A Design of Fire Detection Device Based on YOLOv5

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Abstract

In recent years, fires have become more and more frequent, which has a great impact on people's production and life and even their lives. This paper designs a fire detection device based on YOLOv5, which is mainly composed of Raspberry Pi, Openmv and buzzer, which can be widely used in narrow corridors, parking lots, shopping malls, forests and other scenarios. The device has the characteristics of high recognition rate, fast recognition speed and strong sensitivity, and has excellent recognition effect in fire detection.

Keywords: fire detection, YOLOv5, Raspberry Pi , machine learning

1. Introduction

As one of the hidden dangers that threaten the safety of human life and production, fire has always been the focus of people's attention. Traditional fire monitoring devices detect fires according to temperature, not only poor sensitivity, but also long feedback time, often when firefighters receive alarm messages, the fire chamber has been uncontrollable. In this paper, a set of fire detection devices have been designed by Raspberry Pi, Openmv and Buzzer design, which can perform real-time sensitive detection of fires.

The rest of this article is organized below. The second part describes the working principle of the entire device. The third part introduces the advantages of the YOLOv5 model. The fourth part introduces the functions of each component. In the fifth part, the training set is explained and the detection results are presented. Part VI summarizes the main contents of this article.

2. Overview of Fire Detection Devices

This paper designs a fire monitoring device based on machine vision, which is suitable for most scenes. A convolution neural network is constructed by machine learning, and a large number of training neural networks are trained. The trained model is transplanted to Raspberry Pi, which is used as the main controller to control the operation of other modules.

In terms of the use of components, this paper uses Openmv as a camera to capture the pictures in the scene, and transmits each picture to Raspberry Pi. Raspberry Pi processes and recognizes images. If a flame scene is detected, it will send a signal to the buzzer, and the buzzer will give an alarm to remind the inspectors of the fire, thus achieving the effect of real-time fire monitoring [1]. The design of the The whole device is shown in Fig.1.

Fig.1 The appearance of the devices

3. Introduction of YOLOv5

Generally speaking, YOLO algorithm is a single-stage end-to-end detection algorithm based on anchor-free. After the images are input into the network for feature extraction and fusion, the prediction frame position and class probability of the detection target are obtained. Compared with previous generation YOLO algorithms, YOLOv5 has smaller model, flexible deployment and better detection accuracy and speed. It is suitable for real-time target detection. Its workflow diagram is shown in Fig.2 below.

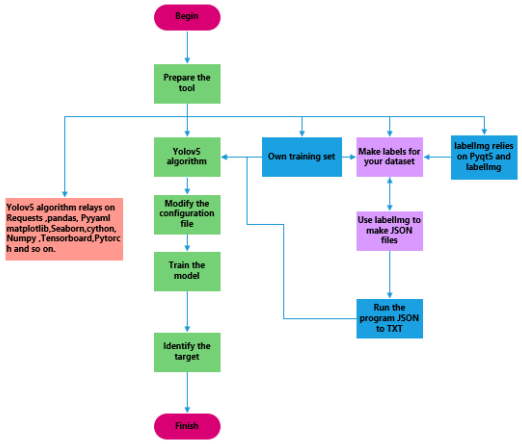

Fig.2 The workflow diagram of the YOLOv5

YOLOv5 is divided into four models: YOLOv5s, YOLOv5m, YOLOv5l and YOLOv5x according to different depths and widths of feature maps. YOLOv5s is the smallest model, so this paper uses YOLOv5s model for fire detection.YOLOv5 is an extension of the YOLO series, and you can also see it as an improvement based on YOLOv3 and YOLOv4.

YOLOv5 does not have a corresponding paper description, but the author actively opens the source code on Github, and through the analysis of the source code, we can quickly understand the network architecture and working principle of YOLOv5 [2].

4. Component Design

4.1. Raspberry Pi

It is a microcomputer motherboard based on ARM, with SD/MicroSD card as the memory hard disk. There are 1/2/4 USB interfaces and a 10/100 Ethernet interface around the card motherboard, which can connect the keyboard, mouse and network cable. It also has TV output interface for video analog signals and HDMI high-definition video output interface. All the above components are integrated on a motherboard only slightly larger than credit cards. Its appearance is shown in Fig.3 below.

