cameras, and the system will then detect any violations. The machine's input, which may be records gathered from Surveillance cameras, is optimized using a genetic algorithm. Background removal is the following step, which enables the user to use those frames as inputs and extract photos foreground for similar processing. In the following phase, we may use a genetic set of rules to assist us to assess whether or not a violation has occurred. The authors' major goal is to do this by developing an Evolutionary algorithm that improves the input algorithm by employing genetic principles to generate the "fittest" algorithm [3]. Number plate identification using image processing techniques, also known as License Plate realization or recognition, is an attractive topic of research in the fields of smart cities and the Internet of Things. The current designs are also based on UK license plates, which may not be ideal for Indian license plates, according to the designers. This study describes an image processing strategy for detecting and recognizing Indian number plates that is capable of dealing with noisy, low-illuminated, cross-angled, non-standard font plates, as well as low-illuminated, cross-angled, non-standard font plates. After the region of interest has been filtered and de-skewered, the K-nearest neighbor technique is employed to identify the characters of interest. There have been encouraging findings for researchers who have used these strategies [4].

Fruit loading and packing are labor-intensive operations during post-harvest marketing, with one of the most important difficulties being the capacity to detect and adjust fruit posture in real-time. In this work, the YOLO-v5 deep learning algorithm was used to evaluate the real-time detection of an apple's calyx or stem using a photo capture system based on fruit posture adjustment equipment, with the results showing that it was successful. Exceptionally, except for Faster R-CNN, this method beats preceding one-stage object recognition methods in terms of detection accuracy and speed. The upgraded YOLO-v5s achieved a 93.89 percent accuracy rate in the identification of fruit stems and calyxes for a wide range of apple cultivars and types. The improved approach might enable low-cost real-time detection under CPU conditions, laying the groundwork for automated fruit loading and packing systems. [5]. When it comes to the contribution of a person's notional visual field, their effective receptive field is the determining variable. That is why we are attempting to lower the number of variables while simultaneously expanding the size of the receptive field. In the course of this endeavour, a more effective receptive field (ERF-YOLO algorithm) was developed. Training and testing portions of the experiment were conducted using the PASCAL and MS COCO data sets. The ERF-YOLO parameter, according to experimental evidence, is approximately half the size of the v4 parameter in most situations. The ERF -YOLO algorithm outperforms some well-known detection approaches [6]. They proposed an OCR system in this study that identifies the contents of handwritten handouts. They reasoned that because the target handouts contain a combination of Japanese and mathematical formulae, a single sort of OCR system would not be accurate enough. As a result, they contemplated integrating two types of OCR systems in their suggested system. Nevertheless, if the suggested system can categorize handwritten contents by future learning, etc., it will be possible to rapidly analyze the handwritten contents, and the handouts will be enhanced, as well as feedback to the lesson plan. To create decisions only based on OCR scores, however, much improvement is necessary at this time [7]. The Devanagari script is the foundation for several Indian language scripts. Manual methods are being phased out in favor of automated ones as computers and technology advance. The purpose of this research is to use an automated approach to replace the current human system for digitization of Devanagari script in helps to save time and preserve historical data. In contrast to Western languages like English, Devanagari is a popular script in India that lacks institutional digitizing methods. This study employs the best tactics for increasing recognition rates and sets up a Convolutional Neural Network for successful recognition of handwritten Devanagari text. This strategy produces positive outcomes in terms of accuracy and training length [8].

III. MATERIALS AND METHODS

A Github repository [9] consisting of two separate folders named to test and train is found. These folders contain images of Indian cars with number plates which will be used for both testing and training the deep learning model which will be used to detect the registration number of the vehicle. A deep learning model is designed using the YOLO algorithm or the You Only Look Once algorithm. The YOLO algorithm is used to detect the presence of the number plate from the images. The detected number plate is then converted into text using a character recognition algorithm named Tesseract. For this purpose, 154 images were used to train the model and 34 images are used to test the trained model. The whole process of number plate recognition to the conversion of the registration number to text is pictorially represented in figure 1.

