ICSE
2009

PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON SCIENCE AND ENGINEERING

Volume - 1

Electronics
Electrical Power
Information Technology
Engineering Physics

Sedona Hotel, Yangon, Myanmar
December 4-5, 2009

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Organized by
Ministry of Science and Technology

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ELECTRONIC ENGINEERING

Implementation of Axis Extension for CNC Milling Machine (Interfacing with Rotary Table)

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***Abstract*- The main purpose of this research is to design and implement the interfacing system between the existing 3-axis CNC milling machine (ANILAM 3000M) and the rotary table controller. Hardware portion for axis extension of CNC milling machine was emphasized in this research work. In order to implement 4-axis CNC milling machine, Controller Area Network (CAN) Board was used as some input/output functions of a machine. Miscellaneous functions (M codes) were typically used as programmable switches (like spindle on/off, coolant on/off, and so on). The advanced techniques for axis extension of existing 3-axis CNC milling machine were also discussed. The required interfacing circuit was designed and built to form a complete representation of 4-axis CNC milling machine.**

***Keywords* — 3-axis, 4-axis, CNC milling machine, Fourth axis, Rotary Table**

I. Introduction

Computerized Numeric Control (CNC) machines have become the basis of many industrial processes. CNC machines include robots, production lines, and all those machines that are controlled by digital devices. Typically, CNC machines have a machine control unit (MCU) which inputs a CNC program and controls the behavior and movements of all the parts of the machine. Computer numerical control is the process of having a computer controlling the operation of a machine. CNC machines typically replace (or work in conjunction with) some existing manufacturing processes. Almost all operations performed with conventional machine tools are programmable with CNC machines. For instance, with CNC machines, motion control can be performed in linear (along a straight line) or rotary (along a circular path) axes.

In today's demanding global marketplace, manufacturers are constantly seeking new strategies to increase productivity. Nowadays new technologies are used and new manufacturing and control processes, and management techniques are applied. A common method is to use CNC machinery, Computer Aided Manufacturing CAM and simulation software, and Coordinate Measuring Machines (CMM) integration. Myanmar country requires advanced manufacturing technologies. In Myanmar, 3-axis CNC milling machine is widely used. Now more advanced technology is essential. In this research, rotary table is considered as fourth axis to extend in existing 3-axis CNC milling machine. To connect the rotary table with three axis CNC milling machine, Controller Area Network (CAN) I/O (input/output) Board will be considered as interface.

The main objective of this project is to design fourth axis for the milling attachment of the CNC milling machine. This machine currently has only a 3-axis milling capability, as shown in Fig. 1 .The fourth axis is a rotary table mounted on the work piece table. Following block diagram is the concept of this research.

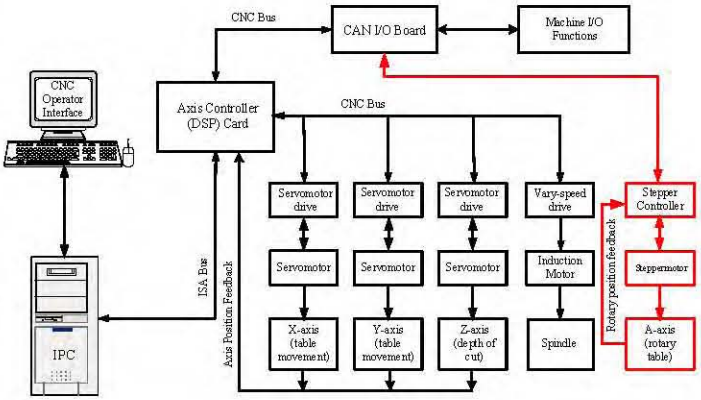

Fig. 1 Block Diagram of 4-axis CNC Milling Machine

II. Methods

In this research, ANILAM 3000M 3-axis CNC milling machine is used as existing CNC machine. And Golden Sun Rotary Table and Controller will be used to extend as fourth axis.

A. Fourth Axis Integration

Fourth Axis is a generalized term referring to an additional axis that can be integrated into the current X, Y and Z axes machining center configuration. The Golden Sun Rotary Table Controller can be used as a manual system or integrated into the CNC manufacturing application as a fourth axis using one of the three interface configurations as shown in the following options.

Option 1. True Fourth Axis via the Host Machine

The rotary table may be connected directly to the host machine and its CNC control. Configured in this way, the rotary table operates in a fully interpolated fashion with the other axes of the host machine. This arrangement does not use the rotary table controller but relies on the capabilities of the host machine's CNC control and its motor amplifier. The programming requirements for the rotary table become fully integrated into the main CNC program and the rotary table is treated as a fourth axis of the CNC milling machine. Custom motors may be fitted to accommodate other brand CNC controls.

