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Traffic Sign Detection and Recognition Using Yolov5 and GTSRB Dataset

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ABSTRACT

Traffic sign detection and recognition play a vital role in road safety and traffic management systems. In this project, we present a real-time solution for traffic sign detection and recognition using the YOLOv5 object detection algorithm. Our objective is to accurately detect and classify various types of traffic signs, such as stop signs, speed limit signs, and yield signs, in different environmental conditions.

We begin by preparing a large datasets of annotated traffic sign images, which is used to train the YOLOv5 model. The model is fine-tuned on the datasets to enhance its accuracy and generalization capabilities. Real-time testing is performed by feeding video streams from a camera into the trained model, allowing for efficient and rapid traffic sign detection and recognition.The proposed system has diverse practical applications, including its potential integration into autonomous driving systems and traffic surveillance systems. By accurately detecting and recognizing traffic signs in real-time, our system can enhance road safety, minimize accidents caused by driver error, and improve overall traffic flow.Overall, this project showcases the power of YOLOv5 as an effective and efficient solution for traffic sign detection and recognition, contributing to the development of intelligent transportation systems and making our roads safer and more efficient.

Keywords :Traffic sign detection, Object detection, YOLOv5, Deep learning, Computer vision .

I. INTRODUCTION

The detection and recognition of traffic signs are crucial tasks in the realm of intelligent transportation systems and computer vision. This project focuses on the development of a real-time system that can accurately detect and recognize traffic signs using the YOLOv5 object detection algorithm.Traffic signs serve as critical visual cues on roads, providing essential information and instructions to drivers. However, ensuring their proper detection and recognition is challenging due to varying environmental conditions, diverse sign types, and the need for real-time processing.

To address these challenges, we employ the YOLOv5 algorithm, a state-of-the-art deep learning-based object detection method. YOLOv5 leverages convolutional neural networks to detect and classify objects rapidly and accurately. By training the model on a vast datasets of annotated traffic sign images, it can learn to identify different sign types, regardless of variations in shape, color, and size.The proposed system operates in real-time, making it suitable for integration into traffic surveillance systems or autonomous driving technologies. It provides quick and accurate detection and recognition of traffic signs, contributing to road safety and optimized traffic management.The project encompasses several key steps, starting with the collection and preparation of a comprehensive datasets comprising annotated traffic sign images. Next, the YOLOv5 model is trained on this datasets, enabling it to learn intricate features and patterns associated with various sign types. Subsequently, real-time testing is performed by feeding video streams from a camera into the trained model, enabling the detection and recognition of traffic signs in a dynamic environment.To refine the system's performance, post-processing techniques like non-maximum suppression are applied to eliminate duplicate detection and enhance the precision of results. The accuracy of the system is evaluated by comparing its performance against other state-of-the-art object detection algorithms using publicly available traffic sign datasets. Overall, the proposed traffic sign detection and recognition system, leveraging the YOLOv5 algorithm, aims to enhance road safety and traffic management. By swiftly and accurately identifying traffic signs, it can assist drivers, autonomous vehicles, and traffic management systems in making informed decisions, ultimately leading to safer and more efficient roads.

II. LITERATURE REVIEW

In this busy life , people usually fails to recognizing the traffic sign and hence break rules. A lot of research has been done in this domain in order to reduce the number of accidents. Researchers have used a variety algorithms to detect and recognize traffic sign.

"Traffic Sign Detection and Recognition: A Survey" by S. Zhang et al. (2019). [1] This comprehensive survey provides an overview of various techniques and algorithms used for traffic sign detection and recognition. It covers traditional computer vision methods as well as deep learning approaches.

[2]"Traffic Sign Detection and Recognition: A Deep Learning-Based Approach" by H. Sadeghi et al. (2020).This paper proposes a deep learning-based approach for traffic sign detection and recognition using convolutional neural networks (CNNs). It explores different CNN architectures and compares their performance on publicly available traffic sign datasets.

"Real-time Traffic Sign Detection and Recognition Using YOLOv5"[3] by R. Suresh and M. Maheswari (2021).This paper presents a real-time traffic sign detection and recognition system based on YOLOv5, achieving high accuracy and real-time performance.

[4]"Efficient Traffic Sign Detection and Recognition Using YOLOv5 and R-CNN" by A. Sharma et al. (2021).This paper presents a hybrid approach that combines YOLOv5 and R-CNN for efficient traffic sign detection and recognition, aiming to enhance accuracy and reduce false positives.

In [5] The trained neural network which contains 4 convolution layers and 2 max pooling layers along with dropout, flatten and Dense layers proved to offer a higher end result in comparison to the alternative CNN Architectures utilized in Alex Net, GoogleNet, VSSANet, VGGNet.

