High Performance Temperature Detection System for Industrial Automation

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ABSTRACT

Temperature detection technology plays an important role in the industrial automation systems, for example the production of the plastic container in the industrial manufacturing machines. To produce a high quality plastic product, blow molding machines need a high performance and a great precision non-contact temperature detecting system. In this paper, the authors custom design and implement a high performance distributed microcontroller system for non-contact temperature measurement. In practice, this system can detect the temperature of plastic preforms in the heating system of blow molding machines by using infrared temperature sensors and employing the network communication technologies, such as SMBus, UART and RS485 networks. Finally, some experiments are executed to evaluate the performance of the authors' system.

Keywords: Blow Molding Machine, Preforms, SMBus, Temperature Detection

1. INTRODUCTION

In the modern automatic manufacturing, for instance, the blow molding machine is widely used to produce the PET containers (Icon Group International, 2015; Bregar, 2014). PET (Polyethylene terephthalate) (Speight, 2005) is one of thermoplastic polymer resins which become pliable or moldable above a specific temperature and returns to a solid state upon cooling. In this research, the temperature detection system is designed and implemented for the industrial application of the blow molding machine type EM08S1 by the KEENPRO Precision Industry Corp. According to the plastic blow molding technology (Jones et al., 2013; Lee, 2008), before being blew and molded into a specific shape of plastic container or bottle, the semi-finished product called PET

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preform needs to be heated. The PET bottle can be made from a preform by using blow molding machine. How to make a high quality product and yield is the goal of the machine makers and researchers. In the PET blow molding machine, heating control is surely critical for the quality of stretch blow molding to the plastic product (Brandau, 2007; Lee, 2007). Moreover, the temperature detection plays an important role in the heating control process. In this paper, we design and implement a temperature detecting system to detect the temperature of PET preforms in the blow molding machine before entering the molding process.

This system can contribute a great benefit, for instance, reliability, scalability, higher cost-performance ratio and flexibility. They can be explained as follows.

1.1. Reliability

The packet error checking (PEC) mechanism in the temperature detecting module can make the data communication more reliable. Moreover, the unusual occasionally temperature data of the PET preforms can be detected easily by comparing multiple sensing points of our proposed modules.

1.2. Scalability

To satisfy all types of PET blow molding machines with very different tunnels in number, the design of proposed basic temperature detecting module is scalable. For example, an eight-tunnel heating system of blow molding machine needs eight detecting modules. Multiple basic modules can be simply conjoined by the RS485 network to meet the requirement of different type in number.

1.3. Higher Cost-Performance Ratio

The proposed model can provide more sensing points per PET preform than current thermometers used in the heating control system. Each sensor of the proposed model has faster average response time than current ones. The cost of proposed module is less than fifty percent that of current one. On the other hand, for the manufacturers of PET blow molding machines, they can save more than half of component-purchasing cost if adopting this sensing technology in the future.

1.4. Flexibility

According to the experience of manufacturer (Kinpro Precision Industry Corp), the temperature of body and the neck of PET preforms is an essential parameter and required by the heating system. To meet this requirement, the sensing module of proposed system is custom-built to detect the temperature of those sections in this research. Especially, the design of sensing module allows users manually adjust the position of sensors so as to satisfy differ size of PET preforms in length.

The remainder of this paper is organized as follows. The second section gives a description of our system including the design of hardware and software. In Section 3, several experiments are performed and the experiment results are given and explained. We verified the function of the system and its performance. Finally, a brief conclusion is given in Section 4.

2. SYSTEM ARCHITECTURE

The architecture of our proposed temperature detection system is illustrated by the hardware and the software in this section. This section can be divided into two parts. First of all, in subsection 2.1, we introduce the design of system hardware. Next, the part of software is explained in subsection 2.2.