Fig.3 The appearance of the Raspberry Pi

With the basic functions of all PCs, you can perform many functions such as spreadsheets, word processing, playing games, playing high-definition videos, etc. just by turning on the TV and keyboard. Raspberry Pi B only provides computer board, without memory, power supply, keyboard, case or connection. In this project, as the master controller, it is responsible for scheduling various functional modules.

4.2. OpenMV

OpenMV is an open source, low cost and powerful machine vision module. With STM32F767CPU as the core, oV7725 camera chip is integrated. On the compact hardware module, the core machine vision algorithm is efficiently implemented with C language, and Python programming interface is provided. Fig.4 below shows the pin definition for Openmv.

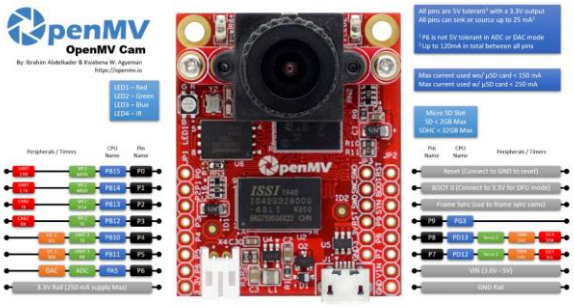

Fig.4 The pin definition for Openmv

In the construction of the fire monitoring device, the Openmv equipped with MT9V034 sensor module is used as the camera to collect pictures in real time and transmit them to Raspberry Pi for detection, which can perfectly provide convenience for accurate visual support and support color and grayscale output. In VGA/QVGA format, it can stably output 90fps frame rate. Output at 200fps frame rate in QQVGA format and 400fps frame rate in QQQVGA format.

4.3. Buzzer

Electromagnetic buzzer is composed of oscillator, electromagnetic coil, magnet, diaphragm and casing. After the power supply is turned on, the audio signal current generated by the oscillator passes through the electromagnetic coil, so that the electromagnetic coil generates a magnetic field, and the vibrating diaphragm periodically vibrates and sounds under the interaction of the electromagnetic coil and the magnet. When receiving the signal from Raspberry Pi, it can quickly send out an alarm to remind us to take corresponding measures. Its appearance is shown in Fig.5 below.

Fig.5 The appearance of the Buzzer

5. Test Results

In this paper, labelImg annotation tool is used to annotate the dataset images, and it is saved in the txt format of YOLO series. By arranging the data out of order, 1442 training sets, 617 test sets and 617 verification sets were randomly selected. Machine learning training through thousands of pictures of fires also has a good detection effect for tiny flames [3]. The detection effect is shown in Fig.6.

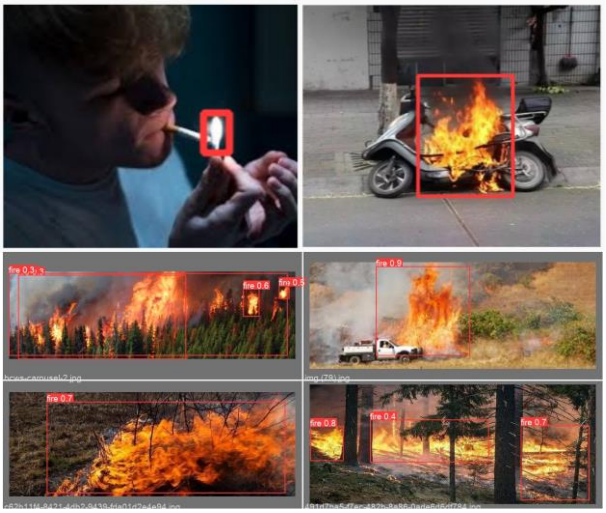

Fig.6 The detection effect of the device

6. Conclusion

Aiming at the problems of poor sensitivity and long response time of similar fire detection devices in the market, a new fire detection device based on machine vision is designed. Compared with the existing temperature and fire detection devices, the machine vision recognition technology has wide application and high practicability.

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