IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 4, April 2025

DOI: 10.17148/IJARCCE.2025.14487

Deep Learning-Based Face and Helmet Detection System for Workplace Safety and Attendance Tracking

Balaji V[1], Jai Surya K[2], J Vinothini[3]

Student, B.E. CSE, Anand Institute of Higher Technology, Chennai, India[1, 2]

Assistant Professor, CSE, Anand Institute of Higher Technology, Chennai, India [3]

Abstract: In modern industrial and construction environments, maintaining accurate employee attendance and enforcing strict safety compliance are vital components of efficient workforce management. This project presents an AI-driven, real-time attendance and safety monitoring system that leverages deep learning technologies to address these critical needs. The system integrates facial recognition using a high-precision deep learning model from the face recognition library and helmet detection using the YOLOv8 object detection algorithm. It ensures that attendance is marked only when an employee is both properly identified and wearing the required safety helmet, thereby promoting safety standards while eliminating identity fraud or proxy attendance. Captured data such as employee name, helmet status, and timestamp is stored securely in Firebase Firestore, providing real-time synchronization and robust cloud-based data management. An intelligent alert mechanism is also embedded into the system, which triggers a notification when unauthorized individuals or non-compliant workers are detected, enhancing on-site security and proactive incident response. A Flutter-based mobile application complements the system by providing real-time access to attendance and safety compliance records, offering a user-friendly interface for administrators and supervisors to monitor workforce activities. This intelligent framework not only automates routine attendance tasks but also supports scalable safety enforcement, contributing to a safer and more accountable working environment. By combining artificial intelligence, cloud computing, and real-time monitoring, the system paves the way for smarter workforce governance in safety-critical sectors.

Keywords: Face Recognition, YOLO, Helmet Detection, Firebase, Workplace Safety, Deep Learning, Real-Time AI.

I. INTRODUCTION

Ensuring workplace safety and accurate attendance tracking is essential in high-risk environments such as construction sites, manufacturing units, and industrial workspaces. These sectors are often prone to occupational hazards, where strict adherence to safety protocols—like wearing helmets—is mandatory. Simultaneously, maintaining reliable attendance logs is crucial for workforce monitoring, productivity assessment, and payroll management. However, traditional attendance systems—such as manual registers, RFID tags, or biometric scanners—often face critical shortcomings. They are susceptible to errors, manipulation (e.g., proxy attendance), require human oversight, and offer no built-in mechanism to verify safety compliance like helmet usage.

In parallel, enforcing safety regulations on-site usually depends on human supervision or standalone surveillance systems, which are inconsistent, resource-intensive, and often ineffective in detecting real-time violations. This dual challenge of reliable attendance tracking and enforcing PPE (Personal Protective Equipment) compliance calls for a smart, automated, and scalable solution.

This study presents an AI-powered Face and Helmet Detection System for real-time attendance and safety enforcement. The proposed solution integrates face recognition and helmet detection using advanced computer vision, deep learning, and cloud technologies. Specifically, the system utilizes the face_recognition deep learning library to identify and authenticate employees, and the YOLOv8 (You Only Look Once) object detection model to verify helmet compliance. These two modules operate in tandem: attendance is only marked when an employee is recognized and detected to be wearing a helmet—ensuring both identity verification and adherence to safety regulations.

To streamline data handling, the system uses Firebase Firestore, a cloud-based NoSQL database, for storing attendance records and helmet compliance statuses. All information is automatically logged in real time and made accessible through

DOI: 10.17148/IJARCCE.2025.14487

a Flutter-based Android application designed for administrators or supervisors. This app provides a user-friendly dashboard to review attendance logs, check safety violations, and monitor employee compliance anytime, from anywhere.

The architecture of the system is modular and extensible, capable of future integration with additional safety gear detection, such as face masks, reflective vests, or gloves. This makes it ideal for evolving industry standards and adaptable to various industrial scenarios.

II. RELATED WORK

Traditionally, helmet detection has been a challenging task, requiring prior identification of individuals before verifying compliance with safety regulations. Early approaches, such as the Haar-like feature algorithm introduced by Du et al. (2011) [11], exhibited high false-positive rates in real-world applications. With advancements in deep learning, CNN-based methods significantly improved detection accuracy and efficiency.

Fang et al. (2018) [18] employed Faster R-CNN to detect non-helmet-wearing workers, achieving high precision but slower processing due to its two-stage architecture. To enhance speed, Bo et al. (2019) [19] implemented YOLOv3 with DarkNet-53, achieving 96.6% accuracy in detecting unsafe worker actions.

The single-stage architecture of YOLO enabled real-time processing, making it well-suited for surveillance applications. Wu et al. (2019) [20] further improved YOLOv3 by integrating a DenseNet backbone, enhancing detection robustness, especially for occluded objects. Similarly, Long et al. (2019) [21] explored Single Shot MultiBox Detector (SSD) for helmet detection, achieving real-time performance at 21 FPS with strong accuracy.

