4 Components Based DCS Design Method

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4.1 Introduction

As the world marketplace becomes increasingly customer-driven, manufacturing environments must be highly re-configurable and responsive to accommodate product and process changes, with rigid, static automation systems giving way to more flexible types. To achieve such flexibility it is necessary to have control system, which are inherently flexible. Over the last few years industrial control systems, in common with many other forms of electronic equipment, have exhibited a trend away from centralised control towards far greater use of distributed intelligence (Hanlon and Weston 1982) although the centralised control system still plays an important role in machine controls. For example, distributed control systems are starting to be used in industrial mobile robots because of the greatest flexibility it offers. Volvo Automation has now commenced delivery of its new range of intelligent, semi-autonomous guided vehicles (SAV) to its customers with a distributed control system (Moore et al 1997,1999). Distributed systems denote a computer system which consists of more than one micro/mini computers, may be of different operating systems, which are inter-connected by an efficient computer network and work co-operatively to achieve a common goal (Shatz 1993).

A significant body of research worldwide addresses building machine control system solutions in multi-vendor based systems (Harris; RCS; Albus 1990; Weston 1989; Hitchcock 1991; Manley) sometimes referred to as ‘open architecture’ control. However, most of this programmer focus on the higher-level system architecture and do not specifically address the issues pertinent to a control system design for mechatronic systems. While the concept and implementation of fieldbus have been on-going for a number of years, it is only the last few years that a tremendous growth has been witnessed in the application and development of fieldbus systems. The market for fieldbus related products is expanding rapidly with many products already installed in plant. Simplified wiring and the resulting cost savings in installation and maintenance are the immediate benefits. The potential in creating added value through integration is likely to be much more significant than the direct cost savings obtained through simplified wiring, installation and maintenance.
Developments in computing electronics have resulted in fieldbus and control network technology, which allow distributed control solutions to be realised cost-effectively and efficiently. ‘Intelligence’ can now be distributed to the component or device level, which provides a new dimension in building manufacturing machines and/or production systems (Moore et al; DG 1992). With such approaches the wiring and installation costs are greatly reduced. Maintenance of plant and equipment is simplified and the control capabilities can significantly improve. The control elements can now be considered truly ‘distributed’ not only in conceptual terms but also in physical forms. As no single all prevailing international standard for fieldbus systems has emerged (in excess of 50 variants currently exist), then approaches which enable interoperability between dissimilar systems in a coherent and complementary manner, without limiting the inherent advantages of the individual bus systems, offer many attractions (Hoffmann; Lasher; Wolfhand 1994). However, significant design issues remain to be addressed, as such technology is still in its infancy.

In the study of distributed control systems, some researchers (Pascal and Mori-waki 1993; Huvenoit 1995) focus on modelling, scheduling and simulation of distributed control systems. Other researcher (Darwish 1988; Huliehel 1993) focused on system structure design. Song, D. proposed a distributed control system based on the FIP Fieldbus (Song et al 1996). It enables each module to be intelligent, improving the flexibility and the fault tolerant capability of the whole system. However, it did not systematically discuss how to design each module, how to design the whole system and how to build, manage and monitor distributed control systems. To realise an effective and coherent strategy for designing and building distributed control systems which can be used within mechatronic systems, a new approach is proposed utilising a ‘components’ based paradigm. This chapter aims to devise methods for the design of distributed control systems for mechatronic types of machines adopting a components-based paradigm exploring fieldbus technology initially addressing the device/field and machine level within the system hierarchy. The method introduced in this chapter was presented in PhD thesis (Xie 1999) “Methods, tools and components paradigms for the design and building of distributed machine control systems”, and it has been successfully applied to the “Intelligent Semi-Autonomous Vehicles in Materials Handling” project (De Montfort 1997–2000). It focuses on the concept and design method of component and components-based distributed control system. Other aspects, such as: building, management and monitoring a components-based distributed control system, associated tools for this method, were mentioned.

4.2 Overview of Components-based Distributed Control Systems

Fig.4.1 illustrates the architecture of the components-based distributed control for mechatronic systems. It consists of many devices and a fieldbus. A device is a copy of a component which stands for the device type. This is similar to the con-