International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 4 Issue: 5 125 - 128

Selective Fire Extinguishing

Mayuresh S. Parkhi
Department of Electronics Engineering,
MIT Academy of Engineering,
Alandi, Pune, Maharashtra, India
msparkhi7@gmail.com

Usha Verma
Department of Electronics Engineering,
MIT Academy of Engineering,
Alandi, Pune, Maharashtra, India
uyverma@etx.maepune.ac.in

Abstract— Lots of techniques are being used to extinguish the fire in the industry or factories. But there are lots of flaws in those systems. For example, in purely sensor based detection and the extinguishing system, the time to detect fire is more than it should be and the water sprinklers used are placed in whole area rather than specifically using it in affected area. It results in damage to the costly machinery or important documents. So, it is proposed to use image processing technique to detect the fire and then selectively extinguish it. Its biggest advantage is that it will be possible to detect the fire at comparatively early stage and extinguish it selectively so that the other unaffected areas of the room won't be damaged. This system is divided into three stages. First of all, fire is detected using image processing. Secondly, an exact location of fire is determined. Then, an electro-mechanical system is built which will selectively extinguish the fire without damaging other property. With this system, fire is detected at comparatively earlier stage and its location is also traced which in turn proved to be useful in extinguishing it with an electro-mechanical system.

Keywords- *fire detection, fire extinguisher, Image Processing, YCbCr colour space, Motion detection.*

*****

I. INTRODUCTION

A fire may occur anytime at any place irrespective of its occupancy status. Fire in any occupancy has the capability to cause damage to its occupants and severe damage to property. Approximately, in India, every year, about 25,000 persons lose their lives due to fires and related causes[1]. Out of them, about 66% of those are female. It is estimated that roughly 42 females and 21 males die every day in India because of fire. These deaths could have been avoided with the help of protective measures. No comprehensive and reliable data is available in India on the economic losses suffered due to fire. However, according to one estimate the major losses reported by the Indian Insurance Companies over the years indicate, that about 45% of the claims reported are due to fire losses. Based on another estimate about Rs.1000 crores are lost every year on account of fires. According to India Risk Survey, 'Fire' climbs 3 places to attain the No. 9 position in the Risk Ranking in 2015[2]. Major reasons for fire threats are because of non-compliance to safety norms and non-renewal of safety licenses, existence of poor infrastructure obsolete equipment and lack of preparation, plus non-up-gradation of skills of firemen even increases the threat. In India, against 70,868 fire stations required as per the norms of Standing Fire Advisory Council, only 1,705 Fire Stations exist. So, firstly there is shortage of 97.59 per cent fire stations, secondly 96.28 per cent firemen and 80.04 per cent fire tenders and rescue vehicles. In India, urban fire services lack 72.75 per cent in fire stations, 78.79 per cent in man power and 22.43 percent in firefighting and rescue vehicles.

Since fire is unavoidable at times, it is highly recommended to detect it as early as possible. There are many ways of doing this. Traditionally, various sensors are used. But their accuracy depend upon various factors such as position. If it is too far from location of fire, then it will be detected in later stages or may fail to detect. Also, sensors increase the cost of the system.

So, an alternate system based on image processing can be used to detect fire at very early stage. With the help of camera, continuous images can be captured and with the help of image processing algorithms those images can be checked for presence of fire. Then with the help of the electromechanical system, fire can be extinguished by reaching to its location by sprinkling water. In this way, fire can be extinguished selectively, preventing the damage to the unaffected areas. That is why the system proposed is cost effective and accurate.

II. LITERATURE SURVEY

Many fire detection techniques are available. Traditionally, system based on sensors is used to detect fire. There are various types of sensors are used in these systems such as heat, smoke, flame and particle [3]. There is different response speed associated with each of them. There are other parameters such as false alarm rate, cost and application areas are also associated with it. Other than traditional techniques, researchers also worked on image processing techniques to detect the fire. All these techniques to detect fire are summarized in the TABLE 1.

Considering the various parameters as well as the cost constraints it is recommended to avoid the use of sensors in the fire detection procedure and make use of image processing technology as it has various advantages and is getting popular rapidly.

Image processing based forest fire detection using YCbCr colour model is used by C. Emmy, Premal et.al [4]. Their method adopts rule based colour model because of its less complexity and effectiveness. YCbCr colour space effectively separates luminance from chrominance compared to other spaces like RGB and rgb(normalized RGB). Since YCbCr colour space [5] separates luminance from chrominance, hence it is robust to changing illumination than other colour spaces like RGB and rgb (normalized RGB.In [6], a fire detection system based on light detection and analysis is proposed. This system uses HSV and YCbCr colour models with given

conditions to separate orange, yellow, and high brightness light from background and ambient light. Growth of the fire is analyzed and calculated based on frame differences.

