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# Fire Prevention System Using RGB Algorithm

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## Abstract
Most of the fire prevention system use smoke and heat sensors to detect the fire, leads to late action to stop the fire and cause a large damage. To avoid the problem, a fire prevention system that utilizes the RGB algorithm for early fire detection has been developed. By employing RGB algorithm and real-time monitoring, the system aims to enhance fire safety in various environments. The system consists of high-resolution cameras strategically placed in the monitored area. These cameras capture real-time video that are processed using the RGB algorithm. The algorithm analyses the video to identify patterns indicative of a fire outbreak, such as intense red and orange colours, and changes in brightness. Once a potential fire hazard is detected, the system triggers immediate alerts to relevant stakeholders through Telegram notifications, and audible alarms. To complement early detection, the system incorporates preventive measures such as automatic sprinkler systems, which can be activated manually or automatically. Overall, the fire prevention system leveraging the RGB algorithm offers early fire detection, real-time monitoring, and seamless integration with existing fire safety infrastructure. By combining these features, the system has the potential to significantly enhance fire safety in various environments, protecting lives and property.

## Keywords:
RGB Algorithm, Real-time Monitoring, Telegram Notifications

## Introduction

Fire prevention systems play a crucial role in safeguarding lives and minimizing damage caused by fire incidents. Traditional systems such as smoke detectors and sprinklers have proven effective in triggering timely responses to fires. Upon detecting smoke, the detector activates the sprinkler system, which acts as a barrier against the spread of flames. The primary objective of a fire prevention system is to protect building occupants and provide them with sufficient time for safe evacuation while also minimizing repair costs.

In Malaysia, fire incidents occur at an alarming frequency, with approximately one fire reported every 24 minutes. The economic impact is staggering, with the country losing RM5.2 billion annually due to fires, not accounting for loss of life, productivity, and inconvenience. Tragic incidents like the 1976 Campbell Shopping Complex fire, which claimed a life, and the 2008 Tanjung Langsat Port inferno serve as stark reminders of the devastating consequences of fires. The 2017 fire at the Darul Quran Ittifaqiyah madrasa resulted in the loss of 23 lives. These incidents underscore the urgent need for effective fire prevention systems.

To address these challenges, a new fire prevention system is being developed as part of this project. Building upon the existing camera-based system that detects fires using an RGB algorithm, the newly developed system incorporates a water sprinkler to actively control fires. Often, the severity of a fire is exacerbated by delayed detection and inadequate response measures. The proposed system aims to empower organizations and users to promptly detect and mitigate fires, preventing their escalation and minimizing the potential for catastrophic damage.

When a fire is detected, the fire prevention system activates the water sprinklers to contain the fire and prevent its spread. Concurrently, a siren is sounded to alert individuals in the vicinity to the presence of the fire, ensuring their prompt evacuation. In the event of a false alarm, users have the ability to manually activate the siren without triggering the water sprinkler system. This comprehensive approach not only curbs the propagation of fires but also minimizes the risk of false alarms causing unnecessary disruption.

The fire prevention system comprises two key components: the user interface and system administration. The user community receives alert notifications, informing them about the fire and advising them to take appropriate action, either by evacuating or extinguishing the fire if feasible. System administrators receive fire alerts and assess their validity. In cases where a genuine fire is confirmed, the water sprinkler system is activated to control the fire until rescue teams arrive. Conversely, if a false alarm is determined, administrators can deactivate the siren without triggering the sprinklers, ensuring an efficient and measured response.

By developing an integrated fire prevention system, this project aims to significantly enhance fire safety measures and reduce the devastating consequences of fire incidents. The proactive approach, encompassing early detection, effective alarm systems, and swift fire control mechanisms, will save lives, protect assets, and mitigate economic losses. As the system prioritizes prompt response and user engagement, it holds the potential to revolutionize fire prevention practices and foster a safer environment for individuals and communities.

## Literature Review

IoT devices have emerged as valuable tools for businesses and companies in their efforts to prevent fires and mitigate potential losses. The global landscape is brimming with innovative ideas and advancements in fire prevention systems. The primary objective behind the development of such systems is to curtail the spread of fires, which can lead to the destruction of valuable assets and loss of life. Uncontrolled fires have the potential to ravage buildings and cause extensive damage. Hence, fire prevention systems play a crucial role in containing small fires and preventing them from escalating. However, certain challenges and limitations in existing fire prevention systems necessitate upgrades and improvements.

