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AUTOMATION AND CONTROL OF GRINDING MACHINE BY USING PLC

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ABSTRACT-The focus of this paper work is on the automatic working of the entire machine or plant. Here in industrial automation, we use PLC, Drives and HMI. With the help of these devices we automate the entire machine. In the present work, the entire working of the cylindrical grinder is controlled. During manual operation of cylindrical grinder, workers, working on the machines face difficulty in synchronizing the speed between grinding wheel and the job head. Both are continuously rotating at some speed. There is also a problem in the movement of slide, which brings the grinding wheel near to the work piece for appropriate cutting of the extra material from the work piece .So in order to overcome all these difficulties, we use FX3U-64M (PLC). It gives command to various Servo drives, VFD Drives and limit switches. For proper starting of the machine, the proper interlocking should be done in PLC programming, satisfying various conditions.

1. To reduce the cycle time of machine.
2. To improve the quality of the bearing.
3. To reduce the maintenance cost of the grinding machine.

Keywords- Grinding, Cycle time, Quality, Mitsubishi PLC, Servo System

I. INTRODUCTION- Almost any production line, machine function or process can be automated using a PLC. The speed and accuracy of the operation can be greatly enhanced using this type of control system. The use of programmable logic controllers (PLCs) with power electronics in electric machines applications has been introduced in the manufacturing automation [1]. But the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information. Since there were problems related to large electrical panels with a number of electrical components and extensive wiring, people felt the need for software logic controllers? So they gave birth to Programmable Logic Controller (P.L.C) wherein the control logicis developed in ladder diagram, a software logic control, with a number of inputs taken from the environment and generating the outputs, depending on the logic programmed, to the environment. This helped to control any machine sequence with small electrical panels, less number of electrical components and less wiring with more flexibility to change machine sequence. These fulfilled some of their needs but the desire to obtain software controlled automation with accuracy necessitated the development of Human Machine Interface (HMI). In order to have better control for positioning, controlled speed and quick reversal of direction of slide movement, servo and induction motors having less inertia, along with servo drives are interfaced with the HMI. The user based part program decoded

by the HMI provides the desired graphical profile with the control being transferred to

P.L.C. and drives as and when required [2].

II. BLOCK DIAGRAM

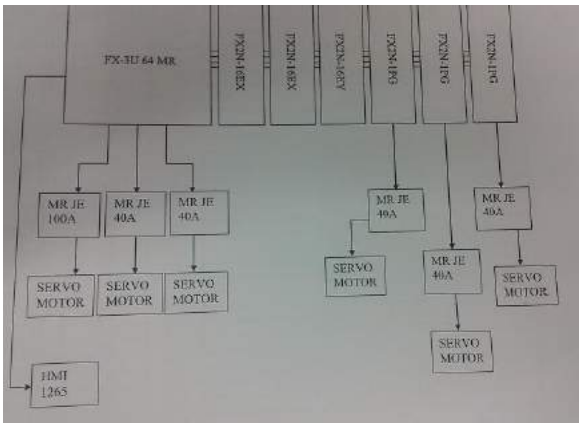

Figure 1: Block diagram of the system

The block diagram below gives the idea of the upgraded system. Proximity sensor detects the inner ring which comers through shaft. This information is given to PLC and according to the set program output signal is given to motor from PLC and hence motor id driven. There are various digital input given to Mitsubishi PLC from proximity sensors (inductive and capacitive). The digital outputs of the PLC are given to various motors which drive grinding wheel, dressing wheel. High frequency drive is used for driving grinding spindle. The block diagram of the upgraded system is as shown in figure 1.

1) **MMI GOT Series**: Man machine interfaces are panels mounted devices that provide effective dialogue between the operator and machine .Equipped with programmable display and keys, MMI allows easy operation and monitoring in the production area. MMIs display operational and fault messages enable a machine specific parameters to be monitored and modified in suitable formats. MMI keeps the operator fully informed of the current status of operations of all times.

Features:

1. High resolution quality with touch screen facility
2. 64 bit high speed RISC processor
3. Serial port connection.

Figure 2: GOT 1000 MMI Front panel

2) **DIGITAL INPUTS**: There are various digital inputs like output from float sensors, inductive proximity switch, push button, selector switch.

Proximity Sensor: Proximity Sensors are available in models using high-frequency oscillation to detect ferrous and non-ferrous metal objects and in capacitive models to detect non-metal objects. Models are available with environment resistance, heat resistance, resistance to chemicals, and resistance to water. Proximity Sensors convert information on the movement or presence of an object into an electrical signal.