Option 2. Fourth Axis via RS-232 port and Interface Cable

The rotary table and controller may be connected to the host machine via the RS-232 port. Using this method, the program commands will be resident in the machine's CNC control and sent directly to the rotary table's motor control. After sending the program information, the host CNC relay signals that the motion should begin and when complete, it returns a finished signal to the CNC. Subsequent machine tool movements occur after the rotary motion is completed. This interfacing technique requires that the host CNC be capable of communicating programming information over an RS-232 communications port.

It is noted that control systems that do not directly provide the ability to write information to the RS-232 port may require special software by the control builder in order to operate in this fashion.

Option 3. Fourth Axis via CNC Interface Cable

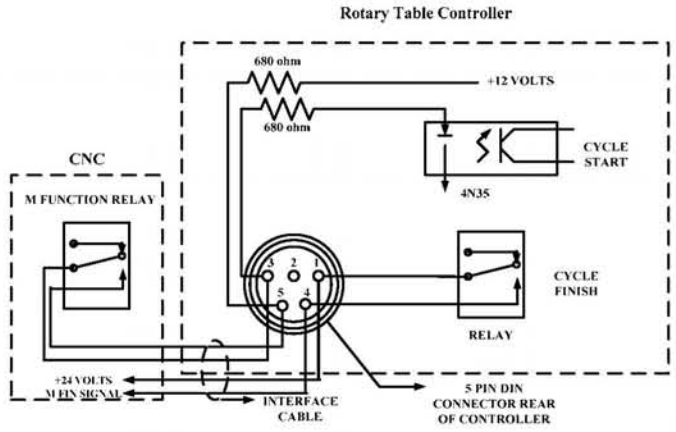

Fig. 2 Interface Cable Connection for Rotary Table Controller and CNC control

In this interface arrangement, the communication that occurs between the rotary table controller and the host CNC is in the simplest form. Logically the host CNC requests that the rotary control processes its next programmed commands and then advises when completed. This requires that the program be stored internally within the rotary stepping motor control, which is then asked to execute the commands sequentially as a signal is received from the host CNC control. Typically the START rotary table command is prompted by a programmable M-code.

At the completion of the rotary table-commanded movement, the unit sends the host CNC a finished signal (so that the CNC machine can proceed with the remainder of its program). The interface cable is provided to connect the host machine to the rotary table controller.

In this research project, this interface arrangement is used as axis extension technique. Their connection is shown in Fig. 2.

III. Results and Discussion

After we connect the rotary table controller and CNC machine as Fig. 3, machining job (fourth axis operation) will be done successfully at proper feed rate. Fourth axis operation can be done by using either M-code such as M10 clamp and M11 unclamp or Start/Finish cycle signals.

Converting 3-axis CNC milling machine into a full 4-axis CNC milling machine gives the machine the capability to machine parts faster, cheaper and more accurately. A rotary table allows for quick access to work-part surfaces in one setup that might take several setups with a 3-axis machine. The setup time is reduced and setup errors are eliminated.

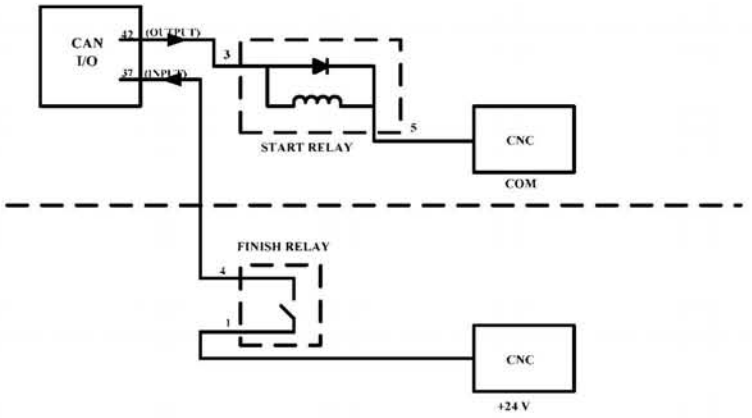

Fig. 3 Connection Circuit with Relay

IV. Conclusion

Now the axis extension has been done by communicating with a separate rotary control via Start/Finish signals. The next decision involves performing as full four-axis control. A single, four-axis CNC is the easiest to use and provides the most control. Four-axis CNC is the best for certain kinds of work pieces. So future research students will be recommended to achieve the full four axis control. Three choices for this purpose can be considered. They are direct full fourth axis using only the machine's CNC, an M-code command from the CNC to a separate rotary control and RS-232 communication between the machine's CNC and a separate rotary control. Each of these choices has advantages and disadvantages.

Acknowledgement

The author would like to acknowledge her supervisor, U Win Khaing Moe, Myanma Scientific and Technological

Research Department for his help, ideas, interest, supervision and encouragement and giving intelligent methods throughout this research work. The author would like to express her thanks to Dr. Htun Kyaw Myint, Technological University (Hpa-an) for his help and cooperation throughout the development of this research.

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