Design and Development of Fire Detection and Dexterous Fire Suppression System

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Abstract— Fire protection system is vital need in this world to save the financial and human loss caused by fire accidents. The losses due to fire are not recoverable. Since different sensors have been developed for fire detection and suppression, very few of them are effective. Fire should be detected and extinguish as early as possible. In this paper, a system is designed which can work cognitively just like human approach for suppressing the fire. The fire detection is carried out by vision based techniques which is very accurate. This technique monitors the parameters of fire pixels. Colour identification algorithm is used in this system for effective detection of fire. This process is done using continuous video surveillance by Camera. The extinguisher system proposed in this paper is automated and point to point suppression can be possible using this technique which is very useful for well-located suppression of fire. This system is equipped with the stepper motor which is very accurate in its results hence improving system effectiveness.

Key words: Fire Detection, Fire Suppression, Camera, X-Y Coordinates

I. INTRODUCTION

Fire accidents in industries are very big issue. In big premises like atriums, warehouses, existing fire detection and suppression technique doesn't provide adequate results. There are several existing fire extinguishing technology which uses water and foam to suppress the fire, these methods are not very convenient as it can cause the financial loss which was actually going to cause by fire. There must be a new system which can minimizes these disadvantages and give best possible result. History tells us that many Fire fighters lost their lives while suppressing the fire. So there is a crucial need to build a new technique which can give best results. Most of the people are using Smoke detector, Heat detector in their house, office for detecting fire [12]. Most current fire alarm systems are based on infrared sensors, optical sensors, or ion sensors that depend on certain characteristics of fire, such as smoke, heat or radiation. These systems are effective in small indoor premises but in big warehouses, atriums, industries these systems cannot provide instant detection of fire causing accidents. In warehouses, the smoke of fire has a limitation that it could not reach to the smoke detector because of very big premises [4]; hence early detection of fire is not possible which can cost very harmful penalty. This traditional technique of fire suppression and detection also are unable to provide any additional information, such as the location and size of the fire.

Sprinklers are frequently being used by industries for suppression of fire. This system also makes financial loss to the industries such as loss of computers and whole premises get damaged by water or foam. Hence, it's not a beneficial investment.

In this paper, a real time intelligent fire suppression system is designed which can extinguish fire effectively by specifying its location; early fire detection is possible here by using vision based technique which monitors colour, motion and size of fire. This intelligent system is very useful for preventing fire accidents as it can detect early fire and suppress it with minimum loss to other equipments.

II. LITERATURE SURVEY

When people started to think about fire detection and suppression system, the new technologies started to emerge every other day.

Firstly In 1995, H.C. Muller and A.Fischer proposed a paper [12] which describes an MSbFD Algorithm using two fire parameters temperature and optical smoke density. In this paper they designed a system which detects fire by using temperature and smoke detectors and their controlling had been done using fuzzy logic but this method was not efficient as smoke detector works effectively in small indoor surrounding only.

Then in 2003 Thou-Ho (Chao-Ho) Chen, Cheng-Liang Kao and Sju-Mo Chang presented a paper [11]. In this paper they proposed fire detection using video surveillance method in which they used COLOUR and fire pixels to identify the fire. Here to minimize the false alarm rate they repeated this method again and again which consumes time and delay in fire detection.

In 2006, Thou-Ho (Chao-Ho) Chen, Yen-Hui Yin, Shi-Feng Huang and Yan-Ting Ye [10], proposed a fire detection concept using camera which detect smoke. But here it is not necessary always that smoke is generated before fire hence this system is not effective.

In 2012, Pedro Santana, Pedro Gomes, and Jos´e Barata presented a paper [6] in which they proposed a fire detection system which detects fire by monitoring the colour and motion of particles. Here they have not mentioned the size of fire using which we can suppress the fire.

Above papers have contributed in detection of fire by different method but these techniques cannot fulfil the requirement of early fire detection. In 2015, Pasquale Foggia, Alessia Saggese and Mario Vento proposed a paper "Real-time Fire Detection for Video Surveillance Applications using a Combination of Experts based on Colour, Shape and Motion"[1]. Here fire detection is done by using colour; motion and shape of fire which can minimize the false rate of fire detection at a great extend and hence we can further increase its accuracy.
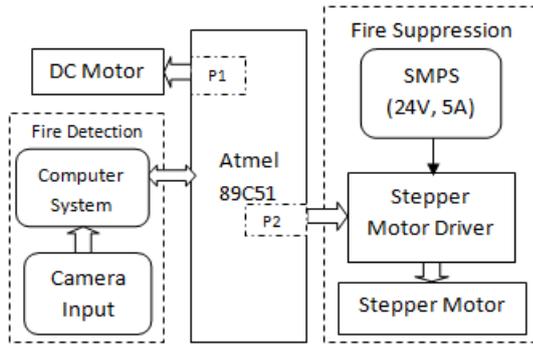
III. PROPOSED SYSTEM

Fig. 1: Functional Block Diagram

Above figure shows the functional basic block diagram of system. In this system, there are three different modules.