Figure 3: Proximity Sensor

3) **DIGITAL OUTPUTS:** Digital output to the Grinding

wheel, Dressing wheel, servo motor.

4) **MITSUBISHI FX PLC**: CPU is the heart of Programming logic control. MITSUBISTHI is the Manufacture of PLC based machine which placed Worldwide.

Features:

1. Expandable from 16 to 4096 I/O s

2. PLC-CPU cycle period/log instruction up to 34 ns

3. High speed counters.

Figure 4: Mitsubishi plc FX3U-64-M

5) **SERVO SYSTEM:** A servo amplifier reads position data directly to perform operation. Data from a command unit is given to the servo amplifier which then controls the speed and rotation direction of servo motor and executes precision positioning. Also conveys the data back from the motor to the corresponding module. Servo motor used id KF HP 40B

Figure 5: Servo motor

6) **SERVO AMPLIFIER:** A servo drive is a special

Electronic amplifier used to power electric servomechanisms. A servo drive monitors the feedback signal from the servomechanism and continually adjusts for

Deviation from expected behavior. Servo drive receives a command signal from a control system, amplifies the signal, and transmits electric current to a servo motor in order to produce motion proportional to the command signal. Typically the command signal represents a desired velocity, but can also represent a desired torque or position. The process of adjusting these parameters is called performance tuning. Servo amplifier used is MR J3 40B.

Figure 6: Servo amplifier

7) VFD CONTROL: The circuit shown in fig.7 is control the direction of rotation and speed of 3-phase induction motor by using VFD.230 V, 50Hz, 1 Phase supply is given across NO contact of relay(terminal A and C of VFD) Terminal SD is Common to the contact input terminal and terminal FM. Common output terminal for 24VDC 0.1A power output. SD terminal is connected to the selector switch 1. Terminal R, S, T is used as input and U, V, W is used as output which is connected to motor. In this there are two control methods (1) control by Auto (2) Control by Manually. In manually control, selector switch2 is connected across STF and STR terminal of VFD which is used for changing direction of rotation.1W, 2K ohm frequency setting potentiometer is connected across terminal 10, 2, 5 of VFD which is used to adjust input voltage and frequency setting of inverter. In automatic control we push the start forward push button on SCADA, relay R3 is energized and motor rotate in forward direction and pushing start reverse button on SCADA ,relay R4 is energized and motor

rotate in reverse direction. Speed of motor is control by Analog output of PLC. Servo drives are used in conjunction with servo motors for better variable speed control with less response time as the inertia of the rotor is less [3]. Fig 8 sows how servo drive is connected with PLC. For this connection servo amplifier is connected between servomotor and PLC.

