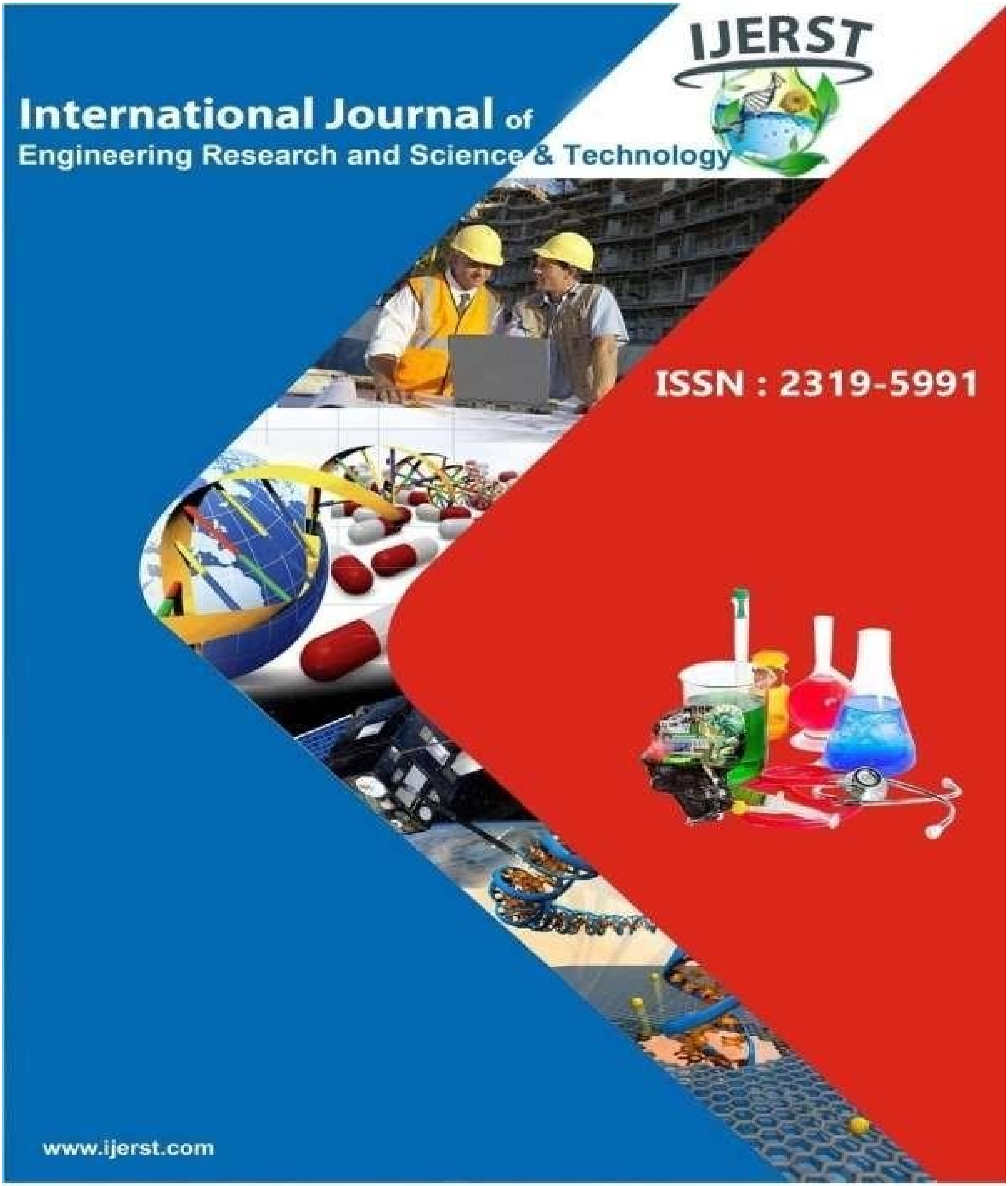

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REAL TIME HELMET DETECTION USING YOLO

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ABSTRACT

Real-time worker helmet detection is an AI-powered computer vision system that ensures workplace safety by automatically identifying whether workers are wearing helmets in live video streams using deep learning models like YOLO and RCNN. Designed for industries such as construction, manufacturing, and mining, the system offers features like instant safety alerts, high-accuracy detection under challenging conditions, continuous monitoring with violation logging, and a Flask-based web interface for remote supervision. It supports scalable, low-latency deployment on edge or cloud platforms and can be customized for other PPE detection, offering a cost-effective solution that minimizes manual supervision while enhancing compliance and safety.

INTRODUCTION

In industrial settings like construction sites, factories, and mining areas, ensuring workers wear helmets is vital for safety compliance and accident prevention. This project leverages real-time helmet detection using computer vision and deep learning, combining YOLO (You Only Look Once) and RCNN (Region-Based Convolutional Neural Network) for fast and accurate identification of non-compliant workers. The system uses OpenCV for image preprocessing, Python for backend integration, and Flask to deliver a web-based dashboard. Live video feeds from CCTV or web cameras are continuously analyzed, detecting helmet violations and instantly alerting supervisors to enhance workplace safety.

LITERATURE SURVEY

Helmet detection using computer vision and deep learning has emerged as a critical area of research, especially for ensuring safety compliance in construction and industrial environments. Advanced object

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detection algorithms like YOLO (v3, v5), Faster R-CNN, and Mask R-CNN have been widely used to identify helmet usage in real-time video feeds. YOLO models strike an optimal balance between accuracy and processing speed, making them ideal for real-time applications, while Faster R-CNN and Mask R-CNN, though more accurate, are computationally intensive and better suited for offline analysis. Deep learning architectures such as CNNs, ResNet, and MobileNet are effective for classification tasks but often fall short in real-time performance. Key challenges in practical deployment include variations in lighting, occlusion, improper helmet usage, and low-resolution imagery. Integrating IoT and edge computing can significantly improve the system's responsiveness and reliability by enabling localized, low-latency processing.