In a research paper by Muhammad Khairullah bin Mohd Ghalil (2018), the utilization of RGB and CIELAB algorithms for fire detection is explored. The RGB color filter model combines red, green, and blue light to generate a vast spectrum of colors. On the other hand, the CIE L*a*b* color space represents all discernible colors in three dimensions, aiming to mimic human vision. The L component within the CIE L*a*b* space defines the perception of lightness. Another study conducted by Amr A. Munshi (2021) emphasizes the importance of early fire detection due to the severe consequences that fire disasters can impose on ecological systems, infrastructure, properties, and human lives. The research investigates the efficacy of three color models - RGB, YCbCr, and HSV - in detecting fires, both indoors and outdoors. The experimental findings reveal that these techniques exhibit high accuracy rates in fire detection across various datasets.

The fire prevention system incorporates the RGB algorithm as an input, triggering outputs such as a buzzer alarm and Telegram notifications to indicate the presence of a fire. Hamood Alqourabah (2020) highlights the integration of an Arduino-powered water system, controlled by a 5V relay. An ultrasonic sensor is employed to measure the water tank level and alert users when refilling is required. The Arduino Mega assumes the responsibility of sensor control, extracting readings from the environment. Each indicator is equipped with threshold settings to assess the potentiality and criticality of a fire.

By harnessing the power of IoT devices and leveraging advanced algorithms, fire prevention systems continue to evolve, enhancing their effectiveness in detecting and responding to fires. These systems play a pivotal role in preserving assets, safeguarding lives, and minimizing the devastating impact of fire incidents. Continuous research and development efforts are imperative to overcome existing limitations and ensure that fire prevention systems remain at the forefront of innovation. As technology advances and more sophisticated algorithms are devised, the future holds promise for even more intelligent and robust fire prevention systems that can effectively combat the challenges posed by fires in various environments.

## Research Methods

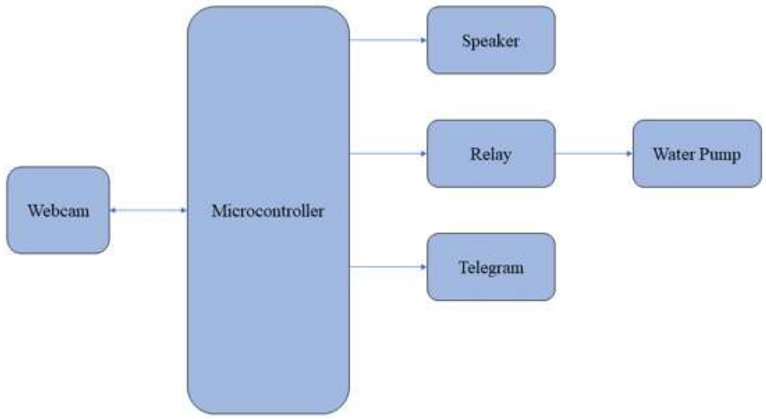


**Figure 1.** Overall Block Diagram of Fire Prevention System

Figure 1 illustrates the utilization of webcams as effective fire detectors, employing the RGB algorithm to detect fires. When a fire is detected by the webcam, the system responds by sounding an alarm and promptly sending a picture of the fire to the user via the Telegram app. This real-time notification empowers users to take immediate action.

The RGB algorithm is employed to detect the color properties associated with fire. By leveraging OpenCV, the flame color recognition process is performed using this algorithm. The RGB color model consists of three elements: Red (R), Green (G), and Blue (B). To detect fire, the color pixels from the original image are extracted and divided into their respective R, G, and B elements. The R element is found to be more prominent in flame color detection compared to G and B elements. Consequently, the RGB algorithm prioritizes the R element for flame imaging, as it serves as the dominant color. The input to the system is provided through the webcam, which captures the video feed for processing using the RGB color model. The images obtained from the webcam are filtered and processed using RGB to accurately determine the presence of a fire. Additionally, user interaction is facilitated through Telegram commands, allowing users to access and control the device.

The primary output of the system is an alert mechanism that sends notifications to the user whenever a fire is detected. In such instances, the alarm is triggered, and a message, along with a photo of the fire, is sent via Telegram. This allows the user to visually verify the presence of a fire and make informed decisions. In the event of a fire, the user has the option to activate the water sprinkler system, providing a means to swiftly and effectively control the fire and prevent further damage.

