YOLOV7-BASED HELMET DETECTION SYSTEM FOR TRAFFIC SAFETY

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***Abstract*— The current predominant issue in India is the escalating number of traffic accidents, primarily attributed to the burgeoning population. A significant contributing factor to this problem is the widespread disregard for helmet usage, leading to an increase in accidents. This project aims to address this issue by implementing a system capable of recognizing individuals who are not wearing helmets and subsequently advising them to prioritize helmet use in the future. The fundamental principle guiding this system is deep learning, with the project encompassing two key phases: the initial detection of individuals and the subsequent identification of helmets using YOLOv7. The utilization of the YOLOv7 algorithm, launched in 2022, is specifically chosen for its accuracy and favorable results. In addressing the associated challenges, this project introduces a Non-Helmet Rider Detection system. This system strives to automate the identification of traffic violations related to non-helmet usage and extract license plate numbers from vehicles. Object detection through deep learning is implemented at three levels within this system. The primary objective is to mitigate the occurrence of head injuries by ensuring that individuals in potentially perilous environments adhere to the requisite protective headgear.**

Keywords—Deep Learning, vehicle, object detection, helmet, YOLOv7

I. INTRODUCTION

Utilizing YOLOv7 in a helmet detection system involves the implementation of a computer vision application designed to accurately identify and locate helmets within image or video streams. YOLOv7, short for "You Only Look Once," is a renowned object detection algorithm known for its real-time, efficient, and precise detection capabilities. According to research published by the World Health Organization, a substantial number of individuals suffer injuries daily due to road accidents, with India ranking highest in road collision fatalities [1]. Factors contributing to this include speeding, failure to wear helmets, neglect of seat belts, and non-compliance with other driving safety measures. The primary aim of this initiative is to ensure the safety of individuals involved in traffic accidents and raise awareness about the importance of wearing helmets. Wearing a helmet while driving is crucial for preserving one's life, as it significantly reduces the risk of direct impact on the skull in the event of an accident. Given that a significant proportion of severe injuries in accidents result from head trauma, safeguarding the head becomes a paramount safety criterion [2]. Therefore, our central objective is to determine the presence of a helmet in video input, providing insight into whether the rider is wearing one or not.

Essentially, the core objective of a helmet system is to enhance safety, especially in sectors like construction, mining, and manufacturing where helmet use is mandatory for personal safety. Workplace accidents leading to head injuries are on the rise, posing severe issues such as mental injuries and fatalities [3]. To tackle these challenges, the helmet detection system employs the YOLOv7 object detection algorithm, well-known for its speed and precision in identifying objects within image and video streams.

II. METHODOLOGY

The methodology can be presented in this section.

A. Object detection

The concept of object detection in YOLOv7 (You Only Look Once version 7) pertains to the algorithm's capacity to recognize and precisely determine the positions of several items present in an image or video frame. The YOLOv7 model is an object identification algorithm that use a grid-based approach to segment a picture [4]. For each grid cell, the model generates predictions for bounding boxes and assigns class probabilities to the detected items. In contrast to conventional approaches that involve numerous iterations of image processing, YOLO employs a single forward pass to process the whole picture, hence enhancing its efficiency for real-time applications.

The YOLOv7 model is capable of concurrently predicting bounding boxes, class labels, and confidence ratings for many objects. The system employs a deep neural network framework with many convolutional layers to effectively capture intricate elements present in the input data [5, 6]. The bounding boxes that are predicted are then adjusted using the confidence ratings, and a technique called non-maximum suppression is used to remove redundant or overlapping boxes.

In general, the object identification capabilities of YOLOv7 render it highly suitable for a variety of applications, as shown in figure 1 including picture recognition, video analysis, and real-time object tracking. Type of object detection are

- Two stage- Detecting and recognizing are distinct processes.

• One stage- Detection and recognition occur concurrently.

