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Helmet Detection for Workers Safety

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Abstract: *Ensuring safety in industrial and construction environments is paramount for the well-being of employees. Real-time object detection plays a crucial role in detecting safety compliance violations, such as workers not wearing safety helmets. To address this issue, we propose a digital safety helmet monitoring system based on convolutional neural networks (CNNs). Our approach combines machine learning and image processing techniques to accurately identify whether workers are wearing helmets or not. By leveraging a diverse dataset and considering various factors like colour, we train the CNN algorithm to detect helmets effectively. Additionally, we integrate an alarm system to provide immediate alerts for non-compliance. Our system utilizes OpenCV for camera access, allowing real-time monitoring and efficient processing. Compared to previous methods, our approach demonstrates improved speed and effectiveness in ensuring worker safety. The automatic monitoring method presented in this project contributes to enhancing construction site safety by accurately detecting safety helmet usage. Through the utilization of live images and robust algorithms, our system achieves high accuracy rates, making it a valuable tool for safety enforcement in industrial and construction environments.*

Keywords: Safety, Industrial, Construction, Real time object detection, OpenCV, Automatic Monitoring, Image Processing

I. INTRODUCTION

Worker safety is a top priority in any industrial setting. Neglecting to wear safety helmets poses a significant risk to workers, making it crucial to develop an automatic surveillance system that can detect individuals without helmets. This system would not only enhance safety but also reduce the labor-intensive task of manually monitoring violations.

The use of safety helmets is essential for reducing injuries in construction sites. However, due to various factors, helmets are not always worn correctly. Therefore, an automatic safety helmet detection system based on computer vision is of utmost importance.Safety is of paramount importance in industrial and construction environments, where workers face multiple hazards. One critical aspect of ensuring worker safety is ensuring the proper usage of safety helmets. Failing to wear helmets can lead to severe accidents and even fatalities. To address this issue, it is crucial to develop a real-time automatic surveillance system that can detect workers without helmets.

In this project, we propose a safety helmet detection method that utilizes Convolutional Neural Networks (CNNs). CNNs have demonstrated outstanding performance in various computer vision tasks, including object detection. By harnessing the power of deep learning and image processing techniques, we aim to create an intelligent surveillance system that can effectively monitor workers' compliance with safety helmet usage. Our main objective is to develop a digital safety helmet monitoring system that can detect workers without helmets, reducing the need for labor-intensive manual monitoring. By employing machine learning algorithms and leveraging a diverse dataset, our system can efficiently detect the presence or absence of safety helmets in real-time scenarios.

CNNs are particularly suitable for this task, as they can learn hierarchical features and patterns from images, enabling accurate differentiation between safety helmets and other objects or backgrounds. By training the CNN model on annotated images of workers with and without helmets, we enable it to make precise predictions on unseen images. To enhance the functionality of our system, we integrate OpenCV for camera access, facilitating real-time monitoring of workers in industrial and construction environments. The system continuously captures live images, processes them using the trained CNN model, and generates immediate alerts or notifications whenever a worker is detected without a safety helmet.

Additionally, we incorporate an alarm system that produces distinct alert sounds based on the specific fieldwork or hazard involved. This feature aims to draw immediate attention to non-compliant workers, reinforcing the significance of safety helmet usage. Compared to previous methods, our project focuses on improving the speed and efficiency of safety helmet detection. Through advanced algorithms and real-time video analysis, our system achieves a high level of accuracy, mitigating the risk of accidents and fostering a safer work environment.In conclusion, the implementation of a safety helmet detection system based on CNNs and image processing techniques represents a significant advancement in worker safety. By automating the monitoring process and providing instant alerts for non-compliance, our system contributes to accident prevention and the protection of workers in industrial and construction settings.

II. LITERATURE REVIEW

Following are some documentation we havw searched.

Swapnil Kurkute , Nikita Ahirao , R. G. Ankad , V. B. Khatal"IOT Based Smart System for the Helmet DetectionProceedings of International" in 2019. Helmets play a critical role in safeguarding bikers from severe injuries. Without wearing a helmet, bikers are highly vulnerable to dangerous accidents, particularly in congested areas or at high speeds. The information mentioned above has been gathered from a reliable internet source. Based on this, we propose the development of a smart system as an integral component of two-wheelers. This system will be responsible for controlling the ignition system of the bike, allowing it to start only when the biker is wearing a helmet.

Han LiangORCIDandSuyoungSeo *ORCID, "Automatic Detection of Construction Workers' Helmet Wear Based on Lightweight Deep Learning"Our proposed automatic helmet detection system is well-suited for real-world construction environments, offering continuous monitoring of workers' adherence to safety regulations. By effectively identifying individuals who are not wearing helmets, the system has the potential to significantly mitigate the risk of head injuries. It can promptly issue alerts or warnings to non-compliant workers or supervisors, facilitating timely intervention and enforcement of safety protocols. Furthermore, the lightweight design of our approach allows for seamless integration with diverse devices such as drones, security cameras, and wearable devices. This versatility enables widespread adoption of the system and enhances overall safety standards within the construction industry.