In [6] AlexNet structure of CNN is used in which the architecture contains eight layers. The first five layers are convolutional layers and the latter three are all connected layers. The accuracy of this architecture comes out to be 92.63

III. PROPOSED SYSTEM

Methodology

1. Dataset :

The German Traffic Sign Benchmark (GTSRB) dataset is a widely used dataset for evaluating traffic sign detection and recognition algorithms. It is specifically focused on traffic signs commonly found in Germany. The dataset consists of more than 50,000 images of traffic signs captured under various environmental conditions, such as different lighting conditions, weather conditions, and viewpoints.

The dataset includes 43 different traffic sign classes, covering a wide range of signs including speed limits, prohibitions, warnings, and information signs.

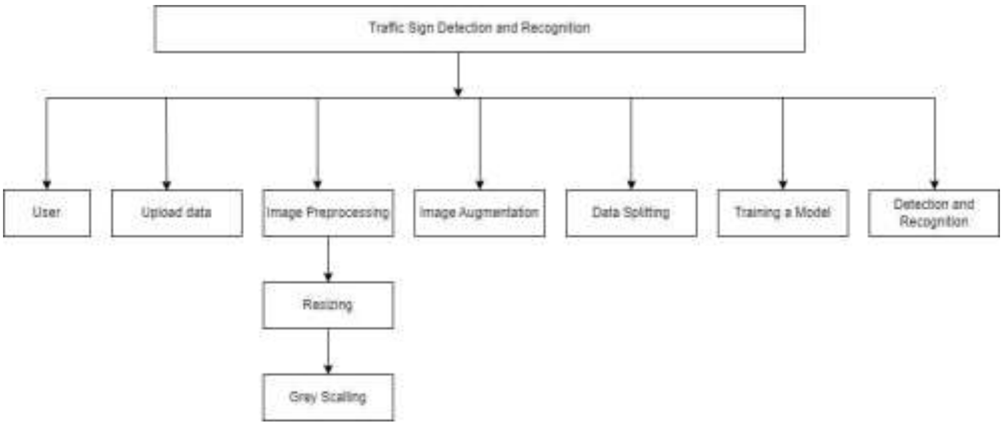


Fig 3.1 System breakdown structure

2. Image Preprocessing :

i. Resizing: Resize the images to a consistent resolution that matches the input size requirements of the YOLOv5 model. This ensures uniformity in image dimensions and facilitates efficient processing.

ii. Gray Scaling : Convert the RGB images in the dataset to grayscale by applying a suitable conversion algorithm. The conversion typically involves calculating the weighted average of the RGB channels to obtain a single grayscale intensity value.Grayscale images have lower memory requirements compared to RGB images, which can be beneficial in terms of reducing computational complexity during training and inference.

3. Image Augmentation:

Apply various data augmentation techniques to the training dataset to increase its diversity and robustness. Augmentation techniques can include random rotation, translation, scaling, flipping, brightness adjustments, and more. This helps the model generalize better to different variations of traffic signs.

4. Data Spliting:

Split into Training and Testing Sets: The GTSRB dataset is divided into a training set and a testing set. The training set contains approximately 39,000 images, while the testing set consists of around 12,000 images. This separation enables fair evaluation and comparison of algorithms.

5. Model Training:

Train the YOLOv5 model using the prepared dataset. The training process involves feeding the augmented training images through the model, computing the loss, and updating the model's weights using backpropagation and optimization algorithms like stochastic gradient descent (SGD) or Adam. The objective is to minimize the loss and improve the model's accuracy in detecting and recognizing traffic signs.

6. Evaluation:

Evaluate the trained model on the validation set and testing set to measure its performance. Calculate evaluation metrics such as precision, recall, and mean average precision (mAP) to assess the model's accuracy, robustness, and ability to detect and recognize traffic signs.

7. Model Deployment:

Once the model has achieved satisfactory performance, it can be deployed for traffic sign detection and recognition tasks in real-world scenarios. The model can be used to process input images or video streams and provide accurate predictions for the presence and classification of traffic signs.

Algorithm Used:

YOLOv5:

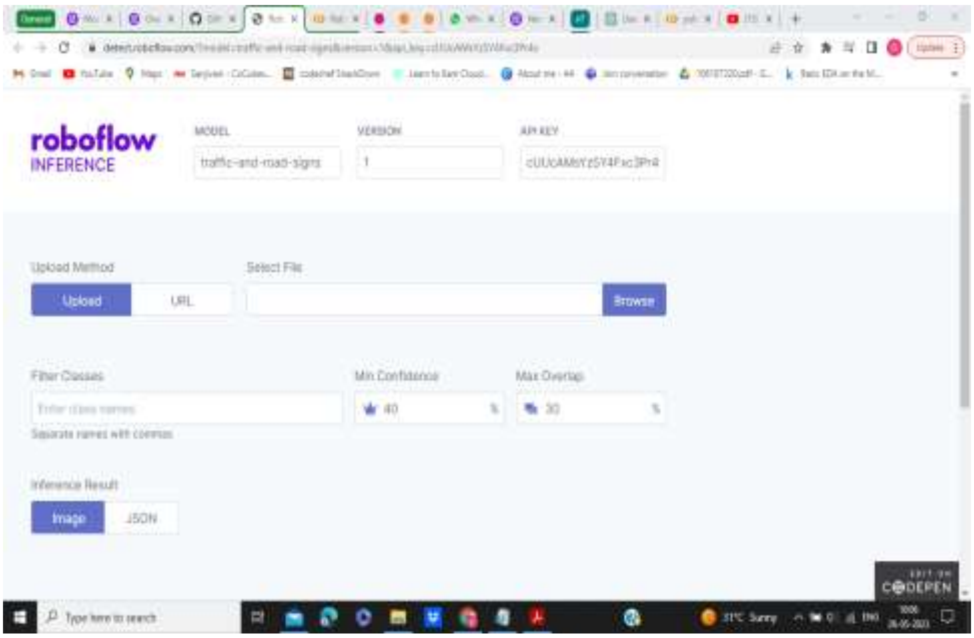
YOLOv5 is the fourth version in the You Only Look Once family of models. YOLOv5 makes real time detection a priority and conducts training on a single GPU.All of the YOLO models are object detection models. Object detection models are trained to look at an image and search for a subset of object classes. When found, these object classes are enclosed in a bounding box and their class is identified. Object detection models are typically trained and evaluated on the COCO dataset which contains a broad range of 80 object classes. From there, it is assumed that object detection models will generalize to new object detection tasks if they are exposed to new training data.

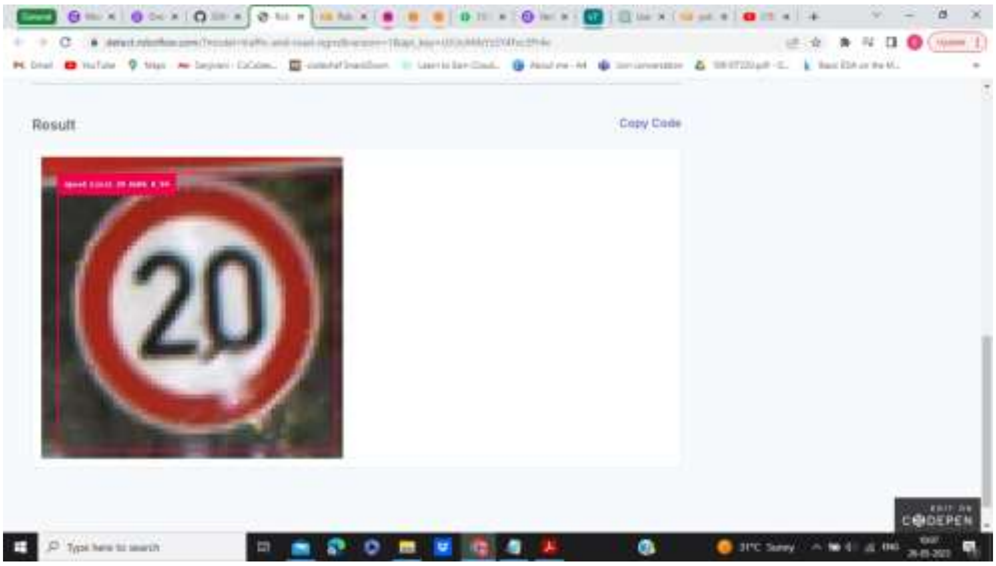
All object detectors take an image in for input and compress features down through a convolutional neural network backbone. In image classification, these backbones are the end of the network and prediction can be made off of them. In object detection, multiple bounding boxes need to be drawn around images along with classification, so the feature layers of the convolutional backbone need to be mixed and held up in light of one another. The combination of backbone feature layers happens in the neck. It is also useful to split object detectors into two categories: onestage detectors and two stage detectors. Detection happens in the head. Two stage detectors decouple the task of object localization and classification for each bounding box. One-stage detectors make the predictions for object localization and classification at the same time. YOLO is a one-stage detector, hence, You Only Look Once.

YOLOv5 is known for its speed and accuracy, making it suitable for real-time applications. It has gained popularity due to its efficient architecture and strong performance on object detection tasks. The algorithm can be customized and fine-tuned to specific domains like traffic sign detection and recognition by training on relevant datasets and adjusting parameters according to the specific requirements of the task.

IV. RESULT AND CONCLUSION

RESULT





CONCLUSION

In conclusion, the traffic sign detection and recognition project using YOLOv5 has successfully addressed the task of accurately detecting and classifying traffic signs in real-world scenarios. The project utilized the German Traffic Sign Benchmark (GTSRB) dataset and applied the YOLOv5 algorithm to achieve robust and efficient results.The project showcased the importance of image preprocessing techniques, such as gray scaling, to simplify the learning process and reduce computational complexity. Additionally, image augmentation played a crucial role in increasing the dataset's diversity and improving the model's ability to generalize to different real-world scenarios.

V. REFERENCES

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