

REAL TIME FIRE AND SMOKE DETECTION SYSTEM

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Abstract: Fire and Smoke detection system has been proven for applications such as industrial, houses, colleges, schools, & offices, etc. To prevent losses caused by the fire we develop the fire and smoke detection system. In this method, we use the image processing system and Raspberry pi to detect the fire. After detecting fire, it will on the emergency mode, and the system will send an e-mail or message to the user. The raspberry pi controls the process camera input and detects fire by using the image processing method. It will report immediately to the person (Owner and Fire Department). These systems send information in a real-time method.

I. INTRODUCTION:-

Fire is dangerous; it can spread quickly & cause great loss for human life. By detecting fire & giving a warning or reporting at an early stage to the users, at that time can be very effective. To prevent the losses caused by the fire, the various systems has been developed such as automatic fire alarm system, the temperature, light & smoke can be sensed for detecting fire. But factors such as temperature, light, smoke, etc are susceptible to interference from the environment. The major disadvantage is that they do nothing to control the fire and sensing only when it reaches the high-level system, also it cannot generate any reports for the process to get a cost-effective solution. The project we are using image processing system & Raspberry-Pi to detect the fire. Here the camera will capture the video and separate image into frames & then, these frames are compared to the original image. This system requires just a few seconds to detect the fire, smoke & then it will search for fire patterns in the video frames. If the fire is detected it will indicate by alarm & it will also send E-mail to the user and Fire Department.

II. RELATED WORKS:-

In this part, we have been discussing the types of fire detection methods using image processing and using raspberry pi Md Rifat Hasan [1]. They designed by using components such as sensor, fuzzy logic, Data fusion. This system is to avoid panic inside the complex. The main disadvantage of this system is a multiple sensor, false alarm, and false message. M.Malathi [2] designed a Raspberry pi, artificial neural network, RGB colors, and the Purpose of this system is to avoid the false alarm. The main disadvantage of this method is it will not send any message to the person and also it does not find the location of the fire. Cao Shunxia et.al [3] designed a system with a single-chip microcomputer (SCM) AT89C51 and ISD1420a, a voice chip. The purpose of making this system is to detect only fire. When this sensor will detect the smoke, a voice message will be sent to the relevant department. And the disadvantage of this is a false alarm will be submitted. Rakesh S et.al [4] designed the system y using Zigbee and FTP Web server. The purpose of this system is to avoid the false alarm when smoke or intruder movement is detected, the system sends warning messages through SMS. And the disadvantage in this method does not take any action to stop the fire. Moreover, the single-board computer is used, and it is costly and has lower technical specifications compare to a raspberry pi.

III. ISSUES TO BE ADDRESSED:-

An important point in smoke and fire detectors are typically used to detect the particular particles is generated by smoke and fire by using ionization or photometry. And then sensors are used to sense particles. The drawback of the existing detectors is that they have a limited distance and its difficult for them to detect fire used to be in open or large spaces. Using the existing sensor many of them have been given a false alarm. And then sensors not cover a large space while detecting the fire. Many of the existing sensors are costly and complicated to use when compare to the raspberry pi.

IV. PROPOSED WORK:-

The proposed system uses Image processing; the strength of using image processing in fire detection is the ability to serve large and open spaces, reduce the chance of getting a false alarm, getting alarmed as soon as possible with any technical delay. The proposed system consists of three stages: In the first stage, Pie-camera will capture the image and it will send that image to the controller for further evaluation. And then the process of detection of the fire frame from the image has been started.

In the second stage, the images are converted into frames and it will compare those images into already booted images. In the third stage, MMS will be sent to the user, fire department, and responsive authorities.

V. MODULE DESCRIPTION: -

We segmented our system design into five modules. Video recording and transferring to the controller is the first module of our system design. In this module, the camera captures continuous frames from the area of its coverage. All the captured images or frames by the camera are transferred to the controller for applying an image processing function. The second module is Colour-based segmentation in this module after separating the frames as a single image it is subjected to standard colour-based segmentation. The segments are further divided into constant sized blocks.

In the third module, the system will find fire pattern recognition, in this module the blocks of the segmented image will be examined for the presence of heat signature or fire patterns. The emergency trigger will be generated in the four-module here, if any particular pattern is identified in any of the blocks for a particular period of time, it will switch on the emergency mode for the purpose of MMS send to the remote user and responsible authorities such fire department and local police station. Multimedia message transmission is our fifth module in this module the multimedia message is created with its content using messaging API and alert message with image will be sent to the recipient.

VI. METHODOLOGY:-

Fire is detected using fire patterns with heat Signature. Heat signature is color patterns to represent the fire. There are three filters are used to find the heat signature. They are:

- RGB filter
- cieLAB filter
- RGB filter 2

A. RGB filter:-

RGB filter is used in this system to Extract Red (R) Green (G) and Blue (B) component of each pixel. And then the system will check in every pixel two conditions are to be verified. They are

- o If it is $R > G > B$
- o If it is $R > R_t$ (R_t is the red threshold value between (0,255))

This is based on the light in the image. Here value 125 is used.