Munkh-ErdeneOtgonbold, "An Extended Dataset and Benchmarking for Safety Helmet Detection" in 2022. Developing an effective deep-learning-based helmet detection model typically necessitates a substantial quantity of training data. Unfortunately, there is a scarcity of publicly available safety helmet datasets documented in the existing literature. Furthermore, the available datasets often suffer from incomplete labeling, and the labeled datasets are limited in terms of the number of classes they encompass. To address this gap, this paper introduces the Safety HELmet dataset with 5K images (SHEL5K), an augmented and enhanced version of the SHD dataset. The SHEL5K dataset provides a more comprehensive and diverse collection of 5,000 images specifically curated for safety helmet detection research.

"Safety Helmet Detection in Industrial Environment using Deep Learning" in 2020 by Ankit Kamboj and Nilesh Powar, Cummins Technologies India Pvt. India. To analyze the video data collected from an industrial plant, a range of image processing techniques are employed. This research introduces a practical and innovative safety detection framework, leveraging the power of Convolutional Neural Networks (CNN). In the first step, the CNN is utilized to detect individuals within the video data, while the second step focuses on identifying whether the detected person is wearing a safety helmet. The proposed model is then benchmarked for deep learning inference on a Dell Advanced Tower workstation. Through a comparative study, the effectiveness of the proposed approach is evaluated by analyzing the detection accuracy, measured in terms of average precision. The results of the analysis shed light on the efficacy of the proposed framework, showcasing its potential in enhancing safety protocols within industrial settings.

III. METHODOLOGY

As the mining industry expands in our country, there is a corresponding increase in the demand for workers. Unfortunately, the lack of adherence to safety measures, such as wearing helmets, has led to numerous fatalities at worksites. Additionally, delayed medical attention exacerbates the severity of injuries. The primary objective of our project is to ensure the security and safety of workers, specifically by addressing the issue of helmet non-compliance.

While studying a research paper focused on safety helmet detection for bike riders, we have shifted our focus to the safety of workers. Unlike the previous study, which concentrated solely on bike riders, our project emphasizes the safety of workers in various industrial settings.

To enhance security, we have implemented a login and registration system, ensuring restricted access and enabling quick alert mechanisms. Additionally, we have incorporated a music system that functions as an alarm, reminding workers to wear their helmets promptly. Compared to previous methods, our project incorporates faster mechanisms, enabling efficient and swift processes. Furthermore, we have introduced different alarm tunes tailored to specific fieldwork requirements.

The automatic monitoring system plays a vital role in overseeing construction workers and ensuring compliance with safety helmet regulations at construction sites. The live image stream allows for accurate and real-time monitoring, thanks to the algorithms employed.

In contrast to the research paper, which solely utilized the CNN algorithm, our project leverages both the CNN and YOLO tool algorithms. To facilitate effective training, we have assembled a dataset comprising a minimum of 5,000 standardized images, all with consistent dimensions. Each image in the dataset represents a valuable piece of information that contributes significantly to our project.

We have organized and stored the dataset using the widely adopted spreadsheet or CSV format. This format presents the dataset as a structured table, with individual images represented as rows and various attributes or features associated with each image represented as columns. By adopting this tabular representation, we ensure efficient data handling and analysis. It's worth noting that while the dataset primarily consists of images, it may also include supplementary data or metadata that enhances the training and analysis processes.

Included below are sample images that offer an overview of the dataset. These images encompass a diverse range of subjects and scenarios, allowing our model to generalize and make accurate predictions.

Annotation in Dataset :In the YOLO labeling format, a corresponding .txt file is generated for each image file in the same directory. These .txt files contain annotations specific to the corresponding image, including object class, object coordinates, as well as the height and width of the objects. This labeling format ensures that each image is accompanied by its respective annotation file, providing comprehensive information about the objects present in the image.

The dataset comprises training images depicting individuals wearing helmets, which serve as the primary source of data. Alongside each image, there is a corresponding text file containing annotations. These annotation files include detailed information such as the bounding box coordinates that enclose the helmets in the images, as well as other relevant details. By combining the images and their corresponding annotation files, we create a comprehensive dataset that provides both visual representations and precise annotations for the helmets worn in the images.

Within our dataset folder, you will find a collection of images. Each image is accompanied by its corresponding annotation file, ensuring that we have consistent annotations for all the images.

The initial step of our process involves capturing live images of workers using OpenCV. These images are then processed through our algorithm, which utilizes the CNN model to extract a feature vector of size 7. This feature vector includes information such as the object's center, bounding box coordinates, and other relevant details.

