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RESTRUCTURING CONTROL SYSTEM OF TOP SURFACE GRINDING MACHINE FOR IMPROVED PERFORMANCE

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ABSTRACT

The development of high performance machines has drawn much attention from industry recently as the need for speed and flexibility increases. So industries have gradually moved from conventional relay logic control to programmable logic control. Then as per needs, industries have moved to Computerized Numerical Control. In this paper, CNC with built-in PLC based control system is applied to the top surface grinding machine. A great level of flexibility and short cycle times can be gained with the use of this system. Performance parameters of the upgraded system are also compared with previous system in this paper. Our results show that the performance parameters cycle time and production rate are improved.

Keywords: Computerized Numerical Control (CNC), Grinding Machine, Programmable Logic Controller (PLC)

I. INTRODUCTION

Almost any production line, machine function or process can be automated using a PLC [1]. Modern precision manufacturing demands extreme dimensional accuracy and surface finish. PLC fulfilled some of the needs of industry, but the desire to obtain software controlled automation with higher flexibility gave rise to Computerised Numerical Control (C.N.C) [2]. CNC's are used now for some specific applications like turning, milling, grinding and many more toward more open and flexible platforms [3].

The top surface grinding machine was previously equipped with PLC based control system. That PLC is becoming obsolete now. When such an obsolete piece of machine breaks down, it leads to increased downtime, as these are very difficult to get from market and the specialized staff are also very difficult to find. Not only this but software systems are also not supported by suppliers any more. Other problems are increased cycle time and downtime [4]. Instead of buying a new machine, we can upgrade the machine with recent technology to perform better. So, a new control system is introduced with CNC having built-in PLC, where PLC works as a slave section, subordinated to a master CNC.

The CNC is used for position control and the PLC is used for logical control. CNC sends a series of coded instruction and operates the machine tools; The PLC consists of ladder diagram programming. As response time of the CNC is faster than PLC, this new system will lead to reduced cycle time and so production rate will

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increase. As editing in part program is possible, we can change the profile of workpiece. Thus same machine can be used for grinding different parts with different dimensions. Upgraded system will be more user friendly.

II. PROPOSED CONTROL SYSTEM

The block diagram representation of the proposed system is shown in Fig.1. Here the developed system consists of a CNC and built-in PLC which will be the controlling part of the machine.

CNC precisely controls various types of motion employed in the machine using PLC. The PLC is a programmable controller which is mainly for the logical sequential control of these various types of operations. Here the PLC will works only after receiving enable signal from the CNC, drives and machine elements input [5].

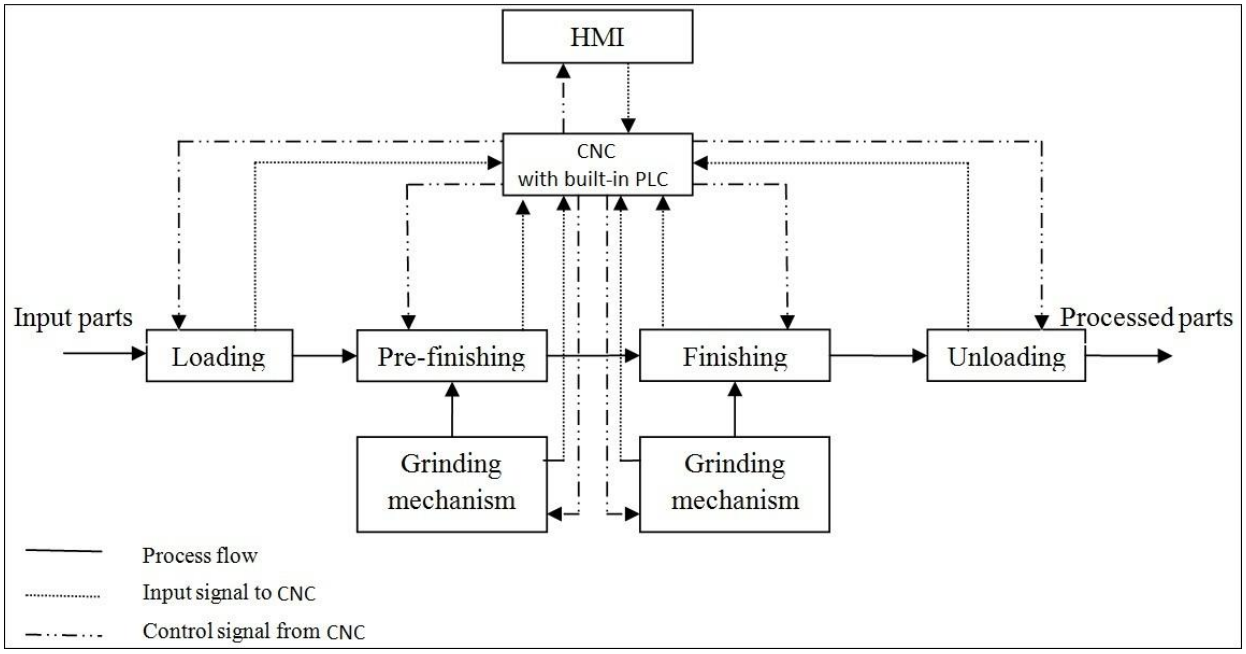

Figure 1: Proposed Control system

2.1 Computer Numeric Control (CNC)

Numeric control is a programmable automation where the numbers, Letters and symbols are used for controlling an operation. Here, the numbers actually form the program of instructions designed for a particular work part or job. As the job changes instruction of program is changed. The system with previous controller only was able to perform operation on one type of job. When job is changed, system was not useful anymore. But with the control of CNC we can perform machining on the new job with little change is in program. This is possible only with CNC controlled system. This ability gives NC its flexibility. Writing a new program is always easier than buying a new machine. CNC is an NC system which utilizes the specially dedicated, stored program Computer that performs some or all of the basic numeric control functions. Additional flexibility and computational capability are offered by CNC. Because of this, we can reprogram part programs and system control options.

