Real-Time Safety Compliance Monitoring with YOLO for Helmet and Face Detection

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Abstract - In contemporary industrial environments, ensuring employee safety is a critical concern. This paper presents an intelligent safety system that integrates facial recognition and helmet detection technologies to automate the enforcement of workplace safety protocols. The system employs strategically deployed cameras, facial feature extraction using Computer vision libraries, and deep learning

Models based on Tensor Flow to identify individuals and verify helmet usage. By combining these technologies, the proposed solution enhances real-time monitoring, improves safety compliance, and mitigates the risk of workplace accidents.

Keywords -Workplace safety, facial recognition, helmet detection, computer vision, deep learning, Tensor Flow, safety compliance, automated monitoring

Introduction:

In contemporary workplaces, ensuring employee safety is a critical priority. To address this need, this project proposes an advanced safety monitoring system that integrates facial recognition and helmet detection technologies. By leveraging computer vision techniques and deep learning frameworks such as TensorFlow, the system is designed to automatically identify individuals and verify their compliance with safety regulations, particularly the mandatory use of helmets. Through the strategic deployment of cameras and the application of facial feature extraction on dedicated systems, this solution provides a robust and automated approach to enhancing workplace safety and enforcing protective protocols.

Proposed System

- The proposed system for helmet detection with face recognition offers a comprehensive solution aimed at elevating workplace safety through advanced technological integration.
- By strategically deploying cameras throughout key areas of the workplace, the system utilizes the facial features extraction algorithm named as Grassmann algorithm
- Extract the facial features and matched with database as Streaming data
- Integrate the system with helmet detection using YOLO algorithm
- Finally rise the alarm at the time of unauthorized access and also non-helmet detection

