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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 larger amounts. Fire detection systems have been designed to detect via sensing different fire related change. Two types of fire detectors have been used so far, normally 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 to flames quickly and can analyze location of fire. In these detectors, flame which is the vision part of the 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 associate 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.

There are many fire detection systems are working in different areas in different manners but mostly are sensor based and detect fire through heat and smoke. But the method of fire detection by using sensors are now not very effective because they generate alerts when fire has reached its maximum level which is very dangerous that is why the systems is proposed that detects fire in the being which is very important to stop it very before so the loss or damages cannot be done by it.

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Fire

Fire is the visible effect of the process of combustion- a special type of chemical reaction. It occurs between oxygen in the air and some sort of fuel. The products from the chemical reaction are completely different from the starting material.

The fuel must be heated to its ignition temperature for combustion to occur. The reaction will keep going as long as there is enough heat, fuel and oxygen. This is known as the fire triangle.

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Proposed Solution

I here am proposing an IOT based Smart Fire Alarm system that has the ability to think and recognize pattern based on experience aka collected data and algorithm that has a heigh probability of resulting in unwanted hazardous fire.

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Proposing Fire Detection System Components

Raspberry Pi

The purpose is to create a hardware which can detect fire from far away. This device supports the Raspberry Pi platform and windows platform. Fire is a dangerous thing which can bring a lot of harm to anything. To prevent from loss, sensors are installed but these sensors are not effective. Sometimes they get destroyed by heat or fire or sometimes they generate alert very late until the damage has been done. In contrast Raspberry Pi is very useful because it consumes low power and it is of low cost and it does not need any sensors because the camera will detect the fire and generate the alert immediately to the users or the members of the organization, where this system is installed.

Pi Camera

- Pi Camera module is a camera which can be used to take pictures and high-definition video.
- Raspberry Pi Board has CSI (Camera Serial Interface) interface to which we can attach Pi Camera module directly.
- This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable.

Buzzer

A fire alarm is a standalone device or a complete network of devices, installed in a building or an area, which gives audible and/or visible warning of an outbreak of fire in that building or area.

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Internet of Things (IoT)

Internet of things (IoT) is the network of programmable software, sensors, electronics, and communication facility that helps to gather and transfer data. The objective of the designed system is to alert the user and send the email fire engine service while the fire accidents occur. This system can be easily installed at any remote locations from where fire can be easily detected by camera. Therefore, sensors are not required for this purpose. 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 intern 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.

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Fire Detection

The fire detection system is a security system. The primary punction of this system is to detect fires and turn on alarm to warn fire accidents. This system is written in python with OpenCV computer vision module. It is using the HSV color algorithm to detect fires.

This system provides a computer vision-based technique for detecting fire and identifying hazardous fire by processing the video data generate by an ordinary camera.

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Computer Vision

Computer vision is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.

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Color Conversion & HSV Color Algorithm

In fire detection systems each color combination responds to the basic spectrum factors of red R, green G, and blue B in the RGB model. The color model is based on the Cartesian coordinate system. The images or video captured in the form of framed by the Camera are then converted from RGB to XYZ color space. The color conversion is very important and in fire detection system the RGB model converted into HSV (Hue, Saturation Value) that is very important for the detection of fire on very high scale because it gives the fire detection at very minimum to high scales.

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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 and damages of any other property or valuable things that are useful for the company or any place where it is installed.

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Tools & Technology

Python is an interpreted high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. OpenCV is a library of programming functions mainly aimed at real-time computer vision. HSV color algorithm is used here HSV is Hue Saturation Value. It uses HSV component and works well in image processing. Using this filter, an object with a specific color can be detected and to reduce the influence of light intensity from the outside. Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing that aims to simplify package management and deployment. Package versions are managed by the package management system Conda. The Anaconda distribution is used by over 6 million users and includes more than 1400 popular data-science packages suitable for Windows, Linux, and MacOS. The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images.

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Conceptual Model

The major steps involve in this process are fire detection and turn on warning alarm or sending warning messages to fire engine service. If we look at how this system works, a warning alarm will sound immediately when a fire is detected by the camera at the place where the system is implemented, and a warning message will be sent via email to the fire engine service. This system is implemented using Computer Vision. What is Computer Vision? Computer vision is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. Next, the HSV color algorithm is used. This system is programmed and implemented in the python programming language using Computer Vision and the HSV color algorithm.

