IMAGE PROCESSING BASED FIRE DETECTION BY USING RASPBERRY PI

[1]D. Gowri,[2]S. Shiva Prasad,[3]O. Sai Kiran,[4]Mr. M. Mysaiah
[123]Students,[4] Assistant Professor
Department Of Electronics And Communication Engineering
ACE Engineering College, Medchal-501301

ABSTRACT

Image Processing based fire detection using Raspberry Pi is an emerging technology that has the potential to revolutionize fire detection and prevention systems. This system uses the power of the Raspberry Pi processing system to perform real-time image processing algorithms that analyze video footage looking for signs of fire. By comparing successive frames of video, it is possible to identify changes in heat, light, and movement that are indicative of a fire.

The proposed system involves capturing an image of the environment using a camera and processing it using the OpenCV computer vision library running on Raspberry Pi. The captured video feed undergoes a pre-processing step before being subjected to image segmentation to identify regions of interest. The features are extracted from these regions, and machine learning algorithms are used to differentiate fire instances from other sources of heat in the image.

The system is designed to be an affordable, low-power, and low-maintenance solution for fire detection. The Raspberry Pi platform offers a low-cost and versatile solution for real-time image processing, and the use of machine learning algorithms allows the system to learn from experience and adapt to different environments. The proposed system can be integrated with existing fire detection and alarm systems to provide early warnings and help to minimize damage caused by fires.

Keywords: Raspberry pi, raspberry Camera, Buzzer, Relay, LCD display, Water spray, power supply.

I.INTRODUCTION

1.1 Introduction

Fire is a serious threat to life and property worldwide. It is usually caused by combustion of materials which releases heat and light in large amounts. Fire detection systems have been designed to detect fire via sensing different fire related change. Two types of fire detectors have been used so far, namely: traditional/sensor-based and vision-based systems. Former responds against smoke, heat, temperature and pressure, whereas later rely on the light detection. Among the two systems used, traditional detectors have several disadvantages associated with them.

These include high cost, slow response time and limited detection range. Additionally, these systems are not feasible as outdoor detectors due to excessive sunlight and wind pressure. Besides, vision-based detectors can respond flame quickly and can analyzed location of fire. In these detectors, flame which is the vision part of fire can be analyzed via its color, shape and movement based on spectral and spatial models. Although, vision- based detectors have several advantages, however, false detections limit their utilities. Therefore, there is still dire to design new models that are more efficient and can solve problems associated with previously reported models. The reason behind proposing a system of like fire detection is to prevent from the loss and damages done by fire very before by generating an alert. The Raspberry Pi controller processes the camera input and detects fire using heat signatures. By using image processing method, the report is automatically generated and sends to the person immediately after the fire is being detected using Wi-Fi. This triggers the emergency mode of system. Advantages including remote monitoring for immediate actions and sending the information at any time or place, are main attributes of this method.

Generate Alert on Fire The main motive of using this system is to prevent from the loss of life or any other damages to the company or the organization. Few years back the system that were installed are now obsolete because they detect fire

or smoke when it reaches the maximum level and until that time the loss was already done.

The fire detection system is used to detect fire in air through camera in real time monitoring system based on Raspberry Pi. The main feature of system is to alert generate when fire is started or reached it minimum level to prevent from the loss of lives.

1.2 BLOCK DIAGRAM

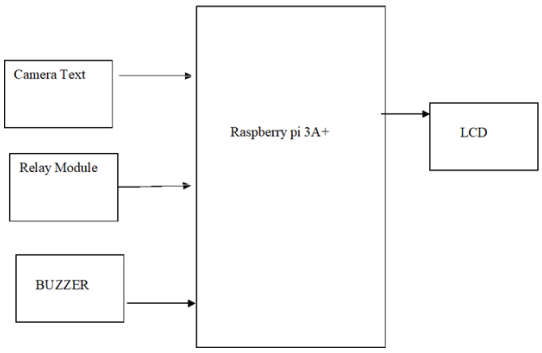

Fig 1.1 Block diagram

II.HARDWARE DESIGN

RASPBERRY PI 3A+:

The Raspberry Pi 3A+ is a compact and powerful single-board computer that is part of the Raspberry Pi family of devices. It was first released in November 2018 and is an improved version of the earlier Raspberry Pi 3 Model A. The Raspberry Pi 3A+ features a 1.4 GHz 64-bit quad-core ARM Cortex-A53 CPU, 512MB of RAM, and a single USB 2.0 port. It also has built-in wireless connectivity, including both 2.4GHz and 5GHz Wi-Fi and Bluetooth 4.2/BLE, making it easy to connect to the internet or other devices.

One of the key features of the Raspberry Pi 3A+ is its compact size. Measuring just 65mm x 56mm, it is considerably smaller than the standard Raspberry Pi 3 Model B+, making it an ideal choice for projects where space is limited. It also has a smaller power footprint, making it ideal for battery-powered projects.

