The Design of MLX90614 Based Kitchen Infrared Temperature Monitor Fire Alarm and A Preliminary Study of Temperature Fitting Algorithm

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Abstract

Recently, the occurrence of household fires, especially kitchen fires, seriously damages the national economy. In order to avoid this situation, this paper, using embedded technology, designs a kitchen temperature monitoring fire alarm based on MLX90614 infrared sensor. A series of experiments are carried out to verify the practicability of the designed system, and the obtained data are made to do fitting and analysis. Finally, it shows that the design of this paper is practical.

Keywords: Kitchen fires, MLX90614, Fire alarm, Fitting

Introduction

The fire analysis and research center of the National Fire Protection Association (NFPA) reports its fire statistics results every year. According to the statistics, in the five years from 2009 to 2013, the average family fires have occurred 162400 a year, causing about 430 people dead and 5400 injured a year. In these family fires, 50 % are caused by the kitchen especially 45 % caused by the kitchen stoves, and the number of deaths and injuries accounts for 16 % and 42 %, respectively [1]. Therefore, it’s not only the desire of people but also a high development demand of the kitchen fire protection to guarantee the kitchen’s safety and give people a safe environment.

In order to avoid the kitchen fires, which caused by the high temperature of pans with not closed kitchen stoves, it is necessary to realize the real-time monitoring for the pan’s temperature. Once detecting the temperature of the pan exceeds the certain limited [2], alarming and turning off the kitchen stoves should be done to prevent fire [3].
For this reason, this paper designs a kitchen infrared temperature monitoring fire alarm system based on MLX90614 infrared temperature sensor [4][5][6] and does a preliminary study of temperature fitting algorithm [7].

**Hardware and Software Design**

With embedded technology, this paper designs a control system architecture diagram of kitchen infrared monitoring alarm. It can be shown in Fig. 1. The system mainly consists of indoor monitoring site and cloud server. The use of sensors and wireless transmission technology effectively improves the system's performance. Smart phones or other client-side can receive data from the indoor monitoring site by wireless router. Thus it achieves the real-time monitoring and alarm of high temperature on pans.

![Diagram of Hardware and Software Design](image)

Fig. 1. The control system architecture diagram of the kitchen infrared monitoring alarm.

The process of the infrared monitoring alarm is shown in Fig. 2. The hardware mainly includes MLX90614 infrared temperature sensor, power module, WIFI module, and the MCU STM32F103. Firstly, the infrared monitoring alarm real-time detects the pan’s temperature, and send these detected data to smart phone through WIFI. When the pan's temperature exceeds the program setting value, the MCU will do false-prevention judgment. Once the kitchen stove is not closed, the MCU can automatically alarm by the acoustooptic sensors and turn off the stove by the relays and solenoid valve. Otherwise, when the pan's temperature is below the program setting value, the MCU will do false-prevention judgment. When it judges the kitchen stove to be closed, the MCU can close the acoustooptic alarm.
Experimental platform and operation

The test apparatus includes the common gas stove, MLX90614 infrared temperature sensor, the infrared thermometer DT810 produced by China Everbest Machinery Industry, and Midea pan with the size of 34 cm of the top diameter, 16.5 cm of the bottom diameter, and 3 cm in height. The straight distance between infrared temperature sensor and the pan is 65 cm or 40 cm. Fig. 3 shows real figure of the hardware system. Fig. 4(a) shows our experimental platform.

Fig. 3. Real figure of the hardware system.

Fig. 4(b) shows an example of experimental operation. Firstly, we put the pan on the gas stove and place MLX90614 infrared temperature sensor above the pan at a certain distance. Then, the liquefied petroleum gas stove heat the pan without water. The MLX90614 infrared temperature sensor is used to detect the pan’s real-time temperature, and these data is sent to computer software MlxCIRT supporting by MLX90614-evb to record. Meanwhile, the infrared thermometer is also used to measure the pan’s temperature.
Data processing and analysis

In order to get mathematical relationship of the measured data between MLX90614 infrared temperature sensor and the infrared thermometer, all the obtained data are fitted by Matlab. In this process, we divide the experiment into four groups, and the experiment time of each group is two minutes. The results are described as below:

(1) When the straight distance between MLX90614 infrared temperature sensor and the pan is 40 cm, and the pan is dry, the result is shown in Fig. 5.

![Graph showing temperature over time for 90614-40cm-dry](image)

Fig. 5. The result of 90614-40cm-dry.
(2) When the straight distance between MLX90614 infrared temperature sensor and the pan is 40 cm, and the pan adds water, the result is shown in Fig. 6.

Fig. 6. The result of 90614-40cm-water.

(3) When the straight distance between MLX90614 infrared temperature sensor and the pan is 65 cm, and the pan is dry, the result is shown in Fig. 7.

Fig. 7. The result of 90614-65cm-dry.
When the straight distance between MLX90621 infrared temperature sensor and pan is 65 cm, and the pan adds water, the result is shown in Fig. 8.

Fig. 8. The result of 90621-65cm-dry.

Among these figures, the green solid line represents the data measured by the infrared thermometer (T), which fitted result is the blue dotted line (TF). The red solid line represents the data measured by sensor (S), which fitted result is the black dotted line (SF). In Fig. 4, when the temperature reaches 120 °C, it will not go up due to the maximum of MLX90614 infrared temperature sensor is 120 °C.

By comparing experimental results, we can get the following conclusions:

1) From Fig. 5 and Fig. 6, the change of temperature is more obvious when the pan is dry.

2) From Fig. 5 and Fig. 7, we can see that the data measured by the MLX90614 sensor is related to the linear distance between the pan and sensor. And the closer the linear distance is, the faster the data changes.

3) From Fig. 7 and Fig. 8, the data measured by the MLX90621 sensor is more precise than MLX90614 due to the limitation of the MLX90614 sensor. But the MLX90614 sensor is enough to meet our needs.
In summary, when the pan is dry and the linear distance between the pan and sensor is closer, it’s easier to find the potential safety hazard. For example, when the alarm value of the sensor is set to 100 °C and the linear distance is 40 cm, the alarm is less than one minute to respond. But when the linear distance is 65 cm, the alarm will not respond within the two minutes.

**Conclusion**

In order to reduce the incidence of kitchen fires, this paper designs a kind of kitchen temperature monitoring fire alarm based on MLX90614 infrared sensor. It describes the hardware and software design of the system and makes a series of experiments. Finally, we analyze and fit these experimental data. The results show that the design of this system is practical.

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**References**