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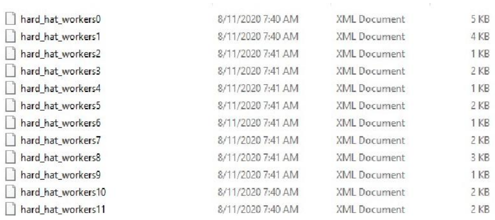

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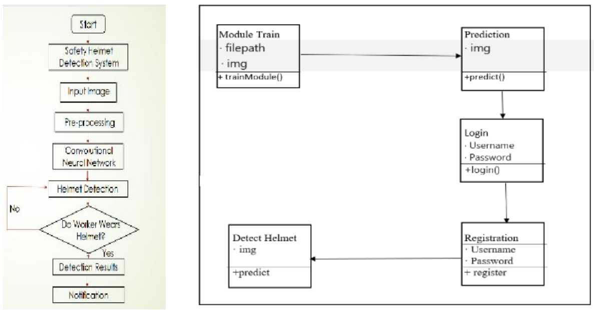
Next, we apply a grid to the image, dividing it into smaller sections, such as 3x3, 4x4, or 16x16, depending on our requirements and preferences.

To assess the performance of our object detection, we utilize Intersection over Union (IoU). IoU is a metric that evaluates how well the predicted bounding box aligns with the ground truth bounding box. It provides a measure of overlap between the two bounding boxes and serves as a crucial evaluation metric in our tutorial.

It's important to note that the main distinction between CNN and YOLO lies in the handling of bounding boxes and the utilization of a grid for the vector array. These differences in approach contribute to the unique strengths and characteristics of each algorithm..



Class distribution in project.

1. Starting with live image it may be video stream or image frame.
2. After that we are doing the operations on picture like cropping, enhancing, adjusting etc.
3. Then, its going to converting part
4. Here we are applying grey scaling for that we require proper fixed sized image i.e. 200 × 200 (black and white). now, the dataset is main in this phase where we are collecting no. of images which are going to be trained by algorithms.
5. Giving input to train module
6. If module is not satisfied then the whole process is continued from dataset.
7. And if yes then the trained module give input.
8. At last, after getting the input the train module will give output by predicting basis on trained module
9. And the output will show as an alarm.
10. Non-max suppression: a crucial step in object detection algorithms, is employed to identify and select the most suitable bounding box for an object.

To determine the most accurate bounding box from multiple predicted bounding boxes, object detection algorithms employ a technique called non-maximum suppression (NMS).

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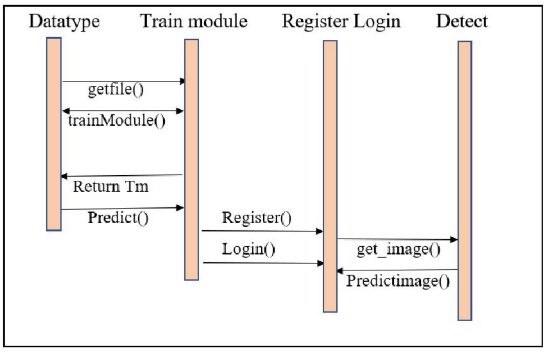
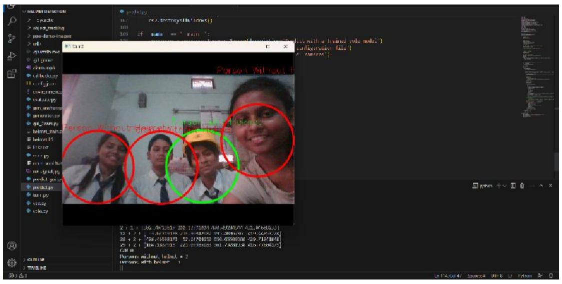


Sequence of our project

This essential technique is utilized to "suppress" or filter out the less probable bounding boxes and retain only the most optimal one. Having established the necessity and purpose of NMS, let us delve into its implementation and understand the underlying concept.

Anchor Boxes: Anchor boxes are pre-defined bounding boxes with fixed dimensions, typically representing various scales and aspect ratios. These boxes are carefully selected to align with the size and shape of specific object classes that need to be detected. The choice of anchor boxes is influenced by the object sizes observed in the training datasets, ensuring they capture the range of scales and aspect ratios encountered in real-world scenarios.



Outputs with accuracy

IV. CONCLUSION

The project proposes a novel approach for accurately detecting the presence of safety helmets worn by workers using Convolutional Neural Networks (CNNs). The model leverages the YOLO algorithm, renowned for its object detection capabilities, to identify safety helmets in the given images. To facilitate model training and evaluation, a comprehensive dataset comprising 5,000 images encompassing diverse helmet variations is meticulously curated. This dataset is subsequently split into three parts for training, validation, and testing purposes. The experimental results convincingly demonstrate the efficacy of the proposed method in accurately detecting safety helmets worn by construction workers at construction sites. By presenting an alternative solution, this method contributes to enhancing safety management and promoting compliance with helmet-wearing regulations in the construction industry. The demonstrated safety helmet detection system exhibits robust performance in identifying workers wearing helmets within industrial environments. To further improve detection accuracy and minimize false positives, ongoing efforts are directed towards refining the prediction mechanisms.

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