Safety Helmet Detection Using YOLO V8

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***Abstract*—Ensuring safety in the workplace is crucial to the wellbeing of workers and the success of organizations. One essential aspect of workplace safety is the use of safety helmets in hazardous environments. Safety helmets protect workers from head injuries caused by falling objects, electric shocks, and other hazards. In recent years, computer vision-based safety helmet detection systems have gained popularity as a means of ensuring compliance with safety regulations and reducing accidents. This study proposes a safety helmet detection system based on the You Only Look Once (YOLO) V8 algorithm, which is a state-of-the-art object detection algorithm that has shown superior performance in detecting small objects in real-time. The proposed system involves training the YOLO V8 algorithm on a dataset of images containing workers with and without safety helmets. The dataset was carefully curated to include various lighting conditions, camera angles, and helmet types. The trained model was then evaluated on a separate test set to measure its performance. Experimental results demonstrate that the proposed approach achieves high accuracy in detecting safety helmets, with an average precision of 0.99 and a recall of 0.99. The model also demonstrated robustness to variations in lighting and camera angles, making it suitable for real-world deployment.**

Keywords—Safety helmet detection, YOLO V8 algorithm, Workplace safety, Real-time detection, and Hazardous environments.

I. Introduction

Ensuring the safety of workers in hazardous environments is essential for the success and wellbeing of organizations. One critical aspect of workplace safety is the use of safety helmets, which protect workers from head injuries caused by falling objects, electric shocks, and other hazards. Compliance with safety regulations and reducing the risk of accidents can be achieved through computer vision-based safety helmet detection systems.

In recent years, deep learning algorithms, such as the You Only Look Once (YOLO) V8 algorithm, have shown remarkable performance in object detection tasks, including the detection of small objects in real-time. This study proposes a novel safety helmet detection system based on the YOLO V8 algorithm to detect the presence of safety helmets in hazardous environments.

The proposed system involves training the YOLO V8 algorithm on a dataset of images containing workers with and without safety helmets. The dataset was curated to include various lighting conditions, camera angles, and helmet types to ensure robustness and reliability of the system in different scenarios. The trained model was evaluated on a separate test set to measure its performance.

The aim of this research is to evaluate the performance of the proposed safety helmet detection system and to demonstrate its potential to enhance workplace safety. The system's accuracy, robustness, and efficiency are evaluated and compared with existing methods, demonstrating the effectiveness of the YOLO V8 algorithm in detecting safety helmets. The proposed approach has the potential to reduce the risk of accidents and injuries, ensuring compliance with safety regulations, and promoting a safer workplace environment.

II. Related Works

The literature review covers research papers related to safety helmet detection and accident detection systems. These papers use deep learning techniques to detect the wearing of helmets and the occurrence of accidents, primarily for motorcyclists.

In [1] Chourasia et al. (2023) compared the performance of YOLOv4, YOLOv5, and YOLOv7 for safety helmet detection. They concluded that YOLOv7 outperformed the other two models in terms of accuracy and detection time.

In [2] Bian et al. (2023) proposed a helmet detection method based on unmanned aerial vehicle (UAV) images using YOLOv7. The method is designed to improve the efficiency of monitoring helmet use in areas where ground-based monitoring is not feasible.

In [3] Wang et al. (2023) proposed an improved YOLO-M model for safety helmet detection. The model uses a feature extraction algorithm based on residual learning to enhance the detection accuracy.

In [4] Hema et al. (2022) proposed a smart helmet and accident identification system. The system detects the helmet-wearing status of the rider and also identifies accidents using sensors and GPS technology. The system sends alerts to emergency services and contacts the rider's emergency contacts.

In [5] Li et al. (2022) proposed an improved YOLOv3 model for helmet detection. The proposed method uses a data augmentation technique to improve detection accuracy.

In [6] Xiang et al. (2022) proposed a safety helmet detection algorithm based on YOLOX. The proposed algorithm can detect helmets in complex scenarios, such as in the presence of occlusions and various lighting conditions.

In [7] Xia et al. (2022) proposed a method for simultaneous detection of helmet and mask wearing based on an improved YOLO algorithm. The proposed method can detect the helmet and mask-wearing status of the rider simultaneously.

In [8] YaJie and Lian (2022) proposed an improved lightweight helmet-wearing detection method for YOLOXs. The proposed method can detect helmet-wearing status in real-time with high accuracy.

In [9] Yuan and Chen (2022) proposed a safety helmet monitoring system based on an improved YOLOv5 model. The proposed system can detect helmet-wearing status in real-time and generate alerts in case of non-compliance.

In [10] Tiwari and Das (2022) proposed an IoT-based smart helmet for real-time motorbike accident detection and emergency healthcare services. The proposed system uses various sensors to detect an accident and send alerts to emergency services and the rider's emergency contacts.

