TRAFFIC SIGN DETECTION USING DEEP LEARNING

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ABSTRACT

For autonomous driving systems, classifying traffic signs is a crucial task. Traffic signs vary greatly in appearance depending on the nation, which makes it more difficult for classification systems to be successful. A larger collection of images should be used, or the classifier should be improved. Advanced Driver Assistance Systems (ADAS) and Intelligent Autonomous Vehicles (IV) are currently used to address the issue of traffic sign recognition. Due to the various and intricate situations they are put in, it is a difficult real-world computer vision problem. Images are grouped into categories like highway signs, speed signs, danger signs, etc. after being categorized. b In this project, we propose to investigate the YOLO Architecture and its compatibility in order to solve this problem. The goal is to find and classify traffic signs in natural street scenes. The main challenge in this problem is recognizing minute targets in a large and complex image background. Other object detection models, such as Fast RCNN and Faster R-CNN, have been used to solve this problem. The main disadvantage of such methods is their slowness - they are not real time. Thus, the motivation for Investigating YOLO for this task is speed - it is about 6 faster than faster R-CNN. In this paper, we also propose a novel Modified loss function for the YOLO model to improve its performance in traffic sign detection.

Keyword : - *Deep Learning, R-CNN, YOLO, Intelligent Autonomous Vehicles, Graphics Processing Units*

1. Introduction

There is a high industrial potential for driver assistance and intelligent autonomous vehicle systems that recognise traffic signs. Without correctly applying and maintaining road traffic signs, traffic signals, and road markings, Improvements in traffic quality and safety cannot be made. Recognizing traffic signal signs is crucial to the ITS (Intelligent Transport System). 20 to 40 million people are injured and 1.3 million people are killed on the world's roads each year. The inability of the driver to interpret and process all of the visual information they received while driving is the primary factor for most of the accidents. In addition, the significantly increased number of hazards on the road makes it more imperative for drivers to obey traffic signs. There are numerous new traffic signs that have been put in place in response to the need to Assist drivers. For the sake of traffic safety, drivers must become proficient at reading all traffic signs. For instance, drivers must process the knowledge of pedestrian signs, cyclist signs, obligatory signs, and advisory signs because failure to do so could result in accident hazards. A Traffic sign detection system could solve the problem by using photos taken by cameras or imaging sensors to detect and identify traffic signs, showing the user what traffic laws are in effect along that section of road. Traffic congestion can make it difficult for drivers to see traffic signs, which increases the risk of accidents. In these circumstances, the Traffic sign detection system is utilized. Traffic sign detection techniques generally use manually selected features to generate region proposals, and classifiers are then trained to filter out the negatives. Image recognition uses deep convolutional networks and object detection because they provide the desired results in terms of speed and accuracy. Convolutional neural networks do not require any handcrafted features because they learn generalized Features inherently. The test time latency is one of the most crucial elements in Real-time traffic sign identification. Because of their intricate processing, CNNs were not thought to be practical for real time traffic sign identification. However, due to the great computing performance of GPUs (Graphics Processing Units), CNNs can now be used for this purpose. We need a model that can recognize and categorize the indicators in real time. In this study, we investigate the YOLO architecture, which can identify objects in real time and classify them at a frame rate of about 45 frames per second. This would be ideal for our issue because it calls for high speed and accuracy.

The benefit of the "You Only Look Once" (YOLO) model as a typical representative of the end-to-end detection model is its ability to predict the categories of objects and generate the bounding boxes simultaneously, which significantly improves the detection. Efficient and capable of performing detection tasks with demanding real-time specifications. The performance of YOLO series models has steadily improved thanks to researchers' ongoing improvements. To increase detection accuracy, YOLOv2 introduces batch normalization. In order to increase the detection accuracy while maintaining a high detection speed, YOLOv3 thoroughly refines the feature extraction network and makes use of multiple scale fusion methods [16]. In order to achieve new levels of detection accuracy and speed, YOLOv4 combines the cross stage partial network (CSPNet) in the backbone part with the spatial pyramid pooling (SPP) and the path aggregation network (PANet) in the neck part.

2. Literature Survey

In 1987, Akatsuka and Imai conducted an initial study on traffic sign recognition and attempted to create a very simple system. A system that can automatically recognize traffic signs and be used to inform vehicles of certain restrictions, dangers from speeding, or construction site activity. It can be used to automatically recognize particular traffic signs. Typically, a traffic sign recognition system's process is split into two steps:

1.Detection

2.Categorization

3. Methodology

3.1 Initial Analysis

When designing the system for detecting and classifying traffic signs, it was necessary to divide the task into multiple smaller tasks which could be tackled independently. The plan is to use 2 neural networks. The first neural network would detect the presence of traffic signs in images captured by the on-board camera. If a traffic sign is detected, the algorithm would also provide the bounding box for the sign. This information is then sent to the second neural network which classifies the detected traffic sign.

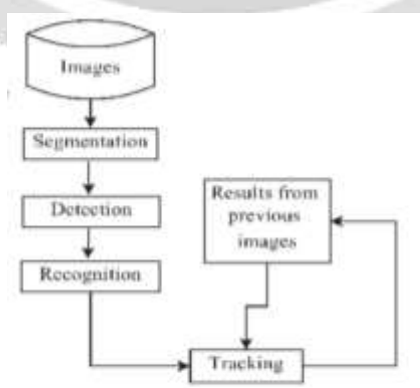

Figure – 1 Initial Methodology

3.2 Proposed Methodology

The YOLO models are end-to-end deep learning models that are preferred due to their speed and accuracy of detection. A YOLO network has a structure similar to a normal CNN, with several convolutional and max-pooling layers leading to two fully connected layers. YOLO takes a very unique approach in that it uses a single neural network to look at the entire image only once, giving it several advantages over classifier-based systems. It uses features from the entire image to predict each bounding box.

