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Data fusion for PT100 temperature sensing system heating control model

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ABSTRACT

This research examines temperature monitoring and automated heating system control. The temperature sensing module utilizes a wireless ZigBee chip. A terminal interface to the RS232 transmission infrared transmitter module issues a control packet through the infrared transmitter module to the infrared receiver module to control the electromagnetic oven. ZigBee chip wireless transmission is the essential network topology design. The subsequent maintenance advantage uses the terminal interface is a Visual Basic program to design the system monitoring interface. Concrete results are: (1) adaptive weighted fusion algorithm for data fusion computing. (2) Completion of the PT100 temperature sensing modules. (3) ZigBee wireless transmission. (4) The infrared receiver, launch control module developed. (5) The design of the interface in this system covers monitoring, automatic control, manual control functions.

1. Introduction

In today society, whether in daily life, or industry and commerce, and even academic research, temperature is a very important parameter for us. It is an integral part of our daily life. When the weather is hot, we use air-conditioners to control the temperature. The temperature is controlled within a certain range to achieve a constant temperature to make us feel comfortable. In cooking, according to the different ingredients different temperatures are required. Controlling the temperature of ingredients plays a critical role in creating a delicious meal. In industrial and academic research, temperature determines the quality of products, public safety and the reliability of experimental data. We examine how temperature is best controlled to meet our needs and objectives. Automatic program control plays an important role in industrial systems. The automatic control concept is extended from human control and is necessary to human control. For example, a heat sink is heated to a certain temperature to heat a liquid.

We want the heat sink temperature remain at a certain level. As long as the proper control valve is open, that heat level can be maintained. However, if the sink temperature changes or the amount of fluid changes, the temperature will change. The operator therefore needs to constantly monitor the liquid temperature and control valves. The operating staff is the reason why there is system reliability. The operating staff monitors the process to see if it has reached the target and if not, repeatedly adjusts the process controls to achieve the requested status. The heated reactor may be subject to run-a-way reactions due to the accumulation of reactants, improper use of catalytic material improper process condition operations, cooling system problems, mixing failure or contamination. Abnormal rise in reaction temperature, leading to loss of control, causing fire, explosion, or toxic gases leak can result from run-a-way reactions. A domestic case occurred in 1996 when a

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Taoyuan County factory reactor exploded. The explosion and fire resulted in 10 dead and 47 injured [1]. The factory body was almost completely destroyed. A neighboring factory was severely damaged. The cause was an oxide reactor temperature control failure, leading to a runaway reaction causing a small explosion and fire causing the catalytic sink to produce a massive explosion [2].

Another instance involved a Changhua County factory reactor in 1992 that suffered an uncontrolled thermal explosion. Fortunately there were no factory casualties. Police and volunteer firefighters arrived at the scene in time to rescue injured employees. The entire factory manufacturing process was destroyed. In this accident, a 15 tons reactor suffered a violent runaway reaction with the operating temperature and pressure rising sharply. The top of the reactor exploded into the external condenser atmosphere, blew the unlocked manhole covers, splashing a large amount of reactants into the unit, causing the reaction to go out of control. Although a large amount of cooling water was poured into the unit by the emergency workers, boiling liquid expanded within the reactor and the pressure exhibited a sharp surge, leading to the reactor explosion. The reactor top cover blew off, accompanied by pressure detonation which toppled neighboring steel bracket near the control room. More than two instances of poor temperature control system design caused chemical disasters. Therefore temperature control system stability is a critical safety issue [2,3].

2. Literature review

The first element in a temperature control system is to have an accurate temperature sensor. Temperature sensing technology can generally be divided into direct with the measurement object in contact with the contact temperature sensor; and non-contact temperature sensor with two temperature projections using radiation heat.

(1) *Contact:* resistance temperature detectors, referred to as the RTD, thermocouple, the thermistor and so on.
(2) *Non-contact type:* such as the optical pyrometer radiation pyrometer, infrared pyrometer and so on.

RTD is a resistance value that changes with the temperature changes in the temperature sensing device. It has the advantages of high accuracy and often used in measurements between −200 °C and 650 °C. It is a common industry temperature sensing device. The RTD in is made of platinum (Pt) because high platinum purity can be achieved more easily compared with other metals. Platinum filaments have very high thermal resistance:

$$R = \rho \frac{L}{A} \tag{1}$$

The above formula shows that the resistance value R and the resistance number ρ is conductor length level L and wire cross-sectional area A related, in L, A, into a fixed, change while resulting in ρ of the changes due to temperature. R also has a certain proportion in the changes, so the size of the platinum resistance value represents the high and low temperature range. Platinum resistance values are Pt as a standard number, such as Pt-50, Pt-100 and Pt-200, on behalf of the standard resistance values at 0 °C, Pt-100 is100 Ω, and when the input signal changes, the output signal of the change in volume for the sensitivity of Pt-100 per Celsius change in volume for the 0.3851 Ω [4].

Expressed the relationship between resistance and temperature:

$$R(T) = R(T_0)[1 + \alpha(T - T_0)] \tag{2}$$

The α represents temperature coefficient, T is the Celsius temperature, $R(T_0)$ the resistance value at $T = T_0$.

At both ends of the coil with a certain voltage, coil current will flow through the current, resulting in the electromagnetic effect. The armature will be attracted to the electromagnetic force to overcome spring tension from attraction to the ferrite core. This drives the armature dynamic contact with the stationary contact (normally open contact) and pull. When the electromagnetic suction disappears, the armature will return to its original position in the spring reaction force. The dynamic contact with the stationary contact (normally closed contact) pulls. This pull, release action achieves conduction in the circuit. Relay normally open, normally closed "contact, can be distinguished: static contact, the relay coil is not energized in a disconnected state known as" normally open contact "; is connected to the state of the static contact The point is called the "normally closed contact" [5].

The ZigBee hardware and software standard was developed by the IEEE 802.15.4 group and ZigBee Alliance organization. The ZigBee MAC layer uses talk-when-ready collision avoidance mechanism. When the data transfer needs is immediately transmitted each data packet sent by the recipient with an acknowledge receipt in hand to confirm the message reply. If not a confirmation message will send it again, this way a substantial increase in the reliability of the system information transmission. According to the official report of the ZigBee Alliance (ZigBee Alliance, 2005), compared with other wireless networks, the ZigBee network has the advantages of power, number of network nodes, transmission distance and system performance [6].

The starting field for infrared transmission, infrared photoelectric broken circuit and the like, is the 780 nm–1.5 μm range. The near-infrared sensors commonly use visible light until the near infrared range has a wavelength sensitivity of silicon photovoltaic diodes. GaAs element infrared light-emitting diode peak emission wavelength 940–950 nm, the human eye does not construct this range of wavelength sensitivity.

3. Systems architecture

The system architecture consists of a sensing module, the terminal equipment, as well as the controlled device, shown in Fig. 1(a). The detailed architecture will be explained in more detail, as shown in Fig. 1(b).

The disquisition PT100 of the sensor signal through the A/D converter, analog signals are converted into digital