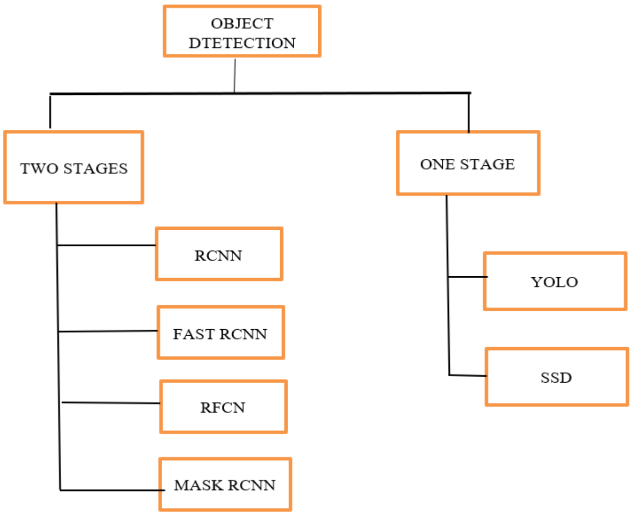

Figure 1: Diagram outlining the concept in YOLOv7.

B. *YOLOv7*

Each release of the YOLO algorithm, such as YOLOv7, introduces enhancements in precision, computational efficiency, and the ability to recognize a wide array of objects in diverse environments. YOLOv7 is anticipated to build upon the successes of its predecessors, incorporating advancements in deep learning architectures and object detection algorithms [7, 8, 9]. Outperforming previous YOLO versions, YOLOv7 boasts superior speed and accuracy. It has surpassed existing benchmarks for object detection, achieving remarkable performance in the range of 5FPS to 160FPS with a high accuracy rate of 56.8AP. As shown in figure 2.

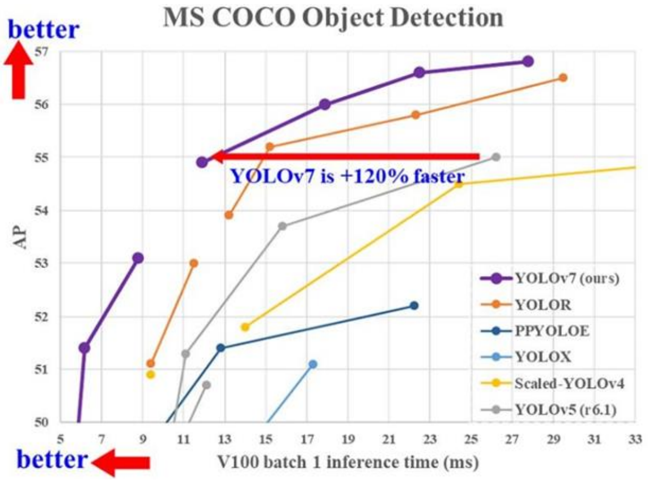

Figure 2: COCO model utilized for detecting objects.

C. *Objective of the Helmet Detection system*

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The primary goal of the Helmet Detection System utilizing YOLOv7 is to bolster workplace safety through several key functionalities:

Real-time Monitoring: Vigilantly observing safety helmet presence by analyzing video feeds and live camera streams.

Rapid Detection: Leveraging YOLOv7's real-time object detection capabilities to promptly identify individuals both wearing and not wearing helmets [10, 11].

Alerting and Enforcement: Providing instant notifications upon the detection of non-compliance, ensuring swift corrective action.

Logging and Reporting: Documenting details of non-compliant instances, including location and images, for comprehensive compliance reporting and analysis.

Road Safety: Ensuring drivers wear helmets to mitigate the risk of head injuries in the event of accidents.

Industrial Environments: Enforcing helmet-wearing regulations in factories and manufacturing facilities to safeguard employees from potential hazards.

D. *Functioning of detection system*

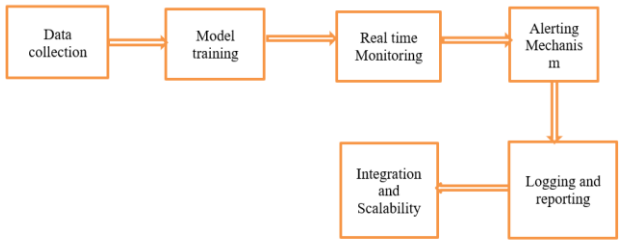

Figure 3: The model processes the collected data for subsequent analysis.