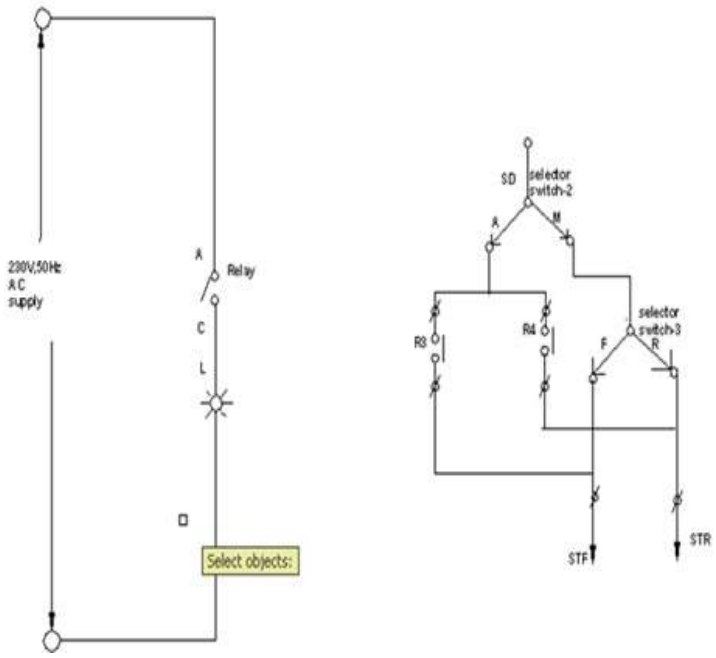

Fig.7: VFD control wirin

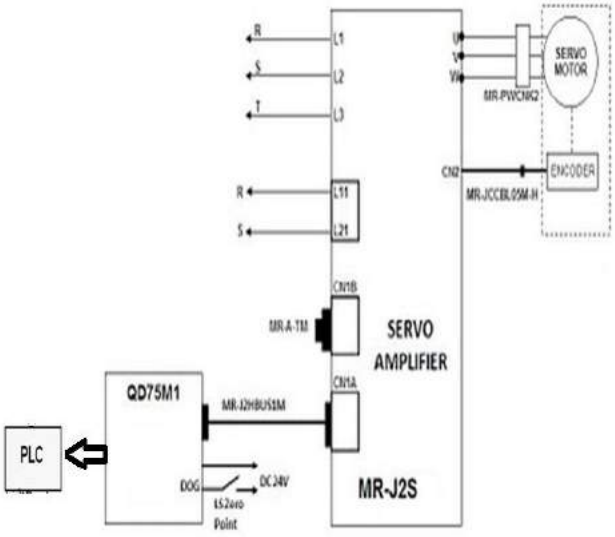

Fig.8: Servo drive connection

III. SOFTWARE IMPLEMENTATION

1) **PLC LADDER LANGUAGE:** Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. Ladder logic is used to develop software for programmable logic controllers (PLCs) used in industrial control applications. Ladder logic is widely used to program PLCs, where sequential control of a process or manufacturing operation is required. While ladder diagrams were once the only available notation for recording programmable controller programs, today other forms are standardized in IEC 61131-3. IEC 1131-3 is the international standard for programmable controller programming languages. Often the ladder logic program is used in conjunction with an HMI program operating on a computer workstation.

2) MITSUBISHI DEVELOPER:GX Developer is the standard programming software for all MELSEC PLC series and combines all functions of MELSEC with the user guidance of Microsoft windows. With this software we can comfortably create PLC programs alternatively in the form of ladder diagrams or instruction lists. Common software GX Developer can create the data of the Q series, Qn A series, a series (including the motion controller (SCPU)) and FX series, with their setting operations common, and is abbreviated to GPPA. Wide range of programming languages GX Developer is compatible with various programming languages and includes the relevant functions such as relay symbol language, logicsymbolic language, MELSAP3(SFC), MELSAP-L and function block.

IV.ALGORITHM:

Figure 9: Algorithm cycle

1. Checking initial condition:

-If lubrication and oil flow is good, cycle starts.

- Else cycle interrupt and emergency return.

- If any error is present servo will not get enable

2. Mode selection:

- Auto dressing selection with auto mode.

- Dressing cycle on.

- Length slide-in condition.

- Cross slide jump-in condition.

3. Start grinding cycle:

- Grind Start.

- When gap eliminator position achieved rough grind1 start.

-Gauge in (unit measurement)

-Rough grinding 2 starts.

-Increment retreat1.

-Marposs signal check (SQ28)

-Fine grinding starts

-Increment retreat2.

-Spark out grinding start.

-Marposs signal check (SQ30)

-Ring size finished.

-Slide out and ring change.

-Cycle repeats.

4. Start the dressing cycle:

-Select the mode of dressing cycle.

-Set dressing compensation

-Cross slide at dressing position.

-Dressing arm length slide-in.

-Next dressing step executed.

V. ADVANTAGES

1. Reduced space: PLC is a solid state device and hence extremely compact compared to hard wired controller.

2. Energy saving: Power required by PLC is less as

compared to the equivalent relay logic board.

3. Re-programmability: PLC can be re-programmed by using programming device.

4. Re-usability: PLC can be re-used for other applications.

5. Easy troubleshooting: Indicator lights are used provided at major diagnostic points to simplify trouble shooting.

6. Greater reliability and lifetime: PLC consists of static devices hence less number of parts reduces wear and tear and hence less down time of machine.

VI. APPLICATIONS

1. The purpose of the PLC is to control and implement the grinding of the face of inner ring which is further used as a part in bearings.

2. PLC can be used in batch processing system, where the same product is to be manufactured over and over again in the same cycle.

VII. CONCLUSION

PLC provides a robust modular platform for automating complex machines and processes. The MITSUBISHI PLC from the leading automation companies offer high performance, flexibility and advanced feature. Scanning time and maintenance time of the system is thus reduced by using PLC. Thus leading in mass production of bearings.The compactness required in the system is achieved by upgrading the grinding machine with the MITSUBISHI PLC. Thus the cycle time is reduced. The selection of the MITSUBISHI PLC helped us in up gradation of the old MTC system. Hence performance of the system is improved.

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