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Data Presentation & Analysis

fire detection is initially required when inputting a video or image into a computer. From fire detection input data, be it a webcam, video file, image or external camera, the computer only needs to target the fire area to detect fire.

Fire detection algorithms often begin by image processing. The fire detection system is a security system. The primary function of this system is to detect fires and turn on alarm to warn fire accidents. This system is written in python with OpenCV computer vision module. It is using the HSV color algorithm to detect fires.

This project provides a computer vision-based technique for detecting fire and identifying hazardous fire by processing the video data generated by an ordinary camera.

HSV color algorithm is the Color isolation can be achieved by extracting a particular HSV (hue, saturation, value) from an image. The algorithm is simple and the main steps are as follows:

- Step 1 - RGB to HSV Conversion
- Step 2 - Apply a Threshold Mask

We want to convert the image to HSV because working with HSV values is much easier to isolate colors. In the HSV representation of color, hue determines the color you want, saturation determines how intense the color is and value determines the lightness of the image. As can be seen in the image below, 0 on the wheel would specify a mild red color and 240 would specify a blue color.

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Testing

The software testing consists of Gmail application working and testing part which is essential and is very useful. Following are the User Interface of Gmail application given down below to understand the send and received mails and the use of it.

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Advantages of This System

IOT based fire alarm system compared to what is widely deployed right now will be alert faster, in real time. flames quickly and can analyze location of fire. In these detectors, flame which is the vision part of the 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 associate 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.

There are many fire detection systems are working in different areas in different manners but mostly are sensor based and detect fire through heat and smoke. But the method of fire detection by using sensors are now not very effective because they generate alerts when fire has reached its maximum level which is very dangerous that is why the systems is proposed that detects fire in the being which is very important to stop it very before so the loss or damages cannot be done by it.

As the notification system is real time that can cut the response time significantly. When the fire has not spread significantly it gives us better access to that area to deal with the fire and can be dealt with pre-installed fire hose or fire extinguisher. Even when the fire has spread the heat signature collected from the data would enable us to identify how the fire spread and thus give us better insight on how to best deal with it.

Unlike existing solutions as this can be a smart solution, continuous collection and storage of data would give us insight on better identifying underlying causes on how to best prevent such scenarios. Through analytics done on the collected data and research we would be able to better correlate a fire happening to different events and thus would let us configure alert systems based on a combination of data rather than just increase of temperature. For example, depending where the system is installed like if it has more flammable objects or fire sparks can occur more often or does not have immediate access to water or fire extinguisher, we can configure our alert system

on that so these areas can be prioritized or labeled as high risk at low temperature increase and deploy needed monitoring system.

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Results

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 we are 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.

The 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. The main advantage of system is that it is portable and can be carry anywhere but very carefully and is very cost effective and is working very well.

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CONCLUSION

Few years back the fire is detected through sensors or any other method or by smoke. But these methods are now old and are not effective because in these methods the fire detects when it reaches maximum level and it was sometimes too late because the damage was already done. To prevent from this and to stop fire when it starts researchers have explored the idea to replace the sensors and to detect fire through internet or by another means that was cheap and useful and beneficial for others.

IoT is very useful way to detect fire and to detect fire by using computer vision. The idea is that is to give a camera a power of human eye and to detect fire when it starts but that is not a easy job. The researchers then design and implement different algorithms using programming languages and they come up with a algorithm of fire detection using camera but it has some flaws. The algorithm that are design until now are not able to detect fire completely but they also detect some other objects in the color combination of fire and generate a false alarms or notification. The working on it are still going and researchers are working to minimize the rate of false alarms or notifications.

A fire detection system is proposed using Raspberry Pi connected with a camera and operates via image processing and HSV Color algorithm. This system uses RGB color models to detect fire color and texture. Proposed model works well and we are working on its fire detection algorithm for more effective results and to overcome the problems of false alarms. False alarms are generated sometimes due to objects of orange color and shapes. Consequently, the proposed system will result in the reduction of loss and destruction. In future, this system will help the fire fighters or rescue team to rescue someone immediately and fire fighters will stop the fire immediately by tracing the source or location of fire.