B. cieLAB filter:-

Here the LAB color model has used .cieLAB color model are Highlights red, yellow, and related colors like orange. For all pixels in the frame, the mean value of L, A, and B components are identified.

- For every pixel four filters are used.

- o If $L > L_{mean}$
- o If $A > A_{mean}$
- o If $B > B_{mean}$
- o If $B > A_{mean}$

- Whose values are to be run from 0 (black) to 100 (white).
- The central vertical of the axis is represents lightness (signified as L^*)
- The color axes are based on the fact that color can't be both red and green, or both blue and yellow, because these colors oppose each other.
- On each axis we will see the values run from positive to negative.
- On the a-a' axis, will see the positive values indicate amounts of red while negative values indicate amounts of green.
- On the b-b' axis, will see the yellow is positive and blue is negative. For both axes, zero is neutral gray

Both:

To satisfy the various lighting conditions we used both the RGB and cieLAB filters are used. If anyone of the filter passes a pixel, it is a fire signature.

C. RGB filter 2:-

Another filter that uses is RGB components. It will work well at night mode. In this method, the R, G, and B components are compared with threshold values.

- $rt=140, gt=100, bt=100$
- Three conditions are checked:

- o $R > rt$
- o $G > gt$
- o $B < bt$

VII. HARDWARE INFORMATION:-

A. RASPBERRY –PI:-

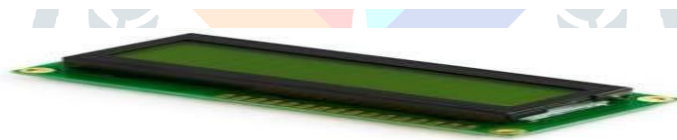
- The Raspberry Pi is a Broadcom BCM2835 SOC (system on chipboard). It comes equipped with a 700 MHz, 512 MB of SDRAM, and ARM1176JZF-Score CPU. The USB 2.0 port of the raspberry pi is the board uses only for the external data connectivity options. The Ethernet in the raspberry pi used as the main gateway to interconnect with other devices and the internet in model B.
- This draws its power from a micro USB adapter, with a minimum range of 2.5 watts(500 MA). The graphics, specialized chip which we used is designed to speed up the manipulation of image calculations. This is inbuilt with Broadcom video-core IV cable, which is useful if you want to run a game and video through your raspberry pi.



Raspberry Pi

B. LCD DISPLAY:-

- LCD stands for liquid crystal display.
- We are using a 16x2 LCD display. It consists of 16 columns and 2 rows.
- It can display 32 characters at a time.
- The LCD display is provided for showing the current status of the system.
- LCD used in 8-bit mode.



LCD DISPLAY

C. RELAY:-

- A relay is an electrically operated switch. It consists of a set of the input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch which is used any number of contacts in the multiple contact forms. Such as make contacts, break contacts, or combinations.
- Relays are used to be where is necessary to control a circuit by an independent low-power signal, or where it is several circuits must be controlled by one signal. Relays at the early stage used in the long-distance telegraph circuits



as the signal repeaters: as they refresh the signal coming in from one circuit by transmitting it on another circuit.

RELAY

D. MCT2E:-

- UL recognized (File # E90700)
- VDE recognized (File # 94766)
- Add option of V for the white package (e.g., MCT2V-M)
- Add option of 300 for the black package (e.g., MCT2.300)
- MCT2 and MCT2E are also available within white package
- specifying -M suffix, e.g. MCT2-M



MCT2E

E. PI CAMREA:-

- The Pi camera module is a portable lightweight camera that supports Raspberry Pi. It is used to communicate with Pi using the MIPI camera serial interface protocol. It is normally used for image processing, machine learning, or surveillance projects. It is commonly used in surveillance drones since the payload of the camera is very less. Apart from these modules, Pi can also use normal USB webcams that are used along with the computer.



PI CAMREA

F. MQ -6 SENSOR:-

- Sensitive material of the MQ-6 smoke sensor is SnO₂, which with lower conductivity in clean air. When the target flammable gas exists, the sensor's conductivity gets higher along with the gas concentration rising. The person who used it can convert the change of conductivity to correspond to the output signal of gas concentration through a simple circuit.
- MQ-6 smoke sensor can detect kinds of flammable gases, especially has a high sensitivity to LPG (propane). It is a low-cost sensor for the n number of gadgets.



MQ -6 SENSOR

VIII. SOFTWARES:-

i. Linux OS:-

- The Linux is a name is a free kind of software such free and open-source software operating system which was distributions built around the Linux kernel.
- The definition of a component of a Linux distribution is the Linux kernel, an operating system that was released by the kernel first by September 17, 1991, by Linus Torvalds. Many sources as used by the Linux distributions use the word Linux in their name.
- Linux is the past that was one of the most prominent examples of free and open-source software collaboration.

