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Industrial Fire Detector Using Colour Detection and Tracking

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Abstract
Conventional fire detection systems use physical sensors to detect fire. Chemical properties of particles in the air are acquired by sensors and are used by conventional fire detection systems to raise an alarm. However, this can also cause false alarms; for example, a person smoking in a room may trigger a typical fire alarm system. In order to manage false alarms of conventional fire detection systems, a computer vision-based fire detection algorithm is proposed in this paper. The proposed fire detection algorithm consists of two main parts: fire color modeling and motion detection. The algorithm can be used in parallel with conventional fire detection systems to reduce false alarms. It can also be deployed as a stand-alone system to detect fire by using video frames acquired through a video acquisition system.
Keywords: Fire, Detection, Colour, Sense, Track

1. Introduction

Fire detection systems are among the most important components in surveillance systems used to monitor buildings and the environment. As part of an early warning mechanism, it is preferable that the system has the capacity to report the earliest stage of a fire. Currently, almost all fire detection systems use built-in sensors that depend primarily on the reliability and the positional distribution of the sensors. It is essential that these sensors are distributed densely for a high- precision fire detection system. In a sensor-based fire detection system for an outdoor environment, coverage of large areas is impractical due to the necessity of a regular distribution of sensors in close proximity. Due to rapid developments in digital camera technology and video processing techniques, there is a major trend to replace conventional fire detection methods with computer vision- based systems [1]-[5].

2. Literature Reviews / Surveys

In this section, we see how color detection and tracking techniques are taking place. Lakshmi, B. Swarajya. (2021). Fire Detection Using Image Processing. Asian Journal of Computer Science and Technology. 10. 14-19. 10.51983/ajcst-2021.10.2.2883. Here author explained the how to detect fire using Fire pixel detection, motion and smoke detection which gives 98% of efficiency. M. Iqbal, B. Irawan and C. Setianingsih, "Detection of Fire with Image Processing using Backpropagation Method," 2019 International Conference on Advanced Mechatronics, Intelligent Manufacture and Industrial Automation (ICAMIMIA), Batu, Indonesia, 2019, pp. 344-349, doi: 10.1109/ICAMIMIA47173.2019.9223392. Here author explains the backpropagation method that is used to carry out object recognition and fire patterns. This system can improve safety in fire prevention [6]-[10].

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3. Proposed Methodology

- Setting up the CAM: The first step would be to code the CAM module using the Arduino IDE software to get the Static IP address and to make sure that Camera is OK.
- Using the Python and OpenCV libraries: After the CAM module setup we use these libraries to use the camera attached to the CAM module.
- Color detection and tracking: The Color detection and tracking is the first step of the fire detection in this we set LSV and HSV and other parameters to track the fire.
- Fire Detecting Algorithms: After the tracking and color detection is done we use multiple fire detecting image processing algorithms which detects fire, more the algorithms more efficiently the fire is detected.
- Alarming the owner: Once the fire is detected by the above system, the owner is notified about it right away.

4. Methodology

The system consists of a ESP32 CAM module which detects the color and tracks the fire. The Python and OpenCV libraries helps in implementing the fire detecting algorithms using image processing. The algorithms analyze the data and then detects the fire with good efficiency percentage as shown in Figs. 1 & 2 [11]-[15].

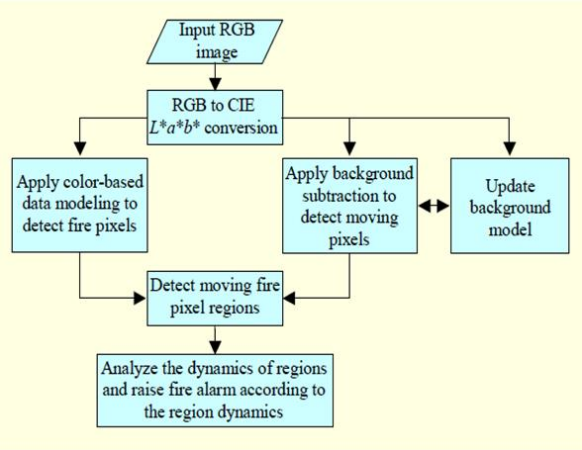

Fig.1 : Block Diagram

Fig. 2 : Fire detection strategy

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5. Specification

ESP32 CAM Module - The ESP32 Based Camera Module developed by AI-Thinker. The controller is based on a 32-bit CPU & has a combined Wi-Fi + Bluetooth/BLE Chip. It has a built-in 520 KB SRAM with an external 4M PSRAM. Its GPIO Pins have support like UART, SPI, I2C, PWM, ADC, and DAC [16]-[20].

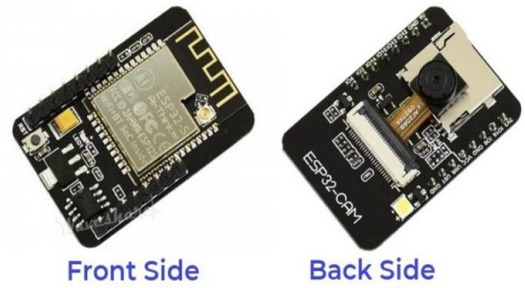

Fig. 3 : Front & back side of sensro

OV2640 Camera - The OV2640 Camera Module has the highest Camera Resolution up to 1600 × 1200. The camera connects to the ESP32 CAM Board using a 24 pins gold plated connector as shown in Figs. 3 & 4 [21].

Fig. 4 : Sensor

FTDI Module- The board doesn't have a programmer chip. So, in order to program this board, you can use any type of USB-to-TTL Module. There are so many FTDI Module available based on CP2102 or CP2104 Chip or any other chip. Make a following connection between FTDI Module and ESP32 CAM module. Connect the 5V & GND Pin of ESP32 to 5V & GND of FTDI Module. Similarly connect the Rx to UOT and Tx to UOR Pin. And the most important thing, you need to short the IO0 and GND Pin together. This is to put the device in programming mode. Once programming is done we can remove it [22].

6. Results & Conclusions

In this paper, a new image-based real-time fire detection method was proposed which is based on computer vision techniques. The proposed method consists of three main stages: fire pixel detection using color, moving pixel detection, and analyzing fire-colored moving pixels in consecutive frames to raise an alarm. The proposed fire color model achieves a detection rate of 99.88% on the ten tested video sequences with diverse imaging conditions. Furthermore, the experiments on benchmark fire video databases show that the proposed method achieves comparable performance with respect to the state-of-the-art fire detection methods [23].

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