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Safety Helmet Wearing Detection Model Based on Improved YOLO-M

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Abstract: The existing helmet-wearing detection algorithm's weaknesses such as many parameters, substantial detection interferences, and poor detection accuracy. We proposes a new helmet wearing detection model called YOLO-M, which uses MobileNetv3 as the backbone set of connections for feature removal, which can reduce the quantity of model parameters and model size. A residual edge for feature fusion, and At last, by changing the connection between CAM and SAM, a new attention module BiCAM is designed. The experiments show that YOLO-M has a higher detection accuracy and faster detection speed than other models, while also reducing the quantity of model parameters.
Keywords: MobileNetv3, BiCAM, ,Safety helmet, YOLO-M .

I. INTRODUCTION

The construction industry, the construction environment is complex, and the injury risk of falling entities is high. Safety helmets can protect the workforce and decrease the impact of falling entity, and effectively avoid workforce from being injured by falling entities. Workforces who do not wear safety helmets have great potential safety hazards. Therefore, wearing safety helmets in production operations can significantly protect the safety of the workforce' lives. Safety helmet wearing detection is essential for the safety of workforce. In the early days of construction sites, some people were specially designated to supervise whether workforce wearing safety helmets or not. However, construction workforce work in a wide range and it was difficult to find the workforce who did not wear the safety helmets. In addition, the traditional supervision method wasted the manpower. For the safety production requirements on contemporary construction sites, deep learning-based computer vision method is more suitable for real-time monitoring of construction sites.

II. LITERATURE REVIEW

Shao Yanhua, Zhang Duo et.al.(2022): The paper "A Review of YOLO Entity Detection Based on Deep Learning" This provides a complete review of the YOLO (You Only Look Once) series of entity detection frameworks, important improvements, and applications. It systematically summarizes YOLO versions, backbone networks, loss functions, and various application scenarios, offering an extensive analysis of YOLO's evolution and impact in computer vision.

Summary: the YOLO entity detection series and its applications offer a valuable resource for researchers and practitioners in computer vision. The study provides a detailed analysis of YOLO's evolution, key improvements, and its widespread use in various application scenarios. It also highlights possible research guidelines for further advancements in entity detection.

Hongcheng Zhao1, Xiuxia Tian et.al Xiaojie Ma , Kefeng Ji et.al.,(2021) : The paper "YOLO-S: A new lightweight helmet wearing detection model "introduces YOLO-S, a lightweight helmet-wearing detection model for construction sites. It addresses unbalanced data compression. This process involves sparsest training with L1 regularization, channel and layer pruning, knowledge distillation, and model quantization from FP32 to FP16 to reduce computational complexity and memory requirements.

Summary: YOLO-S presents a lightweight solution for helmet-wearing detection in construction environments, addressing challenges of reducing model size and computational demands while maintaining reasonable accuracy. Its deployment on NVIDIA Jetson TX2 demonstrates its suitability for practical use. However, some trade-offs in accuracy should be considered depending on the application's requirements.

Zhongzhen SunORCID,Xiangguang Leng et.al.,(2021): The "BiFA-YOLO: A Novel YOLO-Based Method for Arbitrary-Oriented Ship Detection in elevated -Resolution SAR Images" BiFA-YOLO ship detector combines YOLO with novel techniques for SAR image analysis. It employs a bi-directional feature fusion module (Bi-DFFM) for multi-scale ship detection and adds an angular classification structure to detect arbitrarily oriented ships accurately. A random rotation mosaic data augmentation method mitigates angle imbalance.

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Summary: BiFA-YOLO introduces effective techniques for detecting ships in elevated -resolution SAR images, achieving high precision, recall, and F1-score. The method exhibits robustness and adaptability, making it valuable for both military and civilian applications. However, addressing potential limitations and broader applicability across diverse conditions should be explored in future work.