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MICROCONTROLLER:

A microcontroller is a small, integrated computer chip that is designed to control specific devices or systems. It typically contains a central processing unit (CPU), memory, input/output ports, and various peripherals, such as analog-to-digital converters and timers. Microcontrollers are widely used in a variety of applications, such as home automation, robotics, automotive systems, and medical devices. They are popular due to their small size, low power consumption, and ability to interface with other electronic components. One of the key advantages of microcontrollers is their ability to be programmed to perform a specific task or set of tasks. This allows them to be customized to meet the requirements of a particular application or system. In addition, many microcontrollers are equipped with a range of communication protocols, such as SPI, I2C, and UART, that allow them to communicate with other devices.

PI CAMERA:

The Pi camera is a small, high-quality camera module designed for use with the Raspberry Pi computer. It is a low-cost, versatile camera that can be used for a wide range of applications, from simple photography to robotics and machine vision.

The Pi camera module is available in two versions: the original 5-megapixel camera, and the newer 8-megapixel camera. Both cameras connect to the Raspberry Pi's camera port via a ribbon cable, and are controlled using software libraries that interface with the Pi's operating system.

The Pi camera module is capable of capturing both still images and video, with resolutions of up to 8 megapixels and 1080p HD video. It also has a range of configurable settings, such as exposure time, ISO, and white balance, allowing users to customize their images and videos.

One popular use of the Pi camera is in robotics and machine vision. The camera's small size and low cost make it an ideal choice for embedded systems, where space and budget constraints are important. The camera can be used to capture images and videos for object recognition, tracking, and other computer vision applications.

BUZZER:

A buzzer is an electronic device that produces a continuous or intermittent sound signal. It typically consists of a piezoelectric element, an oscillator circuit, and a driver circuit. The piezoelectric element is a crystal that vibrates when an electric current is passed through it, producing sound waves. The oscillator circuit generates the electric current that drives the piezoelectric element, while the driver circuit controls the frequency and volume of the sound signal.

Buzzers are commonly used in alarm systems, timers, and other applications that require an audible alert signal. They come in various shapes and sizes, from small surface-mount devices to larger, standalone units. Some buzzers can produce different types of sounds, such as beeps, tones, or melodies, while others are designed to produce a single, continuous tone. Buzzers are often used in combination with other electronic components,

such as microcontrollers or sensors, to create complex systems. For example, a buzzer can be used with a microcontroller to create a doorbell that plays a melody when someone rings the doorbell button.

RELAY MODULE

Relay modules are simply circuit boards that house one or more relays. They come in a variety of shapes and sizes, but are most commonly rectangular with 2, 4, or 8 relays mounted on them, sometimes even up to 16 relays. Relay modules contain other components than the relay unit. These include indicator LEDs, protection diodes, transistors, resistors, and other parts. A relay is an electrical switch that can be used to control devices and systems that use higher voltages. In the case of module relay, the mechanism is typically an electromagnet

LCD DISPLAY

The LCD is used to display the information of the time and medicine. LCD Displays are dominating LED displays, because these displays can display alphabets, numbers, and some kind of special symbols, whereas LED's (seven segment display) can display only numbers. These LCD displays are very useful for displaying user information and communication. LCD displays are available in various formats. Most common are 2 x 16, is that two lines with 16 alphanumeric characters. Other formats are 3x16, 2x40, 3x40 etc.

III.CIRCUIT CONNECTIONS AND RESULT

Circuit Diagram

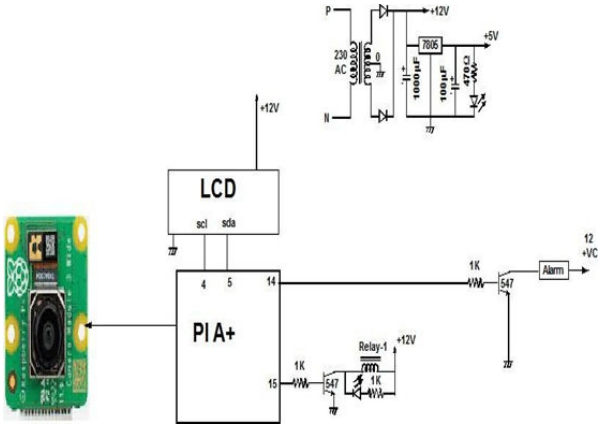

Fig 7.1 Circuit diagram

Result

The final result of our fire detection system is that it started detecting fire when fire comes up in front of camera and the system is working correctly and without any delay. But weare still working on the system to overcome the false alerts as the system doesn't know the exact shape and color of fire so it detects the other objects of same color and fire and generate an alert. We are working on our algorithm and making it more efficient so it can detect the exact shape and color of fire and don't get confuse between another shape of other objects and don't generate false alerts. Fire detection system is very good approach in modern world so that the losses and damages done by fire before will not be repeated again and no other lives will be harm.