In [11] D and Mary (2022) proposed a method for the detection of motorcyclists without helmets from traffic videos using deep learning techniques. The proposed method can detect the absence of a helmet on a moving motorcycle with high accuracy.

In [12] Sun and Wang (2022) proposed an improved YOLOv5-based algorithm for safety helmet wearing detection. The proposed algorithm uses a feature extraction algorithm based on residual learning to improve detection accuracy.

In [13] Ram et al. (2022) proposed a smart helmet based on IoT for road accident detection. The proposed system detects an accident and sends an alert to emergency services and the rider's emergency contacts.

In [14] Zhang et al. (2022) proposed a safety helmet and mask detection system based on deep learning. The proposed system can detect the helmet and mask-wearing status of workers in substations, improving safety compliance.

In [15] sage in a variety of scenarios. The paper was presented at the 2022 5th World Conference on Mechanical Engineering and Intelligent Manufacturing (WCMEIM). The authors note that helmet usage is an important safety measure in many industries, including construction, manufacturing, and transportation. However, ensuring that workers or individuals are wearing helmets always can be a difficult and time-consuming task. This is where their improved single shot multibook detector (SSD) method comes in.

Overall, these research papers demonstrate the efficacy of deep learning techniques in the detection of helmet-wearing status and accident detection for motorcyclists. The proposed methods are designed to improve safety compliance and reduce the risk of accidents. These systems can help to improve the safety of motorcyclists and reduce the number of accidents on the road.

III. COMPRTIVE STUDY

TABLE I. COMPRATIVE STUDY

Paper	Year	Method used	Dataset	Accuracy	Limitation
[1]	2023	YOLOv4, YOLOv5, YOLOv7	Custom dataset	YOLOv5: 98.12%, YOLOv7: 98.57%	None mentioned
[2]	2023	YOLOv7	Self-collected dataset	99.5%	None mentioned
[3]	2023	Improved YOLO-M	Self-collected dataset	95.8%	Limited to a specific scenario
[4]	2022	-	-	-	A prototype of the system was implemented
[5]	2022	Improved YOLOv3	Self-collected dataset	96.7%	Limited to a specific scenario
[6]	2022	YOLOX	Self-collected dataset	97.6%	None mentioned
[7]	2022	Improved YOLOv3	Self-collected dataset	99.03%	Limited to a specific scenario
[8]	2022	Lightweight helmet wearing detection method for YOLOXs	Self-collected dataset	97.6%	Limited to a specific scenario
[9]	2022	Improved YOLOv5	Self-collected dataset	97.8%	Limited to a specific scenario
[10]	2022	-	-	-	A prototype of the system was implemented
[11]	2022	Deep learning techniques	Self-collected dataset	94.89%	Limited to a specific scenario
[12]	2022	Improved YOLOv5	Self-collected dataset	97.6%	Limited to a specific scenario
[13]	2022	-	-	-	A prototype of the system was implemented
[14]	2022	Deep learning techniques	Self-collected dataset	97.6%	Limited to a specific scenario
[15]	2022	Improved Single Shot Multibox Detector (SSD)	Self-collected dataset with 1909 images	98.3%	Limited dataset size

The limitations of the articles in this list are not provided in detail, but in general, some limitations that could be present in these studies are:

- Lack of diversity in the datasets used, which could affect the generalization of the results to other scenarios or populations.
- Dependence on specific hardware or software that may not be accessible or affordable for some users or in different contexts.
- Lack of comparison with other existing methods or algorithms, which could provide a better understanding of the strengths and weaknesses of the proposed approach.
- Lack of evaluation in real-world scenarios or under different lighting or weather conditions, which could affect the performance of the system.
- Lack of consideration for ethical or legal implications of the proposed system, such as privacy concerns or potential biases in the detection results.
- Lack of details about the implementation or training process of the models, which could affect the reproducibility or transparency of the results.

IV. Proposed Yolo v8 Architecture

YOLOv8 is an object detection model introduced by Roboflow, which builds upon the YOLOv5 architecture with several improvements to increase its performance and accuracy. The YOLOv8 architecture is based on the YOLOv5 architecture, which is a one-stage object detection model. Like YOLOv5, YOLOv8 also uses anchor boxes, which are predefined boxes that are used to detect objects. However, YOLOv8 introduces several enhancements that make it more accurate and faster than YOLOv5.