A comparative study by Nath et al. (2020) [22] analyzed multiple YOLOv3-based helmet detection models with different architectures. The first model detected workers and helmets separately before classification, while the second simultaneously detected workers and helmets in a single CNN framework, achieving 72% accuracy at 11 FPS. The third model cropped images before classification, reaching 68% accuracy. Among these, the second approach provided the best balance of speed and accuracy.

With continuous advancements in YOLO, Hayat and Morgado-Dias (2022) [23] introduced YOLOv5x for automated helmet detection, optimizing performance for small object detection and low-light conditions. Wang et al. (2020) [24] developed a lightweight MobileNet-based CNN model for real-time helmet detection, achieving 89.4% accuracy at 62 FPS.

Other studies have focused on optimizing small object detection, such as SCRDet [25], which introduced a sampling fusion network for better detection in dense environments. SCRDet++ [26] further enhanced accuracy by implementing instance-level feature map denoising to reduce background interference.

In this study, we propose an automated attendance and safety compliance system that integrates deep learning-based face recognition and helmet detection.

The system leverages the face_recognition deep learning package for real-time face identification and YOLOv8 for helmet detection, optimizing both speed and accuracy. Attendance records are stored in Firebase Firestore, enabling cloud-based workforce management and salary automation.

Additionally, multi-scale feature fusion and spatial attention mechanisms enhance detection accuracy. The proposed system ensures real-time deployment in industrial environments, significantly improving helmet detection accuracy, processing efficiency, and automated workforce management whil promoting safety compliance.

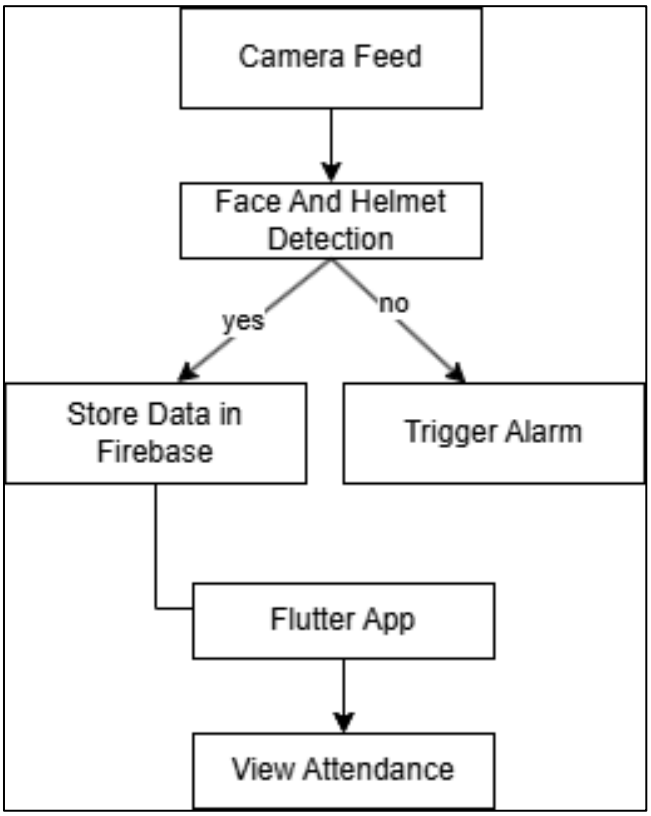
IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 4, April 2025

DOI: 10.17148/IJARCCE.2025.14487

III. PROPOSED METHODOLOGY



A. System Architecture

The system architecture automates attendance tracking and workplace safety compliance using face recognition and helmet detection. It consists of a Django-based web application for processing images and a Flutter mobile app for real-time monitoring of employee attendance and safety status. The backend, powered by Firebase Firestore, securely stores attendance records and triggers alerts for safety violations

B. Database Work Flow

The system starts by capturing live video frames through a camera, detecting employees for face recognition and helmet compliance verification. The django-based web application processes these frames using deep learning models to authenticate employees and ensure they are wearing helmets. If both conditions are met, attendance is recorded and stored in firebase firestore. If either condition fails, an alarm is triggered through a speaker to notify onsite personnel of the safety violation. Real-time data synchronization with firebase ensures that attendance records and compliance status are instantly updated. The flutter-based mobile application provides employees and administrators with access to attendance logs, safety compliance reports, and real-time alerts. Additionally, the system generates reports and analytics to help management track workforce attendance trends and enforce safety policies effectively.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 4, April 2025