1) Fire Detection
2) Microcontroller
3) Fire Suppression

Fire detection is the most important module of this system. This fire detection module is comprises of a Computer system and camera. The camera is used as an input in this system for the purpose of fire detection. Different types of cameras can be used for this purpose like thermal camera, CCTV camera. Detection of fire becomes very easy by using thermal camera, it gives best results with minimum error but the cost of the system increases. CCTV camera can be also used for fire detection by using fire detection algorithm [3]. In this algorithm live frames are extracted from the video of camera input and analyzed it for fire detection. This technique checks the availability of fire pixels in frames, motion of fire pixels and also determines the size of detected fire. Hence in above system a normal CCTV camera is used which is connected to the computer system. This computer system uses the fire detection algorithm to detect the fire. After detection of fire this system can also plot its X-Y Co-ordinate which is the most important characteristics of this system. This result of the detection of fire is interfaced with the microcontroller through RS232 cable.

Microcontroller 89C51 is a low power, high performance CMOS 8 bit microcomputer. Ports P2 and P1 are interfaced with the fire suppression module. When fire is detected, microcontroller will get co-ordinates of fire from the input computer system microcontroller will use these coordinates to operate the fire suppression module of the system.

Fire Suppression system is another important module of this system. It comprises of stepper motor and a DC motor. These two motor forms a complete combination of fire extinguishing technique. This is an automated movable fire suppression technique which is able to replace the existing technologies of fire suppression. Existing technologies of fire suppression like sprinklers has some disadvantage which can be minimizes in this system. In this paper an intelligent fire suppressing system is proposed which will extinguish the fire by specifying its location in the area and shape of fire.

IV. WORKING METHODOLOGY

This paper proposed an intelligent real time point to point fire detection and suppression system which has many advantages over the existing technology of suppressing fire. The complete combination of fire detection and suppression system comprises of many sub modules.

Detection of fire comprises of two important input sub-module, they are Computer system and Camera. These modules are totally software based. No sensors have been used for this method because it will indirectly increase the cost of the system and also increase the required time for the detection process. This software identifies the fire pixels whenever fire occurs and also mentions its size and location of occurred fire. Fire has a specific colour which can be identify by using certain exact combination of red, blue and green colours. Each of these three colours needs to be at some accurate value to form an exact result for fire colour [3]. At pixel value of 255, each of these three colours has their real colour but when value starts decreasing below 255, colour starts to change. Hence combination of these three core colour is useful to create another colour.

Fire pixels detection can be done on below specific value of colours:
Red>250 && green<254 && green>200 && blue>130 && blue<254

When above condition satisfies then only fire pixels can be detected. This detection of fire is done by using camera which will monitor the premises continuously.

After detection of fire, system also determines its exact location by specifying its X-Y co-ordinates. Exact location of fire can be traced by using software function and by locating its centre of fire. This location is then shared with the microcontroller. After the location of fire is detected then its X-Y coordinates is interfaced with the suppression system which will be used for extinguishing the fire hence providing point to point suppression of fire.