Computer Numerical Control (CNC) is one in which the machine tool's functions and motions are controlled by means of a prepared program which contains coded alphanumeric data. CNC can control the motions of the

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workpiece or tool. Also the input parameters such as feed, depth of cut, speed are given in part program along with the functions such as spindle on/off, coolant on/off [6]. PLC interfaced with the CNC is programmed for the machine sequence. The operational sequence of the machine is decided by the CNC part program.

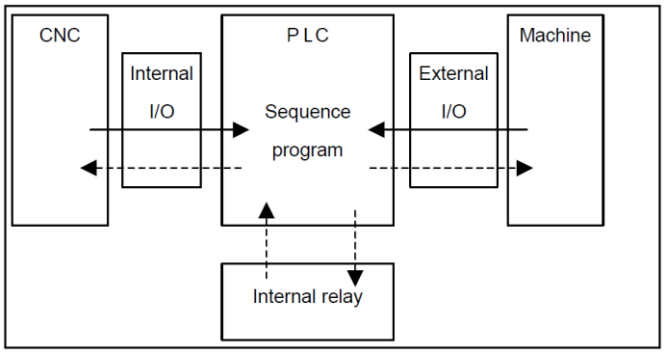

Figure 2: CNC system

After reading a part program, the CNC controller decodes the G codes into pulses to control the driving system to perform the required motions. On the other hand, the CNC controller decodes the M and T codes as Boolean logic signals into the PLC unit to control machine spindle ON/OFF, coolant ON/OFF, tool clamp ON/OFF, etc. Obviously, PLC plays an important role in CNC system as an inter-mediator between the CNC unit and machine tool [7]. When the machine is running, the display unit displays the present status such as the position of the machine slide, feed rate, part programs, etc. It also shows the graphics simulation of the tool path so that part program can be verified before the actual machining.

2.2 PLC

The physical interface to machine I/O and the associated interface control function is delegated to the PLC, which is integrated into the CNC system. While digital I/O is sufficient for most machine tools, PLCs also offer the possibility for analog I/O and the use of function modules for specialized tasks [8]. PLC program consist of logic required to monitor & control the input and output devices in our application [9]. Fig. 3 shows the introductory ladder programming.

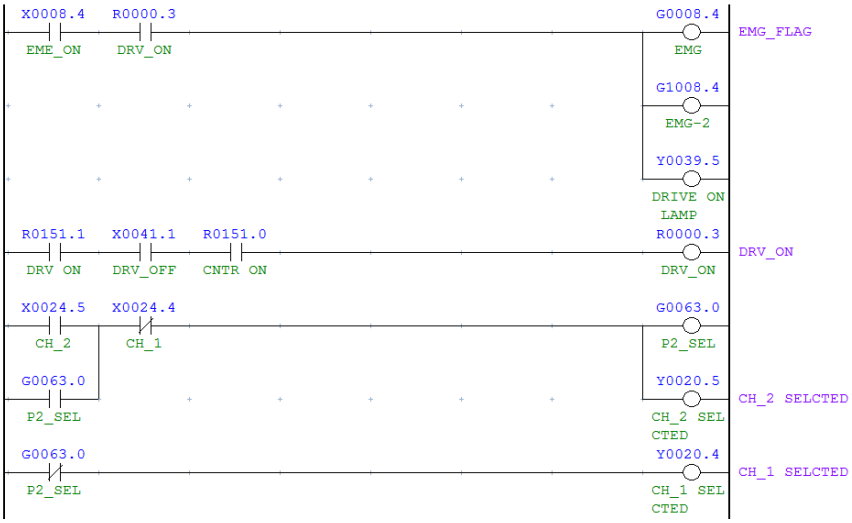

Figure 3: Introductory Ladder programming

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III. PERFORMANCE ANALYSIS

Table-I: Comparison of Performance Parameters

Performance parameter	Previous system	Proposed system
Cycle time	9.5 sec/pc	7.0 sec/pc
Production Rate	2000 pcs/shift	2800 pcs/shift

Table-I lists the performance parameters comparison of upgraded system with previous system. Cycle time of the machine has significantly improved with the CNC based control system, which leads to improvement in production rate also. Figure 4 and 5 shows the HMI and electrical panel of previous and upgraded machine respectively.

a) Previous system

b) Upgraded system

Figure 4: HMI

a)Previous system

b)upgraded system

c) Previous system

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d) upgraded system

Figure 5: Electrical panel

IV. CONCLUSION

Performance analysis showed that the upgraded control system of CNC having built-in PLC has improved cycle time significantly. Production rate of the system has been also increased. Thereby due to higher productivity rate the profitability increases at a considerable rate. The upgraded system achieves high reliability and greater efficiency. Thus the retrofit and automation of the machine paved the way for increasing the productivity and reliability, time saving and HMI enables the operation of machine easier for non-skilled labors too.

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