E. *Data Collection*

Dataset Acquisition: The initial phase of the helmet detection system involves assembling a dataset comprising images and videos, As shown in figure 3. This dataset should encompass instances of individuals both wearing safety helmets and those without helmets in diverse workplace scenarios.

Annotation: Each image and video within the dataset undergo annotation to identify and label the regions of interest indicating the presence or absence of helmets [12, 13].

F. *Model Training*

- Yolov7 Architecture: When training the model, the initial step involves selecting the object detection model algorithm based on its efficiency and real-time performance.

- Data Augmentation: Enhancing the model's generalization involves applying data augmentation techniques, including rotation and scaling, to the dataset.

- Training Parameters: To optimize detection accuracy, meticulous adjustments are made to the model's hyperparameters, such as learning rate and batch size.

- Model Optimization: The trained model is optimized for deployment, reducing its size and enhancing real-time performance on hardware platforms.

- Camera Integration: The system is linked to workplace cameras or live camera feeds, delivering data to the real-time system for processing.
- Frame Capture: Continuous capture of video frames takes place, with the YOLOv7 model applied to each frame for the detection of helmet presence or absence.
- Helmet Detection: The YOLOv7 model predicts and identifies instances of both wearing and not wearing helmets.
- Alert generation: Following helmet detection, provide hints for those not wearing helmets. Use a zero before decimal points: "0.25", not ".25".

G. Logging and Reporting

• Record the detail of non-compliant instances, including location and image for compliance reporting and analysis.

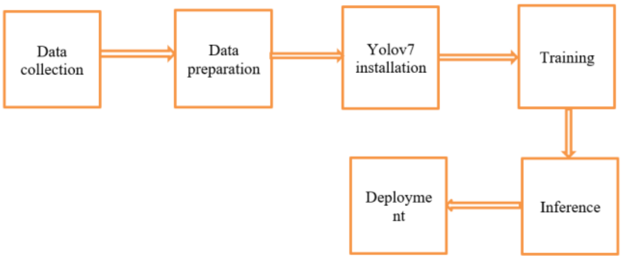

Figure 4: Utilize YOLOv7 for processing the data.

H. Data collection

Gather an image dataset featuring individuals both with and without helmets. Annotate the images to define bounding boxes around the helmets [17, 18]. Structure the dataset in the YOLOv7-compatible format tailored to that algorithm. Proceed to generate a data configuration file, specifying the dataset path and the number of classes as shown in figure 4. Train the YOLOv7 model on our annotated dataset [14, 15, 16]. Finally, establish a configuration file for our helmet detection model.

I. Inference

After Following the training phase, we employ the trained model to perform evaluations on new video streams and images.

J. Deployment

To implement the helmet detection system in real-world scenarios, we integrate it with camera feeds or incorporate it as a component of a larger system.

III. III How to work YOLO algorithm

Residual block: In this context, the image is partitioned into multiple grids, all sharing the same dimensions. Within the image, numerous grid cells of uniform size exist, each tasked with detecting objects present within its confines. As shown in figure 5.

Bounding box regression: Every bounding box in the image have following attributes:

- Width
- Height

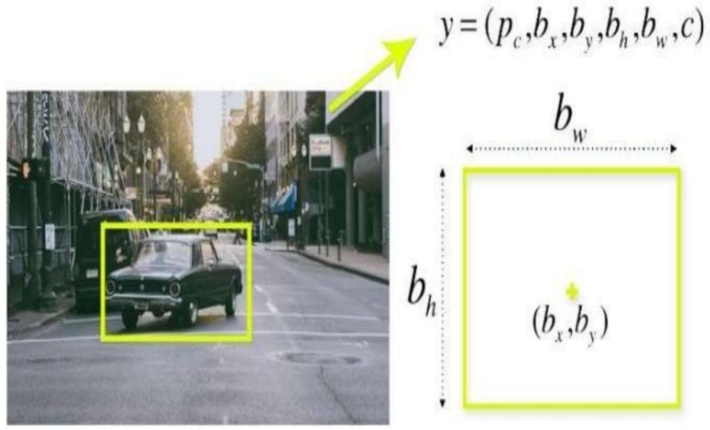

Figure 5: Detect objects along with their height and width.