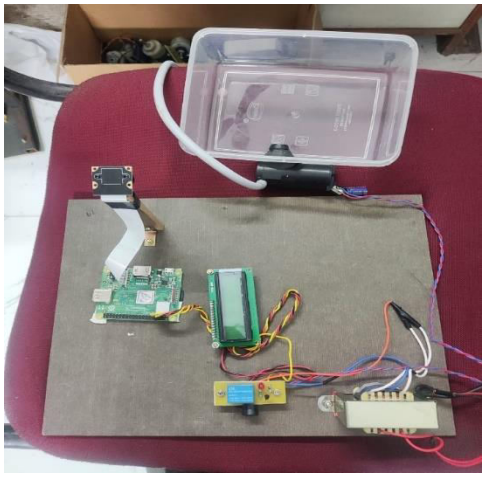

Fig : Without power supply

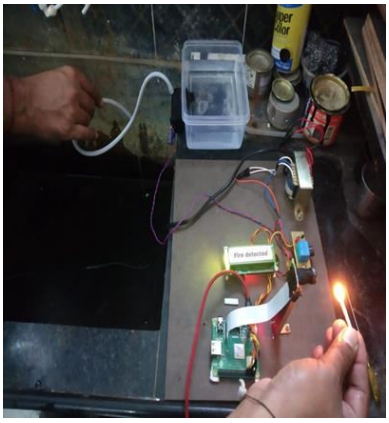

Fig :With power supply

ADVANTAGES

• Real-time detection: The system can detect fire in real-time and prompt immediate action, potentially saving lives and reducing damage to property.

• Low cost: Raspberry Pi boards are relatively low-cost compared to other fire detection systems, and can be easily programmed to handle a variety of image processing tasks.

• Flexibility: The system can be customized and modified based on the specific needs of the application.

• Easy maintenance: Raspberry Pi boards are easy to maintain and require minimal technical expertise.

• No human intervention: The system operates automatically without the need for human intervention.

Disadvantages

• False alarms: The system may generate false alarms due to environmental factors, such as ambient lighting, smoke, or reflections.

• Limited range: The system's range of detection may be limited by the camera's field of view or resolution.

• Limited accuracy: The system's accuracy may be limited by the quality of the camera module and the sophistication of the image processing algorithms.

• Dependence on power supply: The system is dependent on a stable power supply and may not function correctly in the event of a power outage or disruption.

Applications

• Homes and buildings

• Industrial settings and Transportation

• Forests and natural areas

• Military and Defense

• Museums and Heritage

IV.CONCLUSION

This project work “Image processing based fire detection system “is completed successfully and results are found satisfactory. In conclusion, image processing based fire detection using Raspberry Pi is an emerging technology that has the potential to revolutionize fire detection and prevention systems. The low-cost, customizable, and programmable nature of the technology makes it suitable for deployment across various industries and settings.

The future scope of the technology is promising, including potential advancements in AI, cloud-based processing, integration with IoT, emergency response systems, remote monitoring, and integration with lighting systems. These advancements will enhance the accuracy, efficiency, and reliability of image processing based fire detection, making it suitable for deployment in different environments.

However, adequate testing and evaluation are crucial to ensure the technology's reliability and accuracy, and training users on how to operate the system is essential. With proper deployment, image processing-based fire detection technology has the potential to reduce the number of fire-related incidents, injuries, and fatalities, and improve the efficiency and effectiveness of fire detection and response systems.

In summary, image processing based fire detection using Raspberry Pi is a powerful and

versatile technology that can be deployed in various industries and settings to improve fire safety, prevent losses, and save lives. With further development and enhancements, it has the potential to become the leading technology for fire detection systems.

FUTURE SCOPE

The future scope of image processing based fire detection using Raspberry Pi is vast. Here are some of the potential advancements and research areas:

1. Integration with IoT: Image processing-based fire detection systems can be integrated with IoT devices such as smoke detectors, fire alarms, and sprinklers to enhance the effectiveness and reliability of fire detection systems.
2. Advancements in AI and Machine Learning: The incorporation of artificial intelligence and machine learning algorithms in image processing-based fire detection can improve the accuracy and speed in detecting fires in different settings.
3. Cloud-based processing: The integration of cloud-based processing in image processing-based fire detection has the potential to improve the processing speed, reduce false alarms, and enhance the accuracy and reliability of the system.
4. Emergency response systems: Image processing-based fire detection can be integrated with emergency response systems such as firefighting systems, evacuation systems, and building monitoring systems to ensure a swift and coordinated response during fire emergencies.
5. Remote monitoring: Image Processing based fire detection systems can be monitored remotely, enabling real-time alerts and action to close off air ducts and suppress the fire before it becomes critical.

6. Integration with lighting systems: Image processing-based fire detection systems can be integrated with lighting systems to improve the accuracy of fire detection and reduce false alarms in low light environments.

In conclusion, advancements in IoT, AI, cloud-based processing, emergency response systems, remote monitoring, and integration with lighting systems offer significant future scope for image processing based fire detection using Raspberry Pi. These developments can further improve the accuracy, reliability, and effectiveness of fire detection systems, potentially reducing the number of fire-related incidents, injuries, and fatalities

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