Low Cost Shop Floor DNC System

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ABSTRACT

Direct/Distributed Numerical Control (DNC) has a vital role in delivering a successful Computer Integrated Manufacturing (CIM) strategy. DNC is the most popular form of factory automation system in the shop floor environment. Its core function is to enable manufacturing information to flow smoothly and efficiently to and from the shop floor facilities. The current New Zealand small to medium manufacturers are unwilling to make large financial investment in the more expensive packages, and hence, there is a need for a cost effective DNC application software within this sector of the industry.

The research conducted for this project focuses on the application of a multiport serial card, and the development of a low cost DNC application software that can be implemented in the small to medium size companies for transferring data and other manufacturing data such as drawing files, and computerised numerical control (CNC) programs. In addition, the research also looks at methods to allow remote access to the system through the World Wide Web (WWW).

In order to achieve the objectives mentioned above, a powerful and user-friendly user interface programming tool kit — Borland's Delphi 4 was adopted as the key development tool. Delphi 4 is a Rapid Application Development (RAD) package that is fully compatible to the Multiport's serial programming library, and majority of the Microsoft's remote access technology such as Object Linking and Embedding technology (OLE) or ActiveX.

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CHAPTER 1

1. Introduction

1.1. The Research Topic

In the modern industrial production environment, the number of computer application is steadily increasing. The potential for automated process, especially in manufacturing sector, has been put into practice by applying ever more sophisticated computer aided tools and methods.

With the increase saturation of companies with computerised processes. The future development of such beneficial integration will not only lie in the installation of isolated computerised solutions in the different areas (island solutions), but rather in the coupling and therefore in the utilisation the combined effect of automation technology and shopfloor management. Such concept is often referred to as Computer Integrated Manufacturing (CIM), which includes the coupling of all areas linked to the actual manufacturing operations, including Computer Aided Design (CAD), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing (CAM) and Material Requirement Planning (MRP).

As part of the key development in achieving CIM, Direct/Distributed Numerical Control (DNC) and Computer Numerical Control (CNC) were introduced as the first computer control systems in the early 1970 [4]. The DNC control system establishes a direct link between a computer and each NC machine tool, and eliminates the necessity for using punched tape input. In addition, CNC technology consists of a soft-wired controller that can be adapted to various types of machine tools by programming the control functions into the computer memory for a particular machine. Today, the DNC system is a basic self-contained control unit in the manufacturing automation environment, and one of the first steps towards factory automation based for CIM.

DNC is a major necessity for any manufacturing organisation that wants to achieve a successful CIM. However, the costs of employing existing DNC system packages have driven away many small and medium companies within the New Zealand industry. Hence, by developing a low cost shop floor DNC system will be very appealing for this market sector. This research project, led by Dr Liqiong Tang, Institute of Technology & Engineering (ITE) of Massey University, is dedicated to the development of low cost DNC systems that will allow further in depth integration of CIM for the New Zealand manufacturing industry.

1.2. The Scope of Research

The research undertaken here concerns the critical information flow between different users and seeks a low cost and efficient method in delivering manufacturing information between the geometrical/technological domains, this domain area usually only includes the CAD/CAM/CNC Data Communication.

The system developed in this Masters thesis involves the implementation of a suitable interface card and the development of Graphical User Interface (GUI) that will integrate with existing CAD/CAM application in ITE faculty.

1.2.1. Interface Card Selection & Integration

With the aim of connecting the isolated CNC machines, to the current industrial communication systems. The DNC system developed within this research project will implement several serial communication hardware devices.

One of the keys of the research is to understand the hardware system required to deliver a cost effective Serial Distributed Control System. Therefore, factors such as the following will be considered during the selection of the interface card

- Highest performance that meets all speed-demanding and data intensive communication needs.
- Large on-board buffer for high-performance communication
- Compact design size—ideal for high performance systems
- Critical industrial control
- Response demanding monitoring systems
- Cost Efficient

1.2.2. Software Development

A large number of small and medium size companies today possess a significant number of machines and equipment incompatible with the new Operating System (OS) standards. For control of data transfer, there are still many DOS application that can only run single task at a time, which means no other application program can be executed concurrently. Another disadvantage of these DOS application is the lack of communication between application programs such as CAD/CAM, which results in large amount of time wasted in switching between programs and loading saved data.

Therefore, the application program developed in this project will focus on the following core functionality to overcome the shortcomings within the DOS environment.