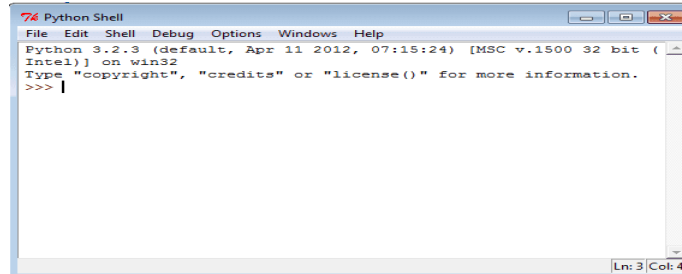


Linux OS

ii. PYTHON –IDLE:-

IDLE features as been given below:-

- IDLE has coded in 100% pure Python, using the Tkinter GUI toolkit.
- IDLE has cross-platform: works mostly the same on Windows, Unix, and macOS.
- IDLE has a Python shell window (interactive interpreter) with the colorizing of code input, output, and error messages.
- IDLE has a multi-window text editor with multiple undo, Python colorizing, smart indent, call tips, auto-completion, and other features.
- IDLE has debugger with persistent breakpoints, stepping, and viewing of global and local namespaces.



PYTHON –IDLE

IX. ADVANTAGES:-

- It will send the SMS to the remote user when it reaches the emergency mode.
- Image processing in fire detection is the ability to serve large and open spaces and reduce the chance of false alarm.
- Raspberry pi gives more features, great specification, and at low cost.

X. RESULTS:-

The proposed method was implemented using Raspberry Pi, OpenCV 3 and python.

The following figure will show the output of the system:-

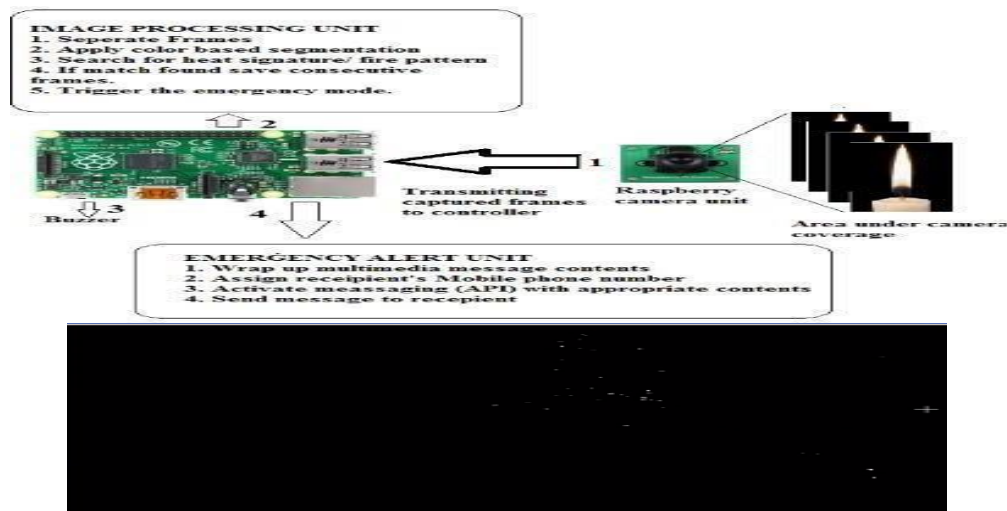


Figure 1. (Output of filter without fire)



Figure 2. (Detected fire and frame where fire occurs)

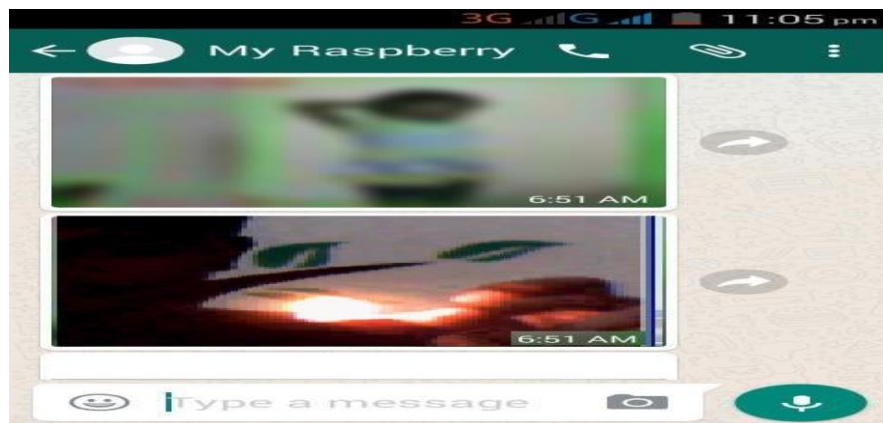


Figure 3. MMS received in phone

XI. CONCLUSION:-

Thus we have a designed a smart surveillance system capable of recording /capturing video /image and transmitting to a smart phone. Its advantages as it offer reliability & privacy on both sides. It offers only the person concerned to view the details. Necessary action can be taken in short span of time in the case of emergency conditions such as smart homes, offices & industries.

XII. REFERENCES:-

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