III. METHODOLOGY

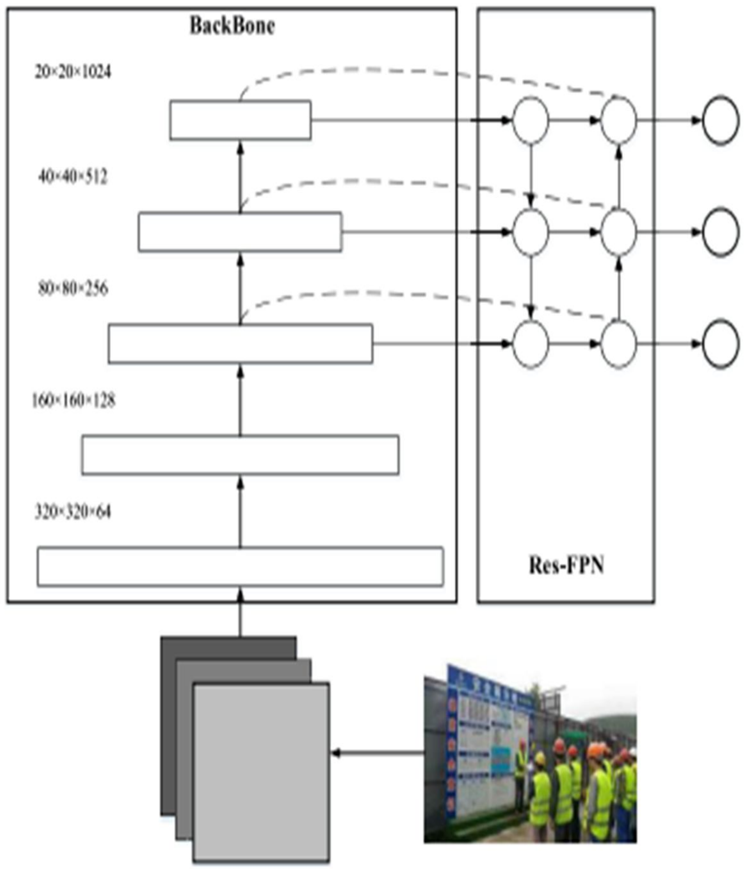

Fig: System architecture

Retina Net – Retina Net is one of the best one-stage entity detection models that has proven to work well with dense and small scale entities. For this reason, it has become a popular entity detection model to be used with aerial and satellite imagery.
YoloV4 – YOLOv4 is a powerful and efficient entity detection model that strikes a balance between speed and accuracy. Its use of unique features and bag of freebies techniques during training allows it to perform excellently in real-time entity detection tasks.
SSD – SSD use a similar phase while training, to match the appropriate anchor box with the bounding boxes of each ground truth entity within an image. Essentially, the anchor box with the highest degree of overlap with an entity is responsible for predicting that entity's class and its location.

IV. CLASS DIAGRAM

The class diagram is used to refine the use case diagram and define a complete design of the system. The class diagram classifies the actors defined in the use case diagram into a set of interconnected classes. The relationship or association between the classes can be either an "is-a" or "has-a" relationship. Each class in the class diagram might be capable of providing certain functionalities. These functionalities provided by the class are termed "methods" of the class. To one side from this, each class may have certain "attributes" that uniquely identify the class.

