International Journal of Innovative Computing, Information and Control
Volume **6**, Number **4**, April **2010**
 ISSN 1349-4198
pp. 1595–1604

CONTROL SYSTEM DESIGN OF INSERTING MACHINE AND ITS HIGH PRECISION ALIGNMENT

Ping Yang[1,2] and De Xu[2]

[1]Key Laboratory of Complex Systems and Intelligent Science
Institute of Automation
[2]Graduate School of Chinese Academy of Sciences
Chinese Academy of Sciences
Beijing 100190, P. R. China
{ ping.yang; de.xu }@ia.ac.cn

Received February 2009; revised June 2009

Abstract. *A control system for inserting machine is designed in this paper. It consists of a touch screen computer, a small Programmable Logic Controller (PLC), sensors and servoing drivers to drive the four motion axes. The touch screen computer works as the master computer to realize Human Machine Interface (HMI), and the PLC as the slave computer. The master computer receives the operator's commands, and sends working coordinates file to the slave controller through communication with RS-232C serial port. The slave controller outputs pulses to the drivers to control the motions of the four axes. A robust method with optical correction based on a fiber sensor is proposed to realize the high-precision alignment of inserting positions. It measures the accurate position of the origin on the Printed Circuit Board in order to correct the position errors in coordinates file. The experimental results verify the validity of the proposed method.*
Keywords: Motion control, Position correction, Alignment, Control system, Inserting machine

1. **Introduction.** An inserting machine is a system to insert components such as resistors and diodes into the specified positions on a Printed Circuit Board (PCB) automatically, which can reduce human cost and improve productivity for electronic manufactures [1, 2]. The machine moves the PCB to the desired position, then feeds component and bends, cuts and inserts it.

In the inserting process, how to locate the inserting positions reliably and accurately are two of the key factors. Compared to the embedded controllers based on single chip microcomputer, Programmable Logic Controller (PLC) has been widely applied to motion control systems because of its simplicity and high reliability [3, 4]. Therefore, a PLC is selected for the motion control system to ensure reliability in hardware.

On the other hand, the high-precision alignment is one of the basic requirements in many position control systems. It attracts the interests of many researchers. Many methods are developed based on specific precise sensors [5-11]. For example, Lee [5] proposed a kind of ultra-high resolution alignment systems based on atomic force microscope or scanning tunnelling microscope. The system could achieve the resolution in a few angstrom levels. But the system is very large, expensive and not suitable for real-time applications. Morgan *et al.* [6] developed a grayscale fiber aligner to reduce the time and cost of optoelectronic packaging. The fiber aligner achieved an estimated resolution less than 1.25 m. But the large size of the aligner limits its applications. In references [8] and [9], automated fiber-laser alignment based on optimization was investigated. When the light intensity reached