Proposed Methodology

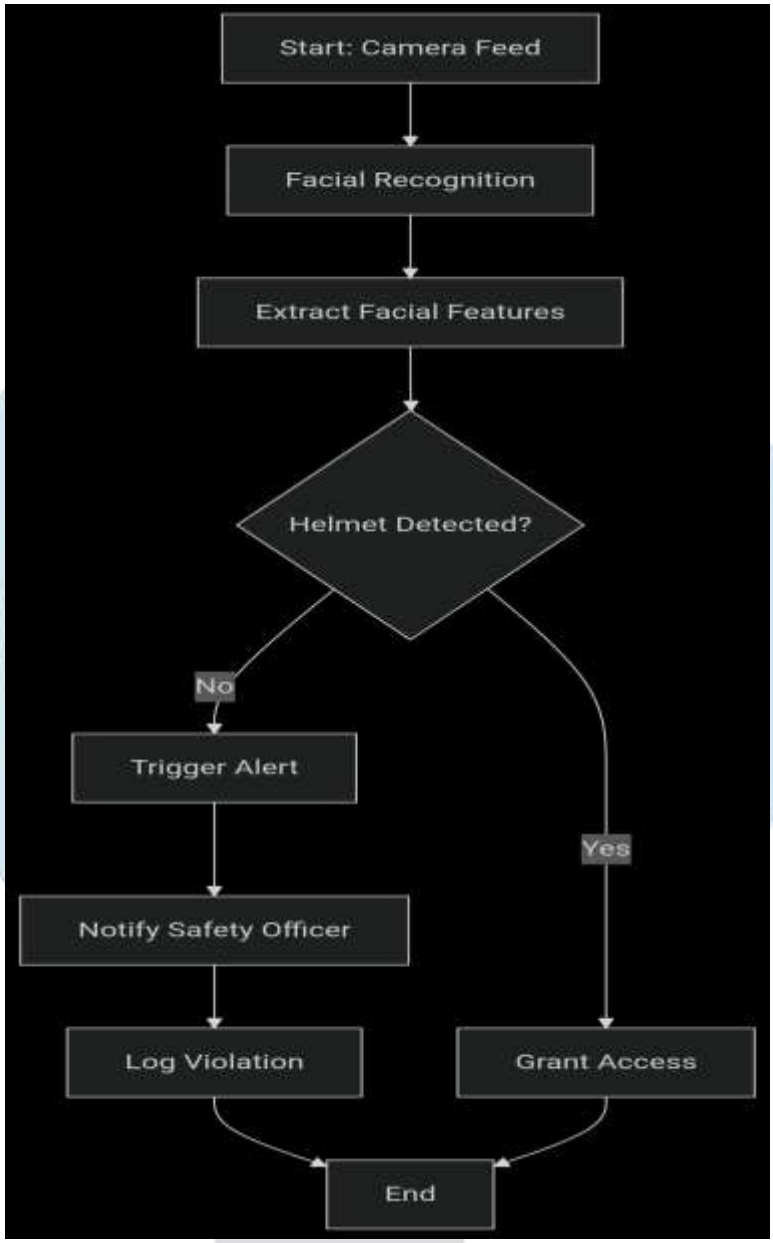
Face Recognition

Grassmann Algorithm:

- The proposed algorithm presents a novel perspective towards frame selection by utilizing feature richness as the criteria. It is our assertion that quantifying the feature richness of an image helps in extracting the frames that have higher possibility of containing discriminatory features. In order to compute feature-richness, first the input (detected face) image I is preprocessed to a standard size and converted to grayscale.
- By performing face detection first and considering only the facial region, we ensure that other non-face content of the frame does not interfere with the proposed algorithm. Given a pair of face coordinates, we determine a set of affine parameters for geometric normalization. The affine transformation maps the (x , y) coordinate from a source image to the (u ,v) coordinate of a normalized image.

CONTD…,

- Input: A set of P points on manifold
- $\{X_i\}^P_{(i=1)} \in G(d,D)$
- Output: Karcher mean μ_K
- 1. Set an initial estimate of Karcher mean $\mu_K = X_i$ by randomly picking one point in $X_i{}^P_{(i=1)}$
- 2. Compute the average tangent vector
- $A = 1/P \sum^P_{(i=1)} [\![\log_{\mu_K}(X_i)]\!]$
- 3. If $\|A\| < \varepsilon$ then return μ_K stop, else go to Step 4
- 4. Move μ_K in average tangent direction $\mu_K = \exp_{\mu_K}(\alpha A)$, where $\alpha > 0$ is a parameter of step size. Go to Step 2, until μ_K meets the termination conditions (reaching the max iterations, or other convergence conditions



MODULES

- Framework construction
- Camera capturing
- Face recognition
- Helmet classification
- Alert system

FRAMEWORK CONSTRUCTION

- In this module, admin can create the GUI for store the user details
- User details contains the information such as Employee id, name, mobile number, and so on.
- These details are trained as employee database

CAMERA CAPTURING:

- Typically deployed in industrial environments and construction sites where the use of helmets is imperative for personal protection, this system involves strategically placing cameras to capture images of the workplace.
- The collected visual data is then subjected to analysis by computer vision algorithms, often incorporating artificial intelligence. These algorithms are trained to discern the presence or absence of safety helmets on individuals within the captured frames
- In this module, enable the camera to analyze the safety helmets
- Implement binarization steps to separate the foreground from background scenes

FACE RECOGNITION:

- By applying the Grassmann algorithm—a facial features extraction technique—the system places cameras in strategic locations throughout critical sections of the workplace.
- A solid foundation for further identification is provided by this algorithm, which makes it possible to extract distinguishing facial traits.
- In this module, construct the face features vectors and also recognize the employees

HELMET CLASSIFICATION:

- In this module implement object detection system using YOLO algorithm
- Then detect the objects and draw bounding box on that objects
- Verify the features which are contains the helmet objects
- If helmet object not occurred means, forward to next

ALERT SYSTEM:

- In this module, recognized user details are extracted from database which are extracted from trained database
- And send the notification about unauthorized access or no helmet detection
- Notification in terms of SMS or Alarm.

CONCLUSION

In conclusion, technology has changed the landscape of worker safety on construction sites by improving compliance and monitoring. Using the Grassmann and YOLO algorithms, the suggested system combines helmet detection and facial recognition, offering a sophisticated outcome. With the help of real-time data processing and well-placed cameras, this system not only enforces safety regulations by looking for safety helmets but also guarantees allowed entry through facial recognition.

The YOLO algorithm efficiently streamlines helmet detection, while the Grassmann method makes exact facial feature extraction possible, offering a dependable foundation for identifications

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