As shown in figure, the YOLO model divides the input image into S×S grids. Each grid cell predicts k bounding boxes, bounding box confidence values, and C conditional class probabilities [14]. The confidence score indicates how certain the model is about the object in the box as well as the accuracy of the box it predicts. Each bounding box predicts five values: x, y, w, h, and confidence. The (x, y) coordinates represents the centre offset of the box with respect to the grid cell boundaries. The w and h values are predicted width and height for the entire image. Prediction with confidence (cfd) is defined as Pr(Object) ∗ IOUtruth. The value of Pr(Object) is 1 when a grid cell contains a portion of a ground truth box, Otherwise it is 0. IOU stands for the intersection over the union between the ground truth box and the predicted bounding box. In order to make global predictions of a traffic sign in the image, we use these predictions to calculate the class-specific confidence score of each bounding box and then choose the bounding boxes with the highest confidence scores in each grid cell.

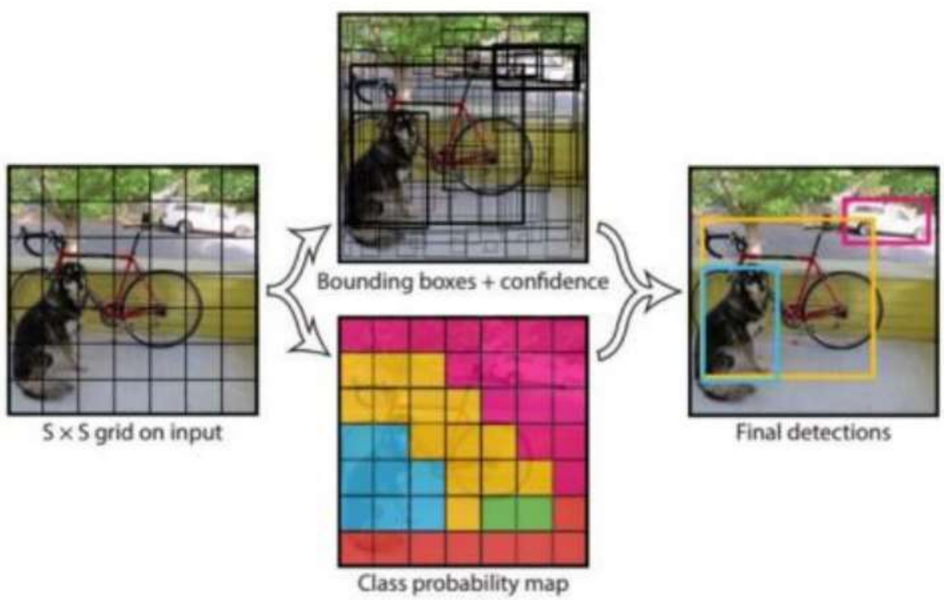

Figure -2 Proposed Methodology

4. Challenges

A challenging task is developing a Traffic sign detection system because the environment and lighting are constantly changing. The recognition of tiny targets in a large and complex image background is the main key challenge. Other problems, such as partial obscuring, multiple traffic signs appearing at once, and blurring and fading of old traffic signs, need to be addressed in order to prevent problems with detection. A quick algorithm is needed to apply the TSDR (Traffic Sign Detection System) in a real Time setting, such as in autonomous vehicles. A recognition system should also address the problem of errors in non-sign recognition. Because of the various and complex scenarios they are placed in, it is a difficult real-world computer vision problem. The YOLO model takes up more computing resources as the number of network layers deepens, and the resulting latency problem directly affects the timeliness of detection. Meanwhile, the location of traffic signs in the input image is variable, and the size changes quite frequently. The detection model is often sensitive to the resolution of the target, and the small size object only carries a limited number of Pixels; thus, the detection performance fluctuates greatly. Furthermore, the performance of the detection model is extremely dependent on the hardware environment. Full-size models are difficult To directly deploy in real-world scenarios, while lightweight models have limited accuracy and cannot meet the basic requirements of some detection tasks. Therefore, finding a suitable balance between performance and efficiency becomes quite a daunting mission.

5. Future Enhancements

There are always methods to make research even better, as with any discipline. The list of potential upgrades that have been identified and could be implemented in the future is provided below. 1. Mainly, the dataset that could be trained can be updated and improved. With larger datasets, better results can be achieved and classification accuracy can be enhanced. 2. A filtering algorithm could be added after the machine learning Detection as an additional benefit. Before stating that a traffic sign had been detected, it would look for several instances of the same sign. The accuracy of Detection and categorization would rise a result. One more field where capturing could be made more precisely is by fitting a camera Balancer with a gyroscope could further enhance the outcomes of detection and classification.

6. Conclusion

Contributions to the current state of-the-art Traffic Sign Detection and Recognition system were presented in this study. We hope that through working on this research, we can get a better understanding of the principles that underlie automatic traffic sign recognition, making both drivers and autonomous vehicles safer on the roads. We also study how different components of image processing and computer vision are applied in the algorithms used to produce desired results. Future research on this subject will be done to create a fully functional traffic sign detection and recognition system

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