Intersection Over Union (IOU) IOU, a concept in detection algorithms, defines the overlap between boxes. Each grid cell computes the boundary boxes, and the Intersection over Union (IOU) equals 1 if the predicted bounding [19, 20, 21] box matches the actual box. In the image above, there are two bounding boxes—green and blue. The blue box represents the predicted box, while the green box is the actual box. YOLO ensures equality between the two bounding boxes. As shown in figure 6.

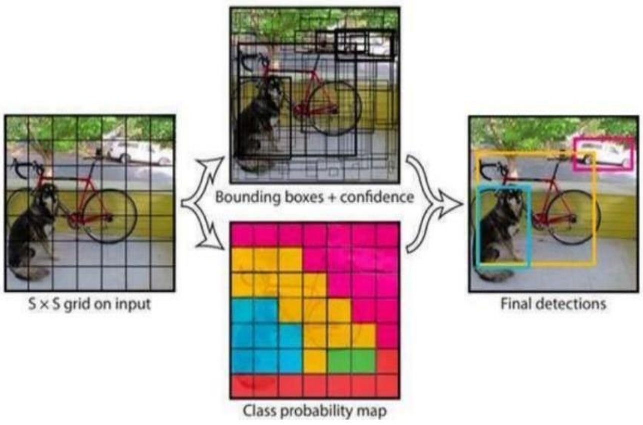

Figure 6: The image is partitioned into grids for processing.

IV. Result

The results section presents the findings of the study, including visual representations such as figures 7 and 8. The model demonstrates its ability to process videos [21, 22, 23], where video data serves as input, extracting images from the running videos and detecting objects. The output consists of images with identified objects. The YOLOv7 model demonstrates the ability to predict bounding boxes, class labels, and confidence ratings simultaneously for multiple objects [24, 25, 26]. Utilizing a deep neural network framework with numerous convolutional layers, the system effectively captures intricate details in the input data [27, 28, 29]. The predicted bounding boxes are refined based on confidence ratings, and a non-maximum suppression technique is applied to eliminate redundant or overlapping boxes.

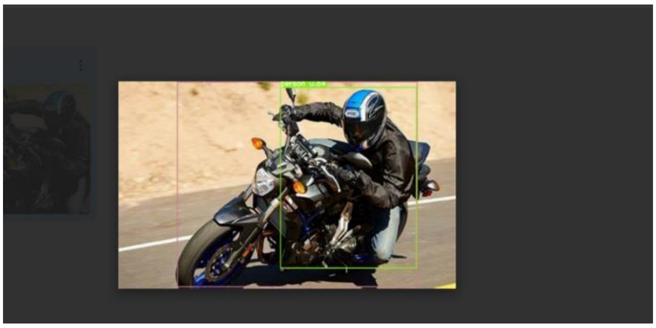

Figure 7: Objects are identified separately.

The YOLOv7 algorithm, a kind of deep learning, is crucial in the two-step process of first detecting objects and then identifying helmets. The decision to use YOLOv7, renowned for its precision, demonstrates a dedication to attaining positive results. The Non-Helmet Rider Detection system aims to automate the detection of traffic infractions specifically connected to non-compliance with helmet use. Additionally, it is designed to retrieve license plate information from automobiles. Deep learning is selectively used at several stages to identify objects, encourage the adoption of protective equipment, and mitigate the likelihood of head injuries in potentially dangerous areas.

Output if input as video

Figure 8: Object detected from the videos.

V. Conclusion

A In conclusion, the prevalent issue of increasing traffic accidents in India, largely fueled by a growing population, is exacerbated by the widespread neglect of helmet usage. This project serves as a proactive solution to this problem, aiming to implement a system capable of identifying individuals without helmets and encouraging them to prioritize helmet safety. Deep learning, particularly the YOLOv7 algorithm, plays a central role in the two-phase approach of initial detection and subsequent helmet identification. The selection of YOLOv7, known for its accuracy, reflects a commitment to achieving favorable outcomes. Introducing the Non-Helmet Rider Detection system, this project seeks to automate the identification of traffic violations related to helmet non-compliance and extract license plate numbers from vehicles. Object detection through deep learning is strategically employed at multiple levels to promote the use of protective headgear and reduce the risk of head injuries in potentially hazardous environments.

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