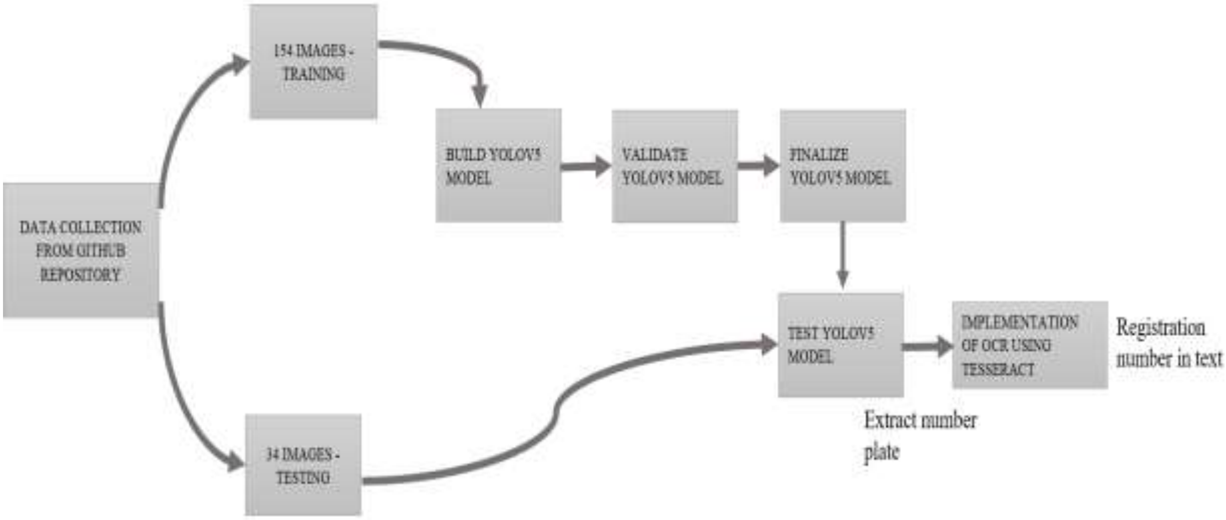

Figure 1. The architecture of the number plate detection process

IV. YOLOV5 ALGORITHM

The word YOLOv5 is an acronym for You Only Look Once Version 5. As the name states, the algorithm scans the image just once for detecting a particular object and gets it done in the first try itself. The algorithm which is used in this research is the fifth version of the YOLO algorithm which was released in the year 2020. This version of the algorithm is written by Glenn Jocher. The YOLO algorithm is developed using the Convolutional Neural Network theory of deep learning. The Convolutional Neural Network is a Deep Learning system that can take an image as input, assign meaning to various objects or elements of the picture, and then differentiate between them. The Visual Cortex's organization is comparable to the connective theory of neurons in the human brain, and the CNN algorithm is based on it. The CNN approach can categorize pictures in several convolutional layers, reducing the number of deep learning models required to complete a job [10]. The YOLOv5 algorithm is said to be one of the fastest object detection algorithms as it can predict real-time objects along with the objects from still images. The YOLO algorithm can be easily modified to a way it can detect the required objects from the images with higher accuracy and minimal error rate. Unlike classifier-based approaches, the algorithm is trained on a loss function that explicitly correlates to recognition accuracy, and the complete model is learned concurrently. The You Only Look Once the algorithm has a stronger generalizing representation of objects than other models, which makes it appropriate for applications that need quick and reliable object recognition [11]. The construction and working of the YOLO are as follows.

The YOLO algorithm divides the images into various grids named residual blocks. The dimension of the blocks varies according to the requirement of the user. Each block is then converted into a bounding box by outlining the residual blocks. Each bounding box consists of two parameters named width (BW) and height (BH). The YOLO algorithm uses a single bounding box for the prediction of objects. Once all the bounding boxes are chosen from an image, the image is checked for intersections over unions to prevent the overlapping of the bounding boxes. The final decision aka the presence of the object from the image is chosen from the integration of all three steps namely the residual blocking, bounding boxes, and the intersection of unions. In this research, the images are scanned for residual blocks at first. The residual blocks are then bounded if a number plate is detected. When a number plate is detected, the number plate is bounded as a box using the outlining as shown in figure 2.

Figure 2. Box bounded using YOLO

As shown in figure 2, the number plate alone is then displayed as a final output of the YOLOv5 algorithm. The image consisting of just the number plate is then sent to the tesseract software for the conversion of the image into text.

V. OCR And Tesseract

Optical character recognition or the OCR is another application of computer vision that can be used to recognize text from images and to convert it into text. The OCR technique is even capable of converting handwritten images into text format. This technique is often used by self-driving cars and automated vehicles to read and analyze road signs. This technique enables the system to identify text on its own. It's like a human body's sight and intellect together. Although the eye can see the words from the pictures, it is the brain that analyses and understands the extracted text. The suggested method corrects text extracted from camera-captured pictures. The handwritten characters are recognized and converted into digital text using an OCR technique devised by Thomas Deselaers [12]. Tesseract is free and open-source software that can be used for optical character recognition. Tesseract is extremely versatile and can handle a broad range of languages, including vertical text. Tesseracts can work on multiple languages of the world. It is more concerned with reducing rejection than with accuracy. Currently, Tesseract is developed and maintained by Google. It also supports a wide range of languages. Much other software like Adobe acrobat, Omnipage ultimate, etc. is used for optical character recognition. But for this research, the tesseract is used and the working architecture of tesseract is explained below. The output image from the YOLOv5 algorithm is given as an input to tesseract. The input image is converted into a binary image using a technique called adaptive thresholding. Adaptive thresholding allows the software to predict the characters with higher accuracy. The outlines of the characters are traced using connected component analysis and the traced characters are connected to form a word. The formed word is then analyzed twice to make sure the word is predicted correctly. The predicted word is then sent as an output from tesseract. In this case, the registration number of the vehicle which was extracted from the image of the car is sent as an output [13].