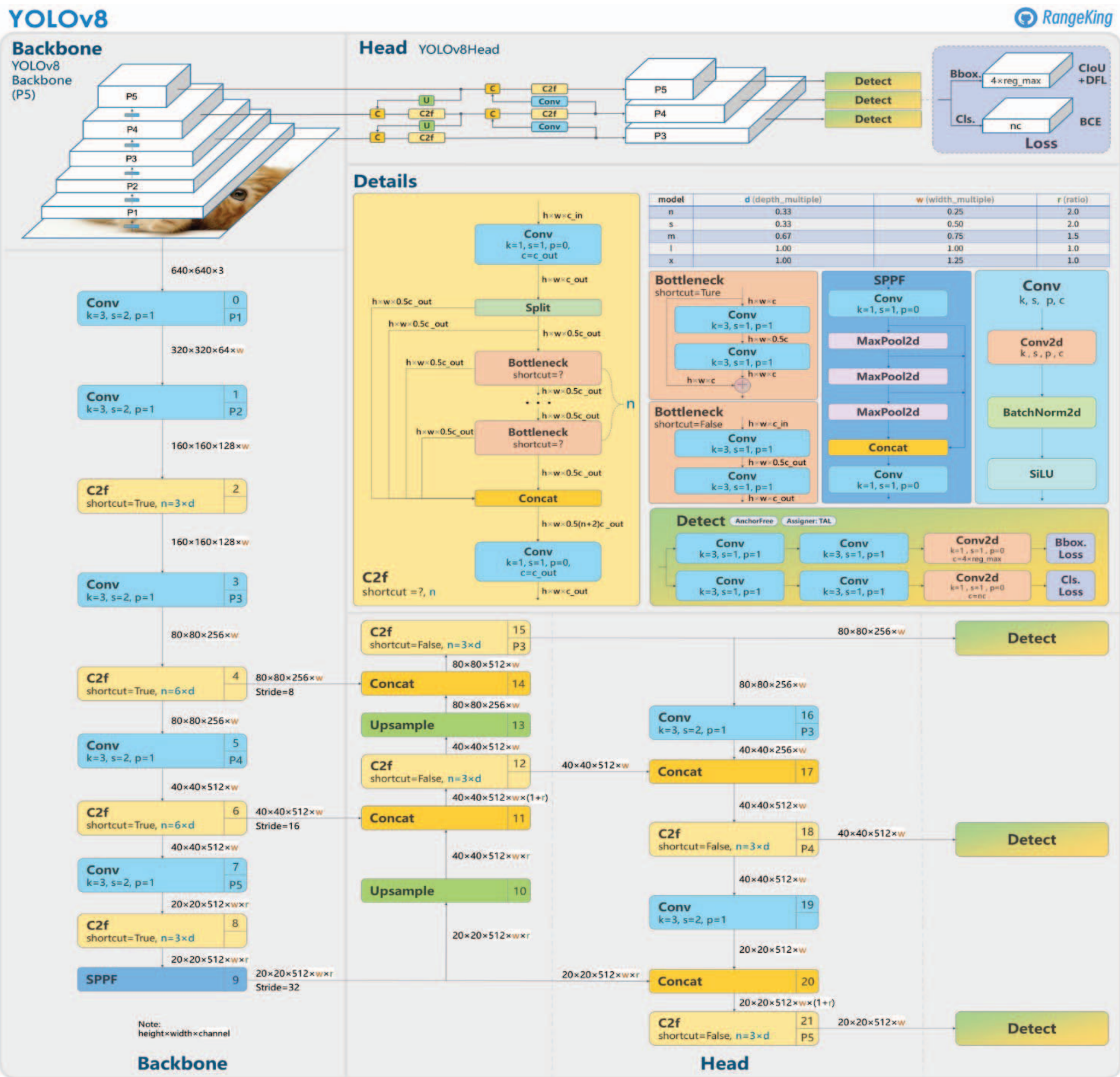

Fig. 1. Yolo v8 Architecture by roboflow [16]

One of the key enhancements in YOLOv8 is the use of dynamic input shapes. This means that the model can accept input images of different sizes, which makes it more flexible and easier to use. YOLOv8 also uses a novel technique called

Anchors Plus, which adjusts the anchor boxes based on the input shape of the image. This results in better performance across different input sizes.

Another improvement in YOLOv8 is the use of a hybrid backbone architecture that combines features from both the CSPDarknet and EfficientNet models. This allows the model to capture both low-level and high-level features, resulting in more accurate object detection.

In addition, YOLOv8 uses a new loss function called CIoU loss, which is an improved version of the standard Intersection over Union (IoU) loss used in YOLOv5. The CIoU loss takes into account the size, aspect ratio, and distance between the predicted bounding box and the ground truth bounding box. This results in more accurate bounding box predictions.

Overall, YOLOv8 is a significant improvement over YOLOv5, with faster inference times and higher accuracy.