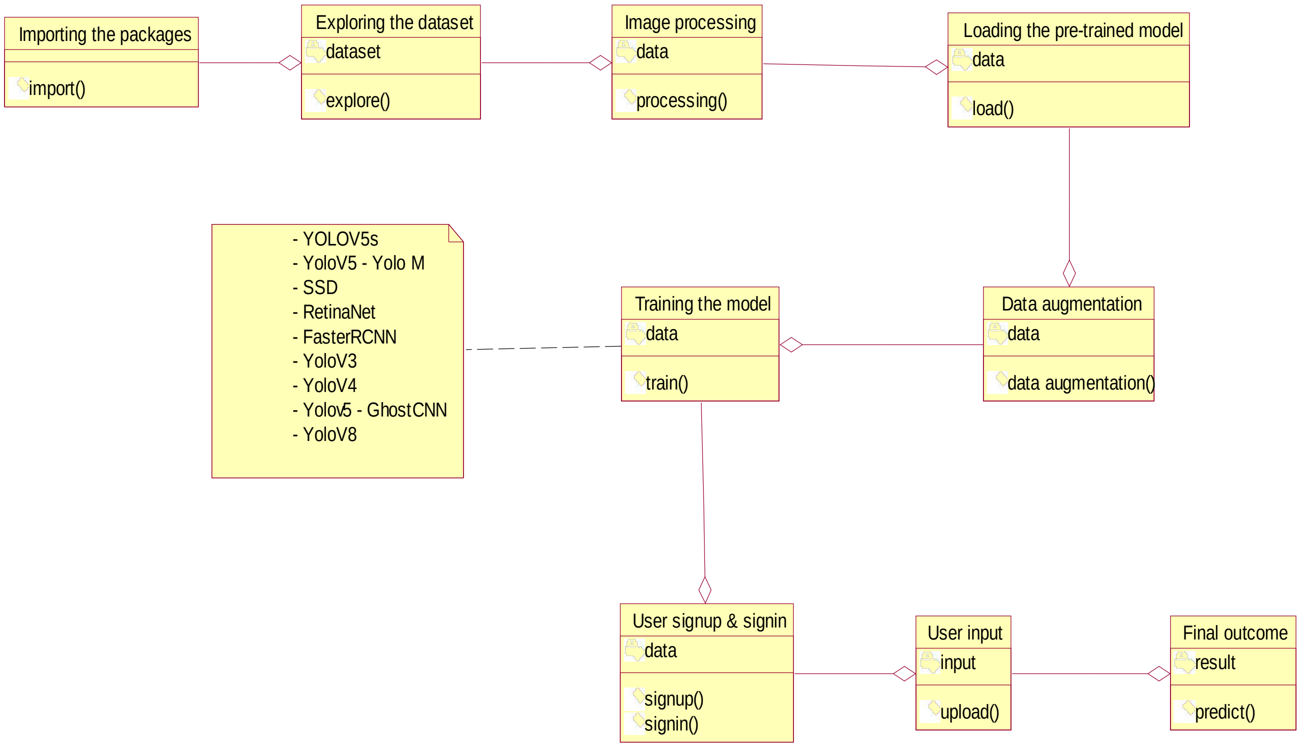

Fig: Class Diagram

V. RESULT

Precision score is a classification performance metric that measures the accuracy of a model's positive predictions.

A higher precision score indicates that the model is more accurate in detecting safety helmets, with a maximum Value of 1.0 (or 100%) indicating perfect precision.