TABLE 1: Summary of sensors

Sr. No.	Authors	Techniques used	speed	False alarm rate	Cost	Application
1	Richard W. Bukowski [3]	Heat sensor	Slow	Low	Low	Confined spaces
2		Smoke sensor	Fast	Medium	Medium	Open or confined spaces
3		Flame sensor	Very fast	High	High	Flammable material storage
4		Particle sensor	Fast	Medium	High	Open spaces
5	C. Emmy Premal and S.S. [4]	YCbCr model	Very fast	Low	Low	Open spaces
6	Jeenarat S., S. Praising and P. Riyamongkol [6]	YCbCr + HSV model and motion detection	Very fast	Low	Low	Confined spaces

III. METHODOLOGY

The block diagram shown in Fig. 1 gives the overview of the system. In this, each block represents operation at every stage.

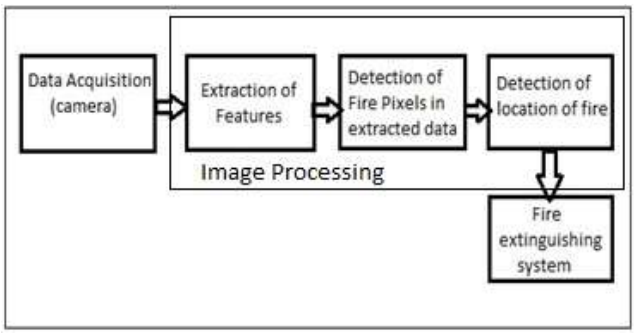

Fig. 1: Block diagram of the system

In the first section, data is captured from the DAS (Data Acquisition System). That includes a thermal camera or a normal CCTV camera. According to the requirements type of the camera is chosen. The cost of the thermal camera is more than the normal CCTV camera. The camera captures or extracts the continuous images and then sends it to the next block to perform further image processing. In the next section, fire pixels are detected in the captured images in the first section if any. Here, MATLAB is used. In most cases MATLAB supports image processing tools. With the help of various tools in image processing toolbox available in the MATLAB, the presence of fire is detected in the extracted data.

Once the fire is detected, the location of the fire is detected. This will be helpful to extinguish the fire selectively with the help of the electro-mechanical system. Here, tracing of the location is done by taking into account the number of pixels captured by the camera and the actual physical area that camera is capturing. Then, location of pixel is calculated in cm or m.

In the final section, the fire is smothered by using water or the foam. The area of fire location is selected which is determined in the previous section. A DC and stepper motor based mechanical system which will be controlled by the controller based system. In this way, the fire is smothered in the shortest possible time.

A. Hardware

To make a prototype of the whole system, a laptop or a pc with the desired software is needed. For fire smothering, an electro-mechanical system is needed which will extinguish the fire selectively by reaching the location of the fire. So a DC and a stepper motor is needed for that. To run these stepper motors, a micro controller based circuit is needed.

B. Software

For the major part of the project, image processing tool, MATLAB is needed to detect fire and localize it. Then in the last part of the project, for controller based circuit, a software programming tool is required e.g. MPLAB and a compiler.

C. Layout of the prototype

The layout of prototype is shown in Fig. 2.

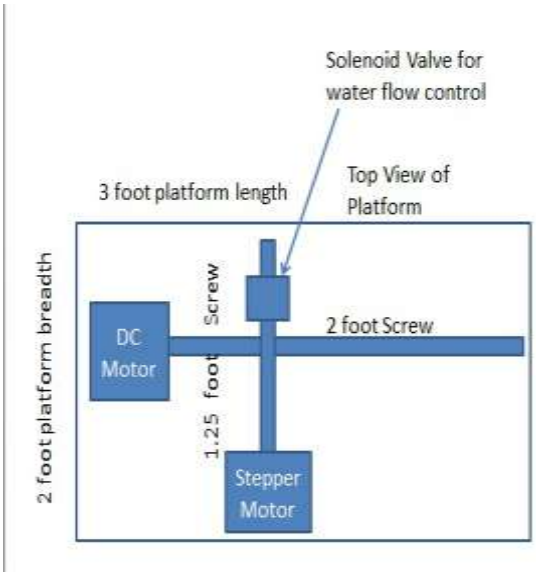

Fig. 2: Top view of the prototype

The top view of the prototype is shown here. Length of the platform is 3 ft. and breadth is 2 ft. There are two types of motors used here viz., stepper motor and DC motor. DC motor has 2 ft. screw lead and stepper motor has 1.25 foot screw lead. Platform is made up of metal (Al). On the screw lead of the stepper motor, we have a solenoid valve which is used for water flow control. Solenoid valve is electrically controlled valve used to control flow of the liquid.

With the help of the above accessories, system reach out to the location of the fire and smother it with the help of water sprinkler. The whole working of the system can be divided into three modules for convenience. The complete flow of system is shown in figure 3.