DOI: 10.17148/IJARCCE.2025.14487

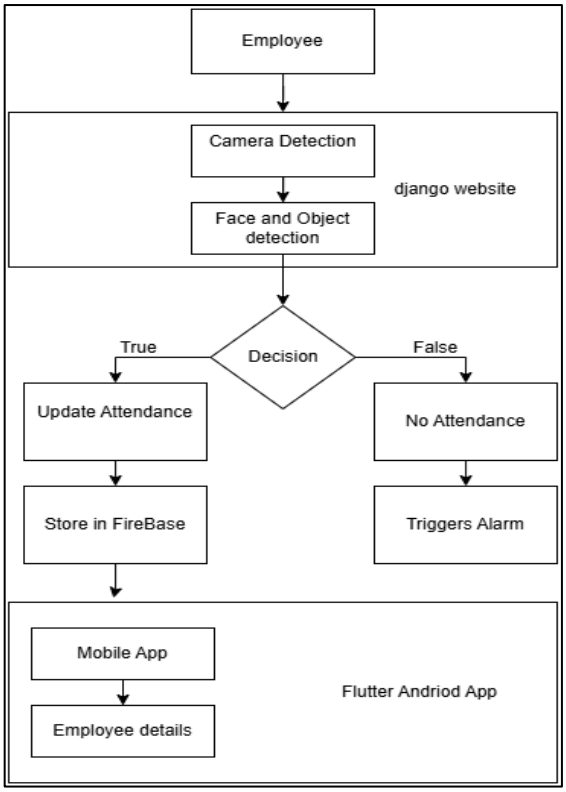


Fig (b) Work Flow estimation

C. IMPLEMENTATION

The system integrates AI-driven facial and helmet detection for automated attendance tracking and workplace safety compliance. It captures real-time video input from a webcam or CCTV, using deep learning models for face recognition and helmet detection. The attendance system logs entries only when both conditions are met, ensuring secure and accurate workforce monitoring. Salary computation is automated based on attendance logs and work hours, with records stored in a cloud-based database. Administrators can monitor attendance, compliance, and payroll via a web and mobile dashboard, providing real-time insights for improved workplace management

IV. RESULTS AND DISCUSSION

A. Overcomes

The proposed Face and Helmet Detection System significantly overcomes the limitations of traditional attendance and safety monitoring methods commonly used in industrial and construction environments. Traditional systems rely on manual registers, biometric scanners, or RFID cards, all of which are prone to manipulation, proxy attendance, and lack integrated safety verification. Furthermore, existing safety enforcement practices typically involve manual supervision to ensure helmet compliance, which is labor-intensive and often inconsistent. The developed system addresses these challenges by combining face recognition and helmet detection using deep learning models—face_recognition and YOLOv8—to automate identity verification and safety compliance simultaneously. This eliminates proxy attendance and ensures that attendance is only marked when a helmet is worn. Additionally, by leveraging Firebase for real-time cloud storage and integrating with a Flutter-based mobile dashboard, the system supports seamless data access, attendance monitoring, and salary calculation based on daily logs, all without manual intervention.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 4, April 2025
DOI: 10.17148/IJARCCE.2025.14487

B. Discussion

The integration of face and helmet detection into a unified system represents a technological leap in workforce safety and attendance automation. Unlike conventional approaches that treat identity verification and safety compliance as separate tasks, this system ensures that both are enforced simultaneously through real-time video processing and deep learning. The use of YOLOv8 for object detection allows accurate helmet detection under varying conditions, while face recognition ensures secure and personalized attendance logging. By storing attendance data in Firebase, the system enables real-time updates, cross-platform access, and centralized data management, which is particularly useful in large-scale industrial deployments.

The Flutter mobile application further enhances usability by providing supervisors with a live dashboard to track attendance and safety violations instantly. While the system addresses many existing shortcomings, it introduces new challenges such as ensuring accuracy under low-light or occluded face conditions, managing camera calibration, and handling diverse helmet styles. Future improvements could involve incorporating mask and vest detection, edge device optimization for real-time inference, and adaptive learning models to increase robustness. Overall, this project offers a scalable and practical solution for automating safety compliance and workforce management in high-risk environments.

V. CONCLUSION

In summary, The Face and Helmet Detection-Based Attendance System provides an effective and automated solution for workforce monitoring and safety enforcement. By integrating face recognition and helmet detection, the system enhances accuracy in attendance tracking while ensuring compliance with workplace safety regulations. The Django-based web application processes real-time video feeds to verify employee identity and helmet usage, while the Flutter mobile application offers supervisors instant access to attendance records, safety violations, and compliance reports.

Firebase Firestore enables secure and real-time data synchronization, allowing administrators to track attendance trends, detect safety breaches, and generate insightful reports for decision-making. The system also includes an automated alert mechanism that triggers alarms for safety violations, ensuring immediate corrective actions and reinforcing compliance. With cloud-based data storage and backup, the system guarantees data integrity, security, and quick recovery in case of failures. Performance optimization techniques, such as database indexing and efficient query processing, ensure seamless functionality even with large datasets. By integrating deep learning and cloud computing, this system significantly improves workforce management, enhances workplace safety, and streamlines payroll processing in industrial environments.

REFERENCES

[1]. YOLOv8: Real-Time Object Detection and Classification.
[2]. Additive Angular Margin Loss for Deep Face Recognition.
[3]. Helmet Detection in Construction Sites Using Deep Learning and Real-Time Image Processing.
[4]. A Deep Learning-Based Safety Helmet Detection Model for Industrial Environments
[5]. Cloud-Based Real-Time Attendance Management System Using Face Recognition and Firebase
[6]. Real-Time AI-Powered Workplace Safety Monitoring Using Computer Vision