A Vision System for Automated Personal Protective Equipment Identification using Deep Learning

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Abstract

In industrial settings, where the failure to wear Personal Protective Equipment (PPE) like helmets, safety vests, and gloves can result in serious injuries and accidents, workplace safety is a major concern. Manual supervision, which is frequently ineffective, time-consuming, and prone to human mistake, is a major component of traditional PPE compliance monitoring techniques. This paper suggests an automated vision-based solution for PPE identification utilising deep learning techniques in order to overcome these issues. The created method uses an object detection model based on convolutional neural networks to recognise and categorise PPE components in photos. The algorithm can accurately detect numerous objects at once after being trained on a labelled dataset that includes different PPE categories.

The trained model is included into a web application created with the Django framework to improve accessibility and usability. Through an interactive interface, users can input photographs and get real-time detection results. By guaranteeing adherence to safety requirements, the suggested solution not only increases monitoring efficiency but also lowers the chance of workplace accidents. The model is appropriate for real-world deployment since experimental findings show that it produces dependable performance under various scenarios. This method demonstrates how deep learning and web technologies can be combined to provide intelligent safety monitoring systems for industrial settings.

Keywords

PPE Detection, Deep Learning, Computer Vision, Object Detection, YOLO, Workplace Safety, Django, Image Classification, Safety Compliance, Industrial Automation

I.   Introduction

For businesses all over the world, ensuring worker safety in industrial and construction settings is a critical duty. Helmets, safety vests, gloves, and goggles are examples of personal protective equipment (PPE) that is essential for reducing the risk of accidents and injuries. However, because of the limitations of manual monitoring and supervision, maintaining strict compliance with PPE rules continues to be a difficult effort. Particularly in large-scale industrial settings, human-based inspection techniques are frequently unreliable, labour-intensive, and unable to provide continuous surveillance.

Automated safety monitoring systems have drawn a lot of attention due to the quick development of deep learning and computer vision technology. These technologies allow machines to quickly and accurately identify things by analysing visual input.

Specifically, in real-time picture processing tasks, deep learning models like convolutional neural networks (CNNs) and object detection algorithms like YOLO (You Only Look Once) have demonstrated exceptional performance. In this regard, this study introduces a vision-based PPE detection system that uses deep learning methods to automatically determine if employees are donning the necessary safety gear. The Django framework is used in the design of the suggested system, which is a web-based application that enables users to interact with the model via an easy-to-use interface. The technology analyses submitted photos, finds PPE components, and gives quick feedback on safety compliance.

The suggested solution seeks to improve workplace safety, lessen reliance on manual supervision, and offer a scalable method for real-time monitoring by fusing deep learning with a web-based platform. This study shows how intelligent automation may enhance regulatory compliance and provide safer industrial settings.

II. Problem Statement

Maintaining workplace safety in industrial and construction settings requires that workers wear Personal Protective Equipment (PPE) including gloves, safety vests, and helmets on a regular basis. However, there are a number of difficulties when utilising conventional manual methods to monitor PPE compliance. Supervisors must constantly monitor employees, which takes time and is prone to oversight, weariness, and human mistake. Because of this, risky behaviours could go unreported, raising the possibility of mishaps and injury. Large-scale workplaces also make it challenging to efficiently track every employee, which results in uneven enforcement of safety rules. The efficiency of current technologies in averting dangerous situations is limited by their lack of automation and real-time monitoring capabilities. An intelligent system that can automatically identify PPE usage and give prompt feedback is obviously needed.

This project seeks on creating a vision-based PPE detection system utilising deep learning techniques in order to address these problems. The objective is to create an automated system that can reliably determine from photos if employees are donning the necessary safety gear and incorporate this feature into a web-based platform. Through accurate and real-time detection, the system seeks to increase overall workplace safety, decrease reliance on humans, and improve monitoring efficiency.

III. Methodology

By incorporating a pre-trained deep learning model into a web-based application, the suggested approach focuses on creating an automated vision-based method for identifying Personal Protective Equipment (PPE). This study makes use of an object identification model that has previously been trained and is capable of accurately identifying PPE products like safety vests and helmets, rather than building a model from scratch. This method guarantees efficient performance while drastically lowering computing demands and development time. The Django framework was used to create an interactive web interface that allows users to input photographs into the system. After an image is submitted, it goes through basic preparation procedures including formatting and scaling to satisfy the detection model's input needs.

After the image has been processed, it is sent to the deep learning model, which examines the visual content and finds pertinent PPE components by producing bounding boxes and confidence scores for every object found. Users can quickly determine whether safety compliance is maintained by viewing the findings on the online interface, where identified PPE items are highlighted. Real-time response and seamless communication are guaranteed by the frontend interface's connection with the backend model. The system as a whole is assessed by to how well it can recognise PPE elements in various input photos, exhibiting dependable performance in real-world situations. This approach is appropriate for practical implementation in industrial safety monitoring applications because it prioritises system implementation, usability, and real-time detection over model training.

IV. Experimental Results

A series of test photos of people wearing and not wearing personal protective equipment under various circumstances was used to assess the effectiveness of the suggested PPE detection system. The evaluation mainly concentrates on detection efficacy and system responsiveness rather than training accuracy because the system is built on a pre-trained deep learning model. In the majority of test scenarios, the model was able to correctly identify important PPE items including safety vests and helmets despite differences in background, illumination, and object placement. Bounding boxes and confidence scores were used to display the detection results, making it easy for users to comprehend which safety equipment was found.

While small errors were noted when objects were partially obscured or when photos were of poor quality, the algorithm showed excellent reliability in detecting PPE components that were plainly visible. The seamless processing of user inputs was guaranteed by the integration with the Django-based web application, with little delay between the upload of images and the creation of results. The system performed satisfactorily overall in terms of response speed, usability, and detection accuracy, making it appropriate for real-world use in workplace safety monitoring. These findings confirm how well deep learning and a web-based interface work together to produce an effective and automated PPE compliance system.

V. Conclusion

In order to enhance workplace safety monitoring, this research offers a vision-based PPE detection system that integrates deep learning techniques with a web-based application. The technology effectively recognises vital safety gear, such helmets and vests, from input photos by utilising a pre-trained object identification model. A user-friendly interface that facilitates simple interaction and real-time result visualisation is made possible by the usage of the Django framework. The suggested approach improves PPE compliance inspections' accuracy and consistency while lowering reliance on manual supervision. The technology is suited for practical deployment because experimental findings show that it operates dependably under a variety of situations. Overall, this work shows how deep learning and web technologies can be combined to build intelligent, scalable, and efficient safety monitoring systems.

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