VI. Result And Discussion

The images of the Indian cars are collected from a GitHub repository and are used to test and train the model. A deep learning model was developed using the YOLO algorithm and the convolutional neural networks. This algorithm clips the image of the car and sends the image of the number plate alone as output. The tesseract software is then used to employ a computer vision application named optical character recognition to convert the registration number of the car from the image to text. For this purpose, 154 images were used to train the model and 34 images are used to test the trained model. The precision and the recall value along with the mean average precision of the YOLO algorithm during every epoch is shown in figure 3.

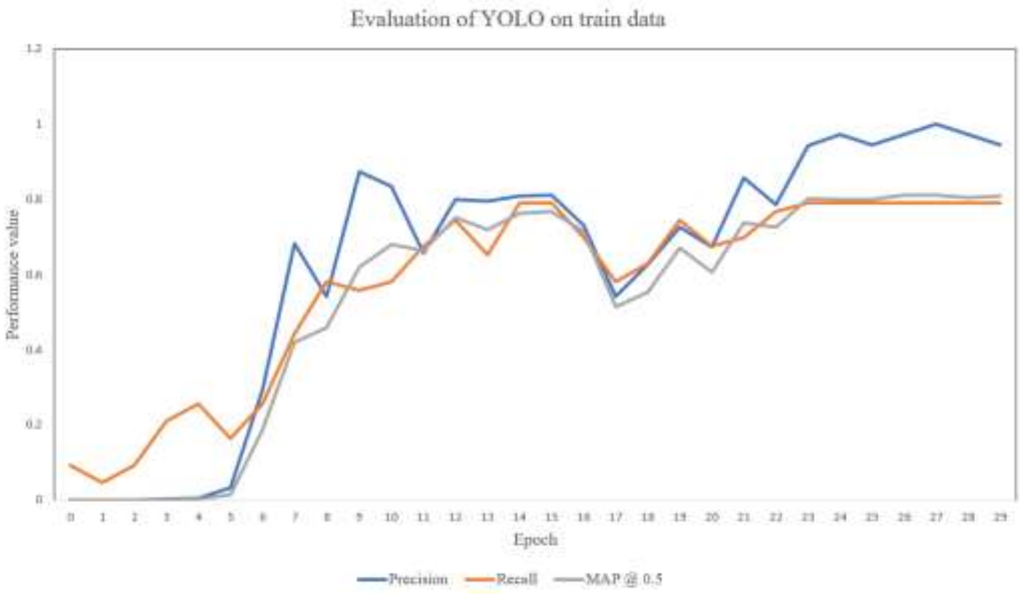

Figure 3. Evaluation of training of YOLO algorithm

From figure 3, it can be seen that the precision, recall, and mean average precision of the model is close to zero in the first epoch. But as the number of epoch increases, the recall value is increased but the precision and the mean average precision remains zero till the fourth epoch. Then the value of precision and MAP also gets increased after the fourth epoch and keeps on increasing. In the end, the precision of the algorithm is close to 1 which is ideal for an object detection algorithm, and the recall and the MAP value reach 0.8 by the thirtieth epoch. The trained algorithm is then tested for higher precision, recall, and MAP value. The below table tabulates the results of the testing of the YOLO algorithm and the OCR technique.

Parameter	Test Data 1	Test Data 2
Original Image		
Yolo5 detected name pate		
Character Recognisation using Tesseract	Detected number : HR 26 BC 5514	Detected number : MH 20 EJ 0364

Figure 4. Testing of the YOLO algorithm and the OCR technique

Though 34 images were used for testing the model, the outputs of two instances are mentioned in figure 4. From the figure, it can be seen that the YOLOv5 algorithm can detect the presence of the number plate with higher accuracy even when the plate is tilted as shown in test data 2. The tesseract also performs efficiently and converts the image of the registration number to text.

VII. CONCLUSION

A dataset consisting of almost 188 images is obtained from the GitHub repository. This dataset consists of images of Indian cars with their number plates. The YOLO method and convolutional neural networks were used to create a deep learning model. The picture of the automobile is clipped in this technique, and just the image of the number plate is sent as output. The result is then transferred to the tesseract program, which converts the vehicle's registration number into text. The combination of both YOLO and OPC is trained about thirty times to increase three parameters named the precision, recall, mean average precision. By the end of the thirtieth epoch, it is found that the precision has reached its maximum. This research can be developed further in the future by adding modifying it in such a way that it is capable of recognizing the over speeding vehicles. Unmanned roads can be monitored using CCTV cameras and the footage from the camera can be filtered through the deep learning model and the vehicles that cross the speed limit can be found with higher precision. If a certain vehicle crosses the speed limit many times, the vehicle can be blacklisted or the driving license of the driver can be evoked.

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