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Suraksha Weapon Detection and Alert System

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Abstract:

The Suraksha Weapon Detection & Alert System is a real-time, AI-based software solution designed to detect weapons using camera input. The software captures video frames through OpenCV and processes them with a lightweight deep-learning model such as YOLO or MobileNet-SSD. The system identifies harmful objects like knives by analyzing each frame and applies multi-frame confirmation and threshold filtering to reduce false positives. Optimized using TensorFlow Lite or PyTorch, it runs efficiently on edge devices such as Raspberry Pi. Once a weapon is detected, the software triggers an alert signal, forming the core intelligence of a reliable security monitoring system.

Keywords **— Weapon Detection, Computer Vision, Deep Learning, YOLO, OpenCV, TensorFlow Lite / PyTorch, Real-time Detection**

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I. INTRODUCTION

The Suraksha Weapon Detection & Alert System is an AI-based software solution that detects weapons in real time using live video analysis. It uses OpenCV for frame processing and deep-learning models like YOLO or MobileNet-SSD to identify harmful objects. Multi-frame validation and threshold filtering improve accuracy, while optimized models enable fast inference on edge devices like Raspberry Pi.

II. LITERATURE REVIEW

Weapon detection has progressed from traditional techniques like Haar cascades and HOG-SVM to advanced deep-learning models such as Faster R-CNN, SSD, and YOLO, offering improved speed and accuracy. Recent studies favor YOLOv5/YOLOv8 and MobileNet-SSD for real-time edge deployment. Research also highlights the importance of high-quality datasets, augmentation, and multi-frame validation to minimize false positives

III. SYSTEM ARCHITECTURE AND METHODOLOGY.

The system uses a real-time AI pipeline where the camera captures frames, OpenCV preprocesses them, and a deep-learning model like YOLO identifies weapons. The decision engine validates detection, and confirmed alerts are sent to the communication module.

A. Methodology

1. **Frame Capture**
   Video is continuously captured from a camera using OpenCV. Frames are resized and preprocessed for efficient model inference.
2. **Pre-processing**
   Image normalization, resizing, and noise reduction techniques prepare the frame for accurate detection.
3. **Deep-Learning Inference**
   A trained YOLO/MobileNet model performs object detection to identify harmful items within the frame. Bounding boxes and confidence scores are generated.
4. **Multi-Frame Confirmation**
   To minimize false positives, the system checks weapon detection across several consecutive frames before confirming.
5. **Confidence-Based Filtering**
   Low-confidence detections are discarded using predefined confidence thresholds.
6. **Alert Trigger Mechanism**
   After confirmed detection, the software creates an alert message and passes it to the communication module (MQTT/BLE) for action.

B. System Architecture

The system architecture of the Suraksha Weapon Detection & Alert System is built as a layered, modular pipeline designed for real-time object detection and alert generation. The software system consists of five major layers: Input Layer, Pre-processing Layer, Detection Layer, Decision Layer, and Alert Communication Layer.

1. **Input Layer (Camera Stream Module)**
   Capturing continuous video frames using Rasberry Pi camera or USB.
   Provides a live feed to the processing pipeline.
2. **Pre-Processing Layer**
   Utilizes OpenCV for resizing, normalization, image enhancement, and noise reduction.
   Converts raw frames into standardized input tensors suitable for deep-learning models.
3. **Detection Layer(AI Model Engine)**
   Uses deep-learning models such as YOLOv5/YOLOv8 or MobileNet-SSD.
   Detects weapon-like objects and generates bounding boxes with confidence scores.
   Implemented using TensorFlow Lite or PyTorch.
4. **Decision Layer (Validation & Filtering Module)**
   Applies algorithmic checks such as:
   - Multi-frame confirmation
   - Confidence threshold filtering
   - Spatial size filtering

   Reduces false positives by verifying detection consistency.
5. **Alert Communication Layer**
   Converts final detection results into alert packets.
   Sends alert signals via BLE/MQTT to connected devices (wearables/hardware).
   Responsible for formatting message payloads.

Fig 1: Workflow

IV. CONCLUSION

The Suraksha Weapon Detection & Alert System provides an effective software-based solution for real-time weapon identification using computer vision and deep learning. By processing live video frames through OpenCV and applying YOLO/MobileNet models, the system delivers accurate detection. The decision engine enhances reliability through confidence filtering and multi-frame validation, reducing false positives. Once detection is confirmed, the software seamlessly triggers alerts through the communication module. Overall, the system offers a reliable, efficient, and scalable approach for enhanced security monitoring

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