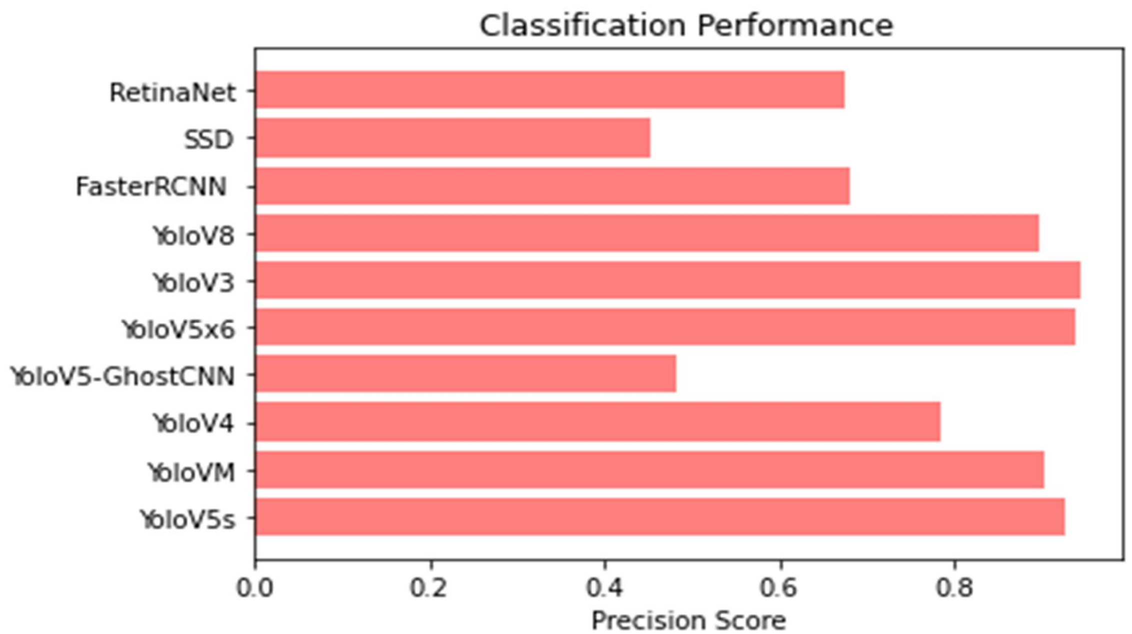

Fig: precision score

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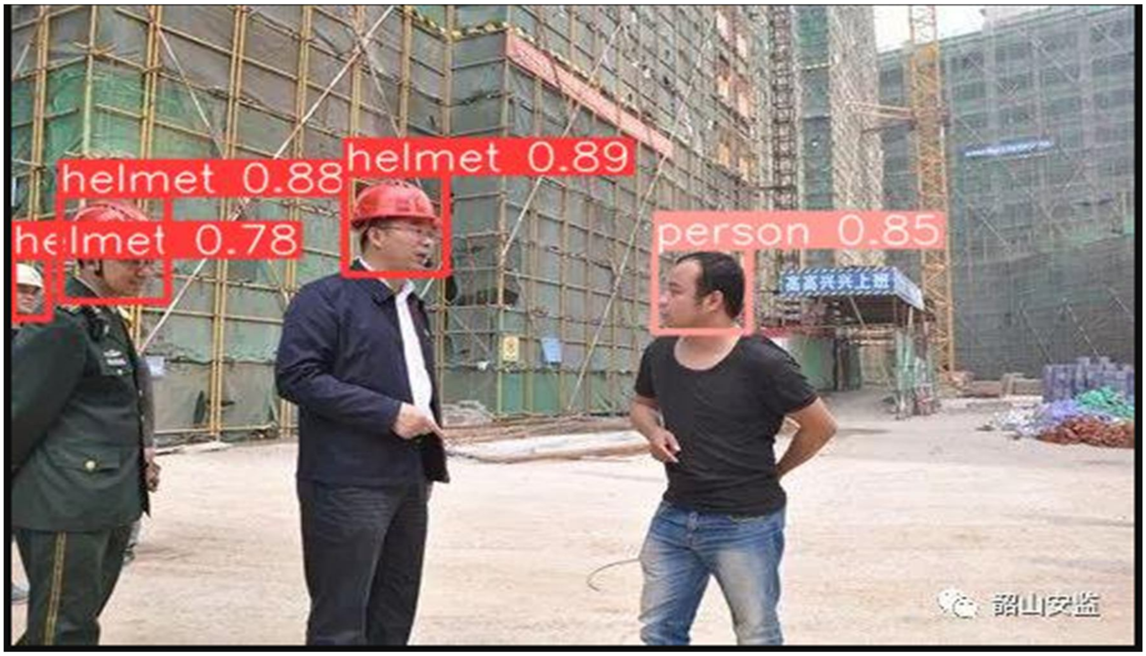

Fig: helmet accuracy

VI. CONCLUSION

The experimental outcome explains that the improved YOLO-M model maintain elevated detection accuracy and has a faster detection speed. However, the construction scenes are changeable, and there are still cases of missed detection in complex scenes. In the future, we will focus on the strength of the model on the various scenarios.

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