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Automation of Conveyor System and Process Control with Power Reduction Using Efficient PLC Programming and SCADA

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ABSTRACT: