Real-Time Fire and Smoke Detection Using OpenCV

1. Introduction

This project focuses on detecting fire and smoke in real-time video streams using OpenCV.

It can be used for early warning systems in homes, offices, forests, and public spaces to improve safety and reduce response time to fires.

2. Objectives

- Detect fire and smoke using camera feed in real-time.
- Trigger alert upon detection.
- Use simple image processing techniques without heavy hardware requirements.

3. Technologies Used

- Python 3
- OpenCV
- NumPy
- Visual Studio Code
- Webcam or video input

4. Methodology

1. Capture video frame-by-frame.
2. Convert frame to HSV/gray color space.
3. Apply color thresholding for fire detection.
4. Use motion and contour analysis for smoke detection.

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5. Display detection results in real-time with bounding boxes and alerts.

5. Fire Detection Logic

- Use HSV color thresholds to detect typical fire colors (red, orange, yellow).

- Analyze contours in thresholded image.

- Filter by area to ignore small/noise detections.

6. Smoke Detection Logic

- Convert frame to grayscale.

- Apply background subtraction to detect motion.

- Check for light gray regions.

- Combine motion and color logic to confirm smoke presence.

7. Results

- Successfully detects both fire and smoke in real-time video.

- Can issue alerts such as displaying warning messages or activating sound.

- Lightweight and works well with webcam streams.

8. Future Enhancements

- Integrate with IoT for remote alerts.

- Add support for thermal camera inputs.

- Improve accuracy using AI/ML-based classifiers.

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9. Conclusion

This project demonstrates a low-cost, efficient method for detecting fire and smoke in real time. It has potential for enhancing fire safety systems using basic image processing techniques.