The integration of webcams, the RGB algorithm, and the Telegram app presents a robust and proactive fire prevention system. By combining real-time fire detection, instant notifications, and user-operated response mechanisms, the system offers enhanced safety and rapid mitigation of fire-related risks.

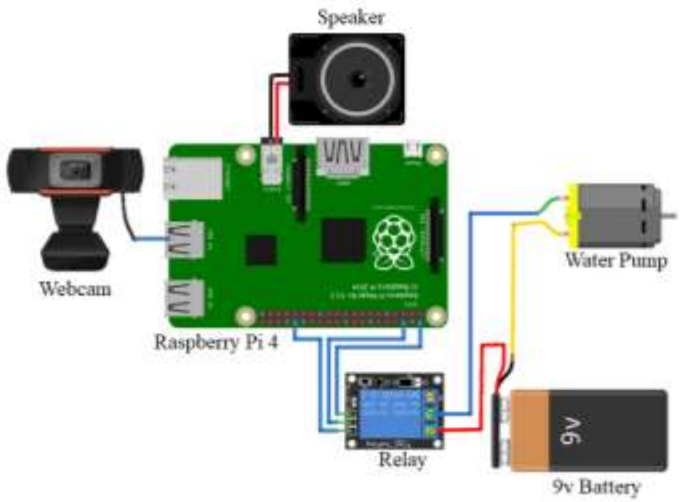


**Figure 2.** Circuit Diagram

Figure 2 showcases the hardware setup for the fire prevention system, incorporating essential components such as Raspberry Pi 4, webcam, speaker, water pump, relay, and a 9V battery. To enable the system's functionality, Raspberry Pi needs to be connected to the Internet. Once a fire is detected, Telegram notifications are sent to the user. The webcam plays a crucial role in fire detection by analyzing the color of the flames. In the event of a fire, the system activates an alarm to alert nearby individuals, while simultaneously notifying the user through Telegram. The user receives a photo depicting the fire's location and can take action by activating the water sprinkler system via Telegram. These operations are orchestrated by Raspberry Pi, utilizing the Node-RED platform. By leveraging this hardware setup and software integration, the fire prevention system effectively detects fires, communicates alerts, and enables prompt response measures to control and extinguish the fire.

## Results and Discussion

This section provides a comprehensive explanation of the specific tests conducted to evaluate the fire prevention system. The test primarily focuses on measuring the distance between the fire and the webcam to assess the system's accuracy. The outcome of this test is contingent upon the specifications of the webcam, as outlined in Table 1.

**Table 1. Webcam Specification**

| Type | Specification |
|---|---|
| Resolution | 1920 x 1080P |
| Image Sensor | CMOS 1/207 Big Chip |
| Frame rate | 30 fps |

During the testing phase, the fire prevention system will undergo evaluations to detect fires within specified distances, as outlined in Table 2. This testing procedure aims to assess the system's performance and its ability to accurately identify fires within predetermined ranges.

**Table 2. Fire Detection Test in A Certain Distance**

| Distance (in meter) | Result |
|---|---|
| 1 | Fire detected |
| 2 | Fire detected |
| 3 | Fire detected |
| 4 | Fire detected |
| 5 | Fire detected |
| 6 | Fire not detected |
| 7 | Fire not detected |

Based on the findings presented in Table 2, it can be deduced that the fire prevention system achieves optimal fire detection accuracy within a maximum distance of 5 meters. The limitations on detection range are primarily influenced by the quality and resolution of the webcam utilized. In summary, the Raspberry Pi demonstrates the capability to detect fires at specific distances, contingent upon the webcam's quality and resolution parameters.

## Conclusions

In conclusion, this paper presents a comprehensive discussion on the design and development of a highly effective fire prevention system. The developed prototype, utilizing Raspeberry Pi 4, demonstrates its ability to prevent fire outbreaks and mitigate potential devastating consequences. By transferring real-time data to the user through the Telegram application, the system ensures prompt response and efficient decision-making. Although the prototype showcased remarkable functionality, further improvements in fire detection accuracy can be achieved by exploring alternative algorithms. This research lays the foundation for future advancements in fire prevention technology, promising enhanced safety measures and minimized fire-related risks.

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