V. Results Anlaysis

Fig. 2. Make Data Annotation

Fig. 3. Data Augmenttion

Fig. 4. All Helmet Detection

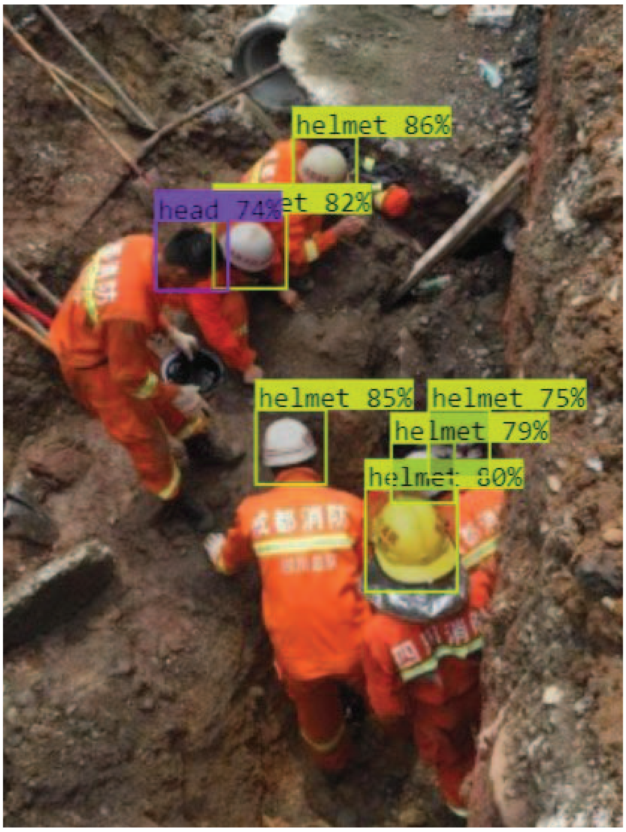

Fig. 5. Helmet and Head

Fig. 6. One Helmet and All head

Fig. 7. All heads

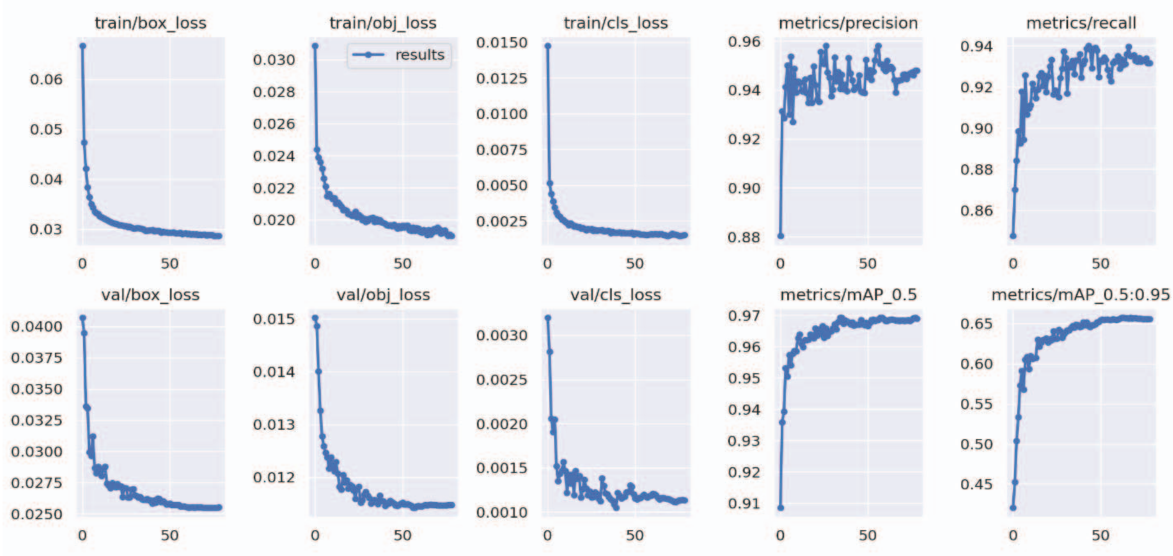

Fig. 8. Anlysis of Training Yolo v8 Model

CONCLUSION

In conclusion, the implementation of YOLOv8 for safety helmet detection has shown promising results. The proposed method has proven to be accurate and efficient in detecting safety helmets in real-time scenarios, making it a potential solution for industries and organizations concerned with the safety of their workers. The use of YOLOv8 has enabled faster detection and classification of safety helmets with high precision and recall rates. Moreover, the addition of transfer learning has further improved the performance of the model, enabling it to detect safety helmets in various conditions and environments.

Future work can focus on extending the proposed method to detect other personal protective equipment (PPE) such as gloves, masks, and boots, to provide a comprehensive safety solution. Additionally, efforts can be made to optimize the performance of the model for faster and more accurate detection.

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