In industries the existing fire extinguisher usually uses sprinklers to suppress fire by water. There are systems which use foam or sand for fire caused by electric short circuit. These systems are not effective because water and foam also causes the financial loss to industries which was actually going to cause by fire. This is because sprinklers covers all portion spanning over a radius of minimum 12 feet irrespective of there is fire or not. So Industries require some intelligent system which will suppress the fire cognitively. This system has an advantage over existing technology because it can suppress fire only at required location rather than sprinkling water all over the premises. This suppression module is a hanging system at the roof which can move throughout the area according to the X-Y co-ordinates provided by the detection module. This movement of the module is done by using stepper motor and dc motor. The X coordinate motion is carried out by dc motor whereas Y coordinate motion is done by stepper motor. Stepper motor here provides very good accuracy thus providing better movement. Hence point to point suppression of fire can also be performed very effectively with minimum error. Animated working flow of system is shown in fig. 2.
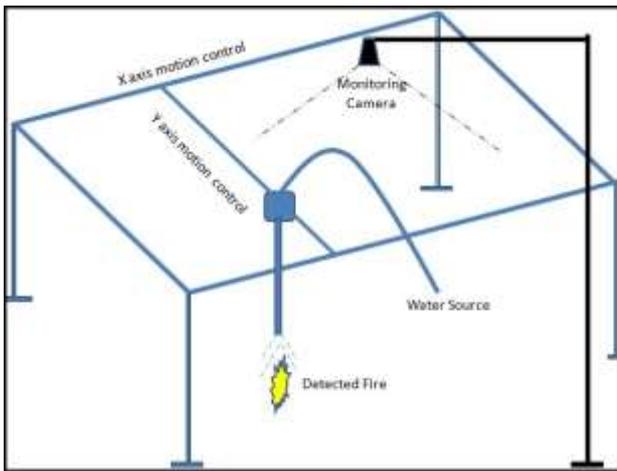
Fig. 2: Working animation of system

The propose system will work according to flow chart in fig. 3 below

Camera is used to detect the fire. This detection method involves testing of required parameters of fire pixels. Hence fire detection can be accurate. According to fire detection system will monitor the parameters of fire and detects fire. If fire is detected then the system will plot its X-Y co-ordinates, X-Y coordinated shows the location of fire. Fire suppression system hanging on top will be activated and will go on top of fire using its x-y coordinates to extinguish the fire. This system minimizes the disadvantages in fire suppression techniques and hence providing best results.

Major hardware component used in the system are:
1) Stepper Motor 9 kg torque, 0.85 Amp.
2) DC motor 60 kg torque.
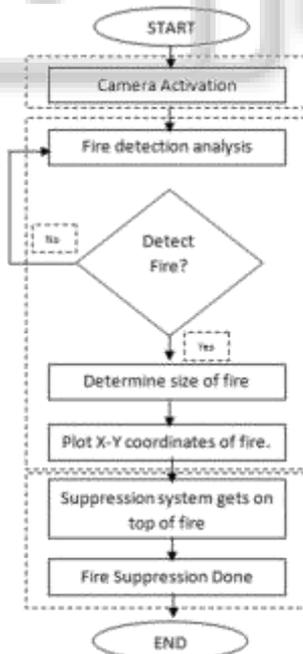3) Microcontroller 89C51
4) Camera

Fig. 3: Flow Diagram

V. RESULT AND DISCUSSION

As there are two tasks to be carried out by the system, the result is also discussed in the two parts. First one is fire detection and second is fire suppression. In fig. 4, the GUI

of the fire detection software is shown. There are two axes for input video and fire detected video. Input video monitors the premises continuously and when fire is detected it shows the detected fire in the fire detected video as shown in fig. 5.

Fig. 4: Fire Detection GUI

After detection of fire, the software also locates the X-Y co-ordinates of the fire and also sends them to the microcontroller as shown in the fig. 5.

Fig. 5: Detection of fire and X-Y co-ordinate of fire

When fire is detected, system can also identify its size as shown in fig. 6, as early fire detection is possible by this method, known size of fire can play important role while suppressing fire.

Fig. 6: Size Determination of Fire

Fig. 7: Suppression System

When first task of the system gets complete then location of the detected fire is transferred to microcontroller which then initializes the suppression system to move to that detected location of fire as shown in fig. 7. For the

movement of the system Stepper motor of 9 kg-cm for Y direction and dc motor of 60 kg for X direction is used. Stepper motor here provides better accuracy giving best possible results for the exact movement. Stepper motor used here can move with 1.8° of step angle and its speed can be increased by providing higher voltage up to 50V.

VI. CONCLUSION

Thus this fire detection and suppression system is very efficient because it will extinguish fire effectively and minimize the financial loss causes by fire accidents. This advanced technology of suppression system which comprises of stepper motor and dc motor provide better accuracy forming a very smart application for fire suppression. This system also minimizing the time in fire detection as it has no hardware components used in detection module hence it speed up the fire detection process. This system is completely automated hence no need of human involvement, thus also reducing the required manpower in the process. Hence this system is very cost-effective.

As technology changes rapidly, it is necessary to acquire new terminology. By using new features in software like velocity vector we can further increase the efficiency of detection system. Telescopic pipe can be used as automated water or foam extinguisher. In future detection of fire will get more advanced and intelligent giving more accurate result.

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