Low-Cost AI-Based PPE Compliance Detection System

Project Overview

This project presents a low-cost AI-based system that automatically detects if workers are wearing Personal Protective Equipment (PPE) like helmets and safety vests in industrial settings (e.g., construction sites). It uses YOLO object detection, a Raspberry Pi 5, a camera, and a GSM module to provide real-time alerts through buzzer sound and SMS messages.

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Features

- Real-time helmet and vest detection using YOLOv11
- Buzzer alert for immediate feedback to the worker
- SMS alert to supervisor via SIM800L GSM module
- Image logging for violations with timestamp
- Low-cost and easy to set up using open-source tools

System Components

Component	Description
Raspberry Pi 5	Edge device for AI inference
Pi Camera V2	Captures real-time images
YOLOv11 Model	Object detection algorithm
SIM800L GSM Module	Sends SMS alerts
Buzzer (85dB)	Audible warning
SD Card (32GB)	Stores OS, logs, and images

How It Works

1. Camera-captures live feed of workers.
2. YOLO model-detects if helmet and safety vest are worn.
3. If PPE is missing:
   - Buzzer is activated
   - SMS is sent via GSM module
   - Image of violation is saved locally

Sample Output

- ![Helmet Violation] (images/sample_violation.png)
  Detected: No Helmet --- SMS sent and buzzer triggered.

Prerequisites

- Python 3.9
- Raspberry Pi OS (Bookworm or Bullseye)
- OpenCV 4.x
- PyTorch
- RPi.GPIO
- pySerial