In module 1, various ways of collecting data are dealt. Since, image processing tools such as MATLAB are used here, it is important to extract better quality and proper frame rate for accurate analysis. More than one camera can be integrated depending upon the requirement of the place. Video cameras can be integrated or interfaced with many other techniques such as USB, Wi-Fi, Bluetooth etc.

In module 2, analysis of every frame obtained is done frame by frame by image processing tool. These frames are checked for availability of fire pixels, detection of motion and availability of smoke pixels. If fire is obtained then location of it is traced. If all the above things are found then only module 3 comes into action.

To check availability of fire pixels, RGB color space is used. It is observed that in fire images, value of R is greater than that of value of G. Also the value of G is greater than B. On this basis, mean values of R, G, B are computed. This information is used to detect fire pixels in the extracted frame.

In module 3, it contains pure hardware operation to extinguish the fire. Co-ordinates of the location of the fire are obtained from previous module then accordingly with the help of motor drivers water sprinkler is positioned just above the detected location of the fire and fire is extinguished.

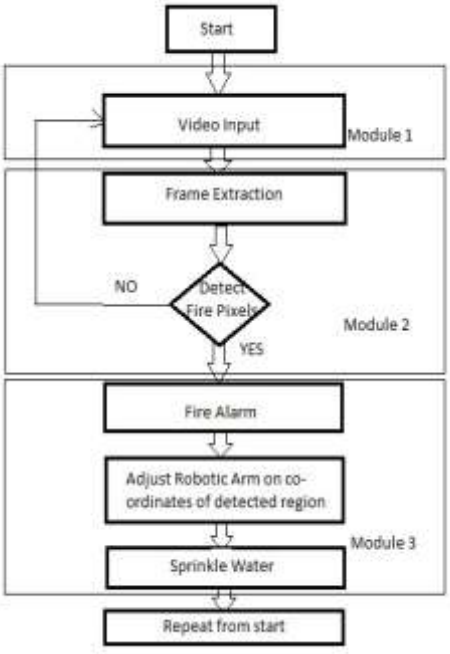

Fig. 3: Flow chart of the system

IV. RESULTS

Fig. 4 shows the case of the small cabin where the prototype is placed.

(a) (b)

(c)

Figure 4: Small cabin case,(a) GUI of fire detection and its co-ordinates,(b) Actual setup of the system, (c) LCD display

As shown in Fig. 4(a), GUI displays the detection and location of fire. It displays the co-ordinates of fire calculated by image processing.

Fig. 4(b) shows actual setup of the system and fig 4(c), displays the situation when the co-ordinates of sprinkler becomes equal to co-ordinates of fire. That is sprinkler has reached to desired location. Experimental results of the system considering different cases are shown in TABLE 2.

TABLE 2: EXPERIMENTAL RESULTS

venue	Brightness Level	Location of fire	speed	Actual condition of fire	Fire detected by system	False detection of other object as fire
Small cabin	Low	Near camera	Fast	Yes	Yes	No
		Far from camera	Fast	Yes	Yes	No
	Medium	Near camera	Fast	Yes	Yes	No
		Far from camera	Fast	Yes	Yes	No
	High	Near camera	Fast	Yes	Yes	No
		Far from camera	Medium	Yes	Yes	Yes

V. CONCLUSION

It can be concluded from the experiments performed on the proposed system that it is much more effective than the traditional purely sensor based systems in terms detection speed, fire detection and rate of false detection. But when it comes to the performance in high brightness areas and far away from the camera, there is false detection of objects.

REFERENCES

[1] An article by R.R.Nair on "Fire Safety in India-An Overview", published in "Industrial Safety Review",October2013 http://www.ind-safety.com/Articles/fire-safety-in-india-an-overview/242025/5254725/5250000

[2] India Risk Survey 2015-FICCI. www.Ficci.in/Sedocument/20328/India-Risk-Survey-2015.pdf

[3] Richard W. Bukowski, "Techniques for fire detection", published at NIST(National Institute of Standards and Technology) publication portal. www.fire.nist.gov/bfrlpubs//fire87/PDF/f87013.pdf

[4] S. S. V. C. Emmy Premal, "Image processing based forest fire detection using ycbcr colour model," International Conference on Circuit, Power and Computing Technologies [ICCPCT], Nagarcoil, Tamilnadu, India, March 2014, pp.1229-1237.

[5] R. C. Gonzalez and R. E. Woods, Digital Image Processing. Pearson,4th edition.

[6] S. P. Jareerat Seebamrungsat and P. Riyamongkol, "Fire detection in the buildings using image processing," Third ICT International Student Project Conference, March 2014, pp. 95-98.

[7] L. Agrawal, Shruti Wandre and N. A. Ashrafi, "An automatic point to point fire detection and suppression system by image processing," IJSR – INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH, vol. 4, November 2015, pp. 4-5.