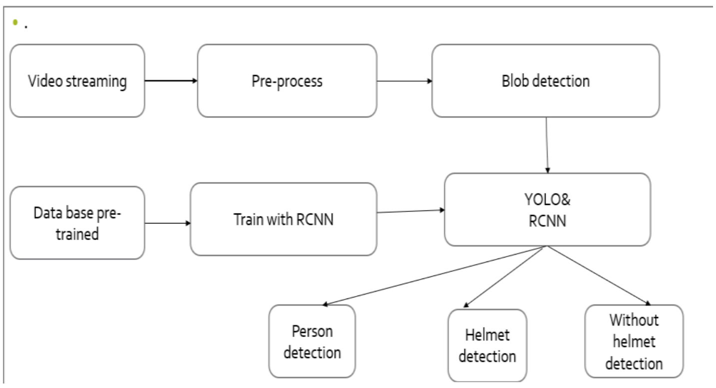
EXISTING SYSTEM

Helmet detection is vital for ensuring worker safety in construction and industrial settings, with various computer vision and machine learning methods developed to automate helmet usage detection. Approaches such as Support Vector Machines (SVM), Convolutional Neural Networks (CNN), YOLO (You Only Look Once), Kalman Filters, and Region-Based CNN (RCNN) have been used, each offering distinct benefits and limitations. While SVM and CNN provide high accuracy, they are computationally intensive and struggle in dynamic environments. YOLOv4 offers fast real-time detection but can sacrifice accuracy, particularly in complex scenes. The Kalman Filter is effective for tracking movement but lacks object classification and is sensitive to noise. This section analyzes the strengths, weaknesses, and real-time application suitability of these methods for helmet detection.

PROPOSED SYSTEM

The proposed system enhances worker safety in industrial and construction environments by using advanced deep learning models like YOLO and RCNN for real-time helmet detection. Unlike traditional methods that require human supervision, this automated system analyzes live video feeds to identify workers without helmets, sending instant alerts via email or SMS. The YOLO model offers fast object detection, while RCNN ensures high precision by reducing false positives. Integrated with a Flask-based web app, the system allows supervisors to monitor safety remotely and stores violation records for long-term analysis. Using GPU acceleration, continuous model training, and data analytics, the system improves efficiency, accuracy, and compliance, making it a scalable solution for maintaining workplace safety.

SYSTEM ARCHITECTURE



Real-time helmet detection using YOLO (You Only Look Once) involves

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leveraging a pre-trained YOLO object detection model—such as YOLOv5 or YOLOv8—to identify whether a person riding a two-wheeler is wearing a helmet. The process begins with collecting and annotating a dataset containing images of riders with and without helmets, then training or fine-tuning the YOLO model using this labeled data. Once trained, the model is deployed in real-time using a webcam or CCTV feed, where each frame is passed through the YOLO network to detect and classify the presence or absence of helmets. The system can be further integrated with alert mechanisms or number plate recognition for law enforcement, providing an efficient, automated solution for road safety monitoring.

Software Requirements

1. Operating System : Windows
2. Module : Open CV
3. Frame work : Numpy
4. Processor : i5

Hardware Requirements

1. Pentium 4 processor
2. 2 GB RAM
3. 80 GB Hard Disk Space

CONCLUSION

We developed a real-time helmet and person detection system for construction sites using the YOLO object detection framework, aiming to enhance safety by identifying individuals without helmets. Future improvements will focus on increasing detection accuracy and robustness through techniques like multi-scale object detection, contextual understanding using scene layout and object relationships, and adapting to environmental variations such as lighting and weather. Additionally, we plan to deploy the system on-site with integrated alert mechanisms and explore advanced methods like graph and recurrent neural networks to model temporal and spatial dependencies for more accurate and reliable scene interpretation.

FUTURE SCOPE

The future of worker helmet detection using OpenCV and Python looks highly promising, especially with the growing focus on safety in sectors like construction, manufacturing, mining, and logistics. Advancements in machine learning and computer vision, particularly deep learning models, are expected to significantly improve detection accuracy under diverse conditions such as poor lighting or partial occlusion. Furthermore, this technology can be seamlessly integrated into workplace safety systems to automatically trigger alerts or actions when a worker is found without proper headgear, reinforcing compliance with safety standards.

REFERENCES

1. **Redmon et al. (2016)** – Introduced YOLO (You Only Look Once), a real-time object detection framework that processes images in a single pass, offering both speed and accuracy in object detection tasks.
2. **Ren et al. (2015)** – Proposed Faster R-CNN, a powerful object detection method that uses Region Proposal Networks (RPN) for faster and more

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accurate detection compared to traditional techniques.

3. **He et al. (2017)** – Developed Mask R-CNN, an extension of Faster R-CNN, which not only detects objects but also generates pixel-wise segmentation masks, improving object localization and recognition.
4. **Zhang et al. (2020)** – Presented a deep learning-based approach for detecting industrial safety helmets in construction site environments, highlighting practical applications for enhancing workplace safety.
5. **Chandran & Narayanan (2020)** – Proposed a method leveraging deep learning for detecting safety helmets on construction workers, emphasizing real-world application and automation in construction safety.
6. **Huang et al. (2020)** – Developed an intelligent system using deep learning to detect improper helmet wearing, aiming to improve compliance and safety in industrial environments.