



# AI Fire Detection & Alarm System

## Project Overview

An intelligent fire detection system powered by **Python** and **OpenCV** that provides real-time monitoring through computer vision. The system uses HSV color thresholding to identify fire patterns and triggers immediate visual and audio alarms when fire is detected.

### Dual Display Mode

Live camera feed with detection overlay + dedicated alarm status window

### Real-Time Processing

Fast HSV color-based detection with FPS monitoring

### Audio Alerts

Looping alarm sound with configurable on/off control

### Multi-Camera Support

Automatic camera detection and selection interface

## System Architecture



### Camera Input

Captures video frames at 640×480



### Fire Detector

HSV color analysis & filtering



### Alarm Manager

State management & audio control



### Display Renderers

Dual window visualization

## How Fire Detection Works

### 1 Frame Capture & Conversion

Captures video frame from camera and converts from BGR to HSV color space for better color detection

### 2 Multi-Range Color Filtering

Applies three HSV color ranges: Orange-red (H: 0-15), Yellow-orange (H: 15-35), Deep red (H: 170-180) with high saturation (100-255) and value (200-255)

### 3 Mask Processing & Cleanup

Morphological operations (close, open) remove noise, Gaussian blur smooths edges, creating clean binary mask

### 4 Contour Analysis

Finds contours in mask, filters by minimum area (500 pixels), calculates confidence based on total fire area detected

### 5 Consecutive Frame Confirmation

Requires fire detection in consecutive frames before triggering alarm to reduce false positives

## 🌟 Key Features & Capabilities

- ▶ Real-time fire detection using computer vision
- ▶ Dual display windows (feed + alarm)
- ▶ Confidence meter display
- ▶ FPS performance monitoring
- ▶ Configurable detection sensitivity
- ▶ Consecutive frame validation
- ▶ HSV color-based detection algorithm
- ▶ Visual bounding boxes around fire regions
- ▶ Looping audio alarm (M4A/WAV support)
- ▶ Multi-camera auto-detection
- ▶ Keyboard controls for interaction
- ▶ Three-state alarm system (Normal/Warning/Alarm)

## 🚀 Quick Setup & Installation

### 📦 Prerequisites

Python 3.7+   Webcam

### ⚙️ Required Dependencies

opencv-python  
numpy  
pygame (optional)

### 💻 Installation Steps

```
# Install dependencies
pip install -r requirements.txt

# Or install manually
pip install opencv-python numpy
pygame
```

## ▶ Running the Application

```
python fire_alarm_system.py
```

The system will scan for available cameras and present a selection menu. Select your camera and the application will start monitoring for fire.

## 🎮 Keyboard Controls Reference

Key	Action	Description
Q	Quit Application	Cleanly exits the fire detection system and closes all windows
S	Toggle Alarm Sound	Enables or disables the audio alarm (visual alerts remain active)
R	Reset Detection	Stops current alarm, clears detection history, resets to normal state

## 💡 Testing & Configuration Tips

### 🔥 Testing Fire Detection

Display fire/flame images on your phone screen and show to the camera. The system detects orange, red, and yellow fire colors.

### ⚙️ Tuning Sensitivity

Adjust `FIRE_MIN_AREA` (minimum pixels) and `CONSECUTIVE_FRAMES` in the code for your environment.

## 💻 Technology Stack

### Python 3.7+

Core programming language for the application

### OpenCV 4.5+

Computer vision library for image processing

### NumPy

Array operations and numerical computations

### Pygame

Audio playback for alarm sounds

Made with ❤️ by

**Amarjeet Sharma**



@amarjeet.creator