Research Paper

An Automatic Point to Point Fire Detection and Suppression System by Image Processing

Engineering

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ABSTRACT

Fire is the visible effect of the process of combustion. At various places such as offices, hospitals, schools, colleges, industries, etc sudden fire may initiate and spread which can cause losses. The losses due to fire are not recoverable. So, it should be detected and extinguished as early as possible. Types of fire may be classified as due to ordinary combustibles, flammable liquids and gases, energized electrical equipment, combustible metals, cooking oils and greases. For all these types of fire, water is the best and easily available resource for suppression. So, various existing systems include water for suppression of fire. Once fire is detected by these systems or any high end foam based system, they may kill fire but makes loss of important documents, electronic devices, furniture, etc. This is because sprinkler based system covers all portions spanning over a radius of 10 feet or more irrespective of whether there is fire or not. To recover all these faults and losses, this paper proposes point to point fire suppression system, by image and video processing for detection and automated controls for suppression of detected fire.

INTRODUCTION

Fire detection is required to detect the accidental fire at various places. The only method to protect from this fire is to detect and suppress fire at its early stages. Various methods already exist for detection and suppression of fire. Detection by sensors is one of the methods. But in this the position of sensor must be near to fire otherwise it may detect fire at later stages or may not detect. Also, in this or other method if fire is detected water is sprinkled such that most of the area is covered by system under single sprinkler.

Now days, image processing is among rapidly growing technologies. Image processing is a method to perform some operation on an image, in order to get an enhanced image or to extract useful information from it. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement and display information extraction. As far as fire detection is concerned, thermal cameras can be best suitable input for providing exact position of fire. But we can even develop the suppression system using normal cameras.

In this paper we have proposed a method in which software can detect fire and region of fire by using image processing techniques on continuous video frames. The software is used to analyze the images in range of camera and detect any heat change or pattern of flames. The software detects the (X,Y,Z) coordinates of detected fire. The data of position of fire is passed on to controller system using interface between PC and hardware. The microcontroller controls motion of 3 motors to position the water jet exactly on top of fire and then releases a hose pipe. This pipe is operated manually and the people can suppress the fire. If hose is not operated for a specific time (Say 10 seconds) after it is released by system then the sprinkler connected to hose starts automatically and extinguishes the fire.

LITERATURE SURVEY

Sensors such as smoke detector, heat detector etc are used for fire detection. This method requires large quantity of sensors at various locations to cover big area. At the same time this method give slow response in event of fire.[1]

Image processing techniques uses video as input; hence fire or unwanted temperature variations can be detected from long distance. Fire is detected by analyzing smoke and fire pixels.[2]

In alternate method of fire detection, fire is detected by combining analysis of fire pixels and motion in continuous video frames.[3]

The proposed system is developed by considering following existing techniques of fire detection and suppuration. A fire sprinkler system is an active fire protection measure, consisting of a water supply system, which requires adequate pressure and flow rate to a water distribution piping system, onto which fire sprinklers are connected.[4] In foam based firefighting, foam is used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion.[5]

PROPOSED WORK

The proposed system is divided into three different modules as shown in the flowchart

Fig. Proposed Fire Detection and Suppression System
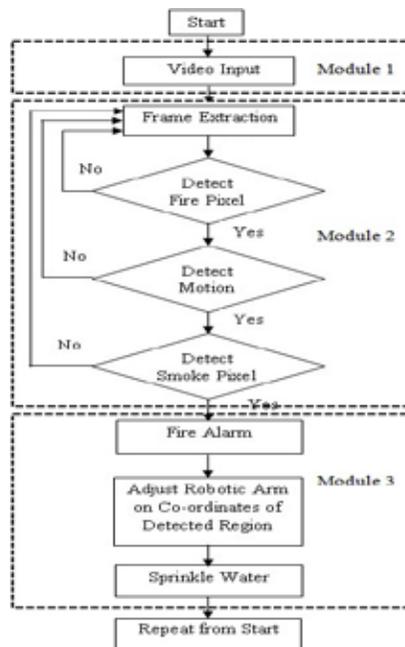
The outline of each module is as follows:

Module 1 (Video Input)

This module deals with different ways of gathering video stream. As we are using image processing tools, we need better quality and proper frame rate for accurate image analysis. We can integrate different cameras depending on area of place under surveillance, type of atmospheric conditions, type of material present in surveillance area and human intervention. Video camera can be interfaced with the computer using various methods such as USB, Wi-Fi, Bluetooth, etc.
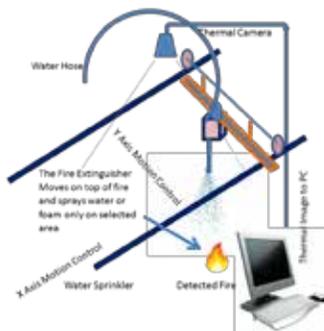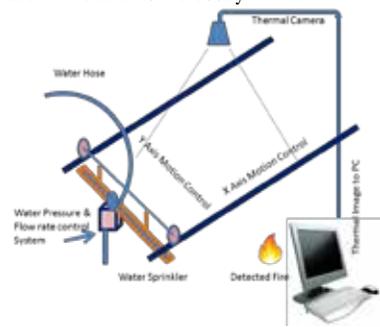
Module 2 (Image Processing)

This module performs analysis of every sampled frame taken from video camera. At first, frames are extracted from the video as processing is done frame by frame. Three conditions are analyzed for fire detection; first is availability of fire pixels then detection of motion and third is availability of smoke pixels. If all three conditions are satisfied then only the process precede to Module 3 otherwise the same procedure repeated from start for every sampled frame.

We can use two type of camera:

a. Thermal Camera

Thermal imagers are instruments that create pictures of heat rather than light. They measure radiated IR energy and convert the data to corresponding maps of temperatures. Today, instruments provide temperature data at each image pixel and, typically, cursors can be positioned to each point with the corresponding temperature read out on the screen or display. Images may be digitized, stored, analyzed and conclusions can be drawn for presence of fire. All objects have a certain temperature and emit waves of energy called infrared radiation. Hot objects emit more energy than cold objects. A thermal imager translates these energy waves into a viewable image, which shows a "heat picture" of a scene. So, detection of fire using thermal camera requires less processing and of less errors. But disadvantage is that thermal cameras are costly.

b. Normal CCTV Camera

Fire can also be detected by using normal cameras by applying various image processing algorithms or techniques. In this method, frames are extracted from video input. Then by image processing methods fire pixels, motion and smoke pixels are detected. The normal CCTV camera is cheaper as compared to thermal camera. But chances of errors in normal CCTV are more. The system may interpret bright light source, glass or metallic reflections or even bright red-orange cloths as fire.

Module 3 (Robotic fire suppressing system)

This module comprises of robotic arm, a pressurized water hose, a buzzer and water flow control mechanism. The first module provides camera feed to the system. The second module performs frame by frame analysis of camera feed and detects X,Y and Z coordinates of fire. There are two type of cameras which may supply necessary video stream to the fire detection and suppression system. A thermal camera and normal CCTV footage, both systems are covered in second module.

The third module receives data of X,Y and Z coordinates and positions the water sprinkler exactly on top of fire. The motor drives are used to position the sprinkler. The solenoid valve drops the pressurized water hose pipe from ceiling and waits for 10 seconds for user to start operating and controlling the water flow. If no one operates the water sprinkler/ foam jet, then the robotic system takes over and starts sparing the area covered by fire with water of foam.

As shown in fig 1, the thermal camera detects the fire and reported the coordinates to the PC.

The robotic arm moves on top of fire and starts fire extinguishing system. (Water or Foam based)

The figure 2 shows water hose being moved on top of detected fire

REFERENCE

[1] Fire and Gas Protection Systems Part 3(2009). PETRONAS Fire and Gas Protection Systems. [2] Gaurav Yadav, Vikas Gupta, Vinod Gaur, Dr. Mahua Bhattacharya, "Optimized Flame Detection Using Image Processing Based Techniques", IJCSE, 2012 [3] Tjokorda Agung Budi W, Iping Supriana Suwardi, "Fire Alarm System Based-on Video Processing", International Conference on Electrical Engineering and Informatics, 2011 [4]https://en.wikipedia.org/wiki/Fire_sprinkler_system [5]https://en.wikipedia.org/wiki/Firefighting_foam