- Front-end Application interface for CAD/CAM Environment
- Communication interface programs for both serial data transfer and networking between the CAD/CAM workstations and CNC machines.
- Application programs for NC code editing and for accessing other software application within the workstation.
- Remote software access through Internet for cost effective software distribution.

With the previous listed functions, Figure 1.1 illustrates three interfaces that are considered within this research.

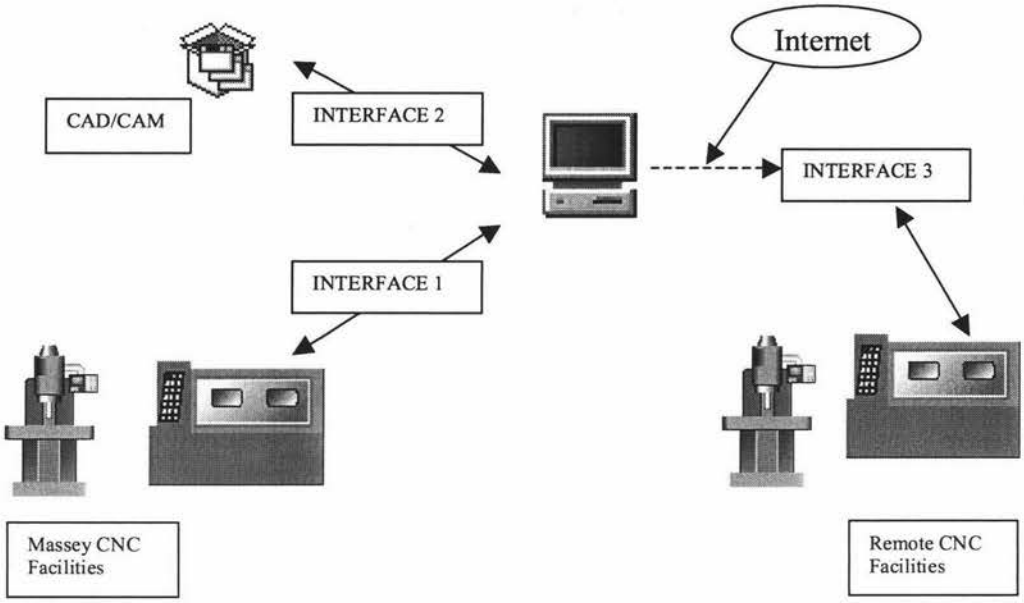

Figure 1.1: Proposed interface connections

- *Interface 1* --- For communication with CNC machines
- *Interface2* --- For communication with CAD/CAM System and other desktop applications
- *Interface 3* --- Internet interface for remote access to software from remote site.

The front-end application interface within this research project is designed through Borland's Delphi 4. Delphi offers all of the windows GUI advantages, which allows the programmer to write standard window features such as title bar, menu bar and common tool bars for quick access to commonly used commands.

1.3. Organisation of Dissertation

The dissertation is arranged as follows:

Chapter 2 deals with the methods and theories of current shopfloor manufacturing strategies, concepts such as Computer Integrated Manufacturing (CIM), Virtual Manufacturing, Direct/Distributed Numerical Control (DNC) and serial communication devices are described in detail. This chapter aims to provide essential theoretical support and research direction for this project.

Chapter 3 focuses on the installation process of the selected multiport card, and describes some of the serial programming utilities that accompany the multiport card.

Chapter 4 covers the software engineering process applied. The chapter only covers the analysis and design stages. Allowing the implementation and testing stages to be described in later chapters.

Chapter 5 describes the basic steps used for establishing communication interface to the multiport device. The chapter denotes some of the fundamental functions used within the program, and illustrates the testing results ascertained through a RS-232 tester.

Chapter 6 illustrates the implementation of the character exchange interface. This section describes the application of Threading function from Delphi, allowing user to view the keyboard input from the other end of the serial network.

Chapter 7 denotes the definition of several serial communication protocols, and explains how these protocols are implemented through the Application Programming Interface (API) functions

Chapter 8 describes the methods used in implementing Multiple Document Interface (MDI) function within this project. The MDI interface will be used for the NC editor and OLE child form. This chapter will describe the code used in constructing the NC editor.

Chapter 9 discusses the application of Component Object Model (COM), and Object Linking & Embedding (OLE) technology within the research thesis. The chapter will also describe the code used constructing the OLE child form

Chapter 10 focuses on the use of ActiveX technology, describing how the resulting interface will allow remote access to the restricted version of the interface through the World Wide Web (WWW).

Chapter 11 describes the testing procedures conducted on the interface program.

Chapter 12-14 discusses the results of the project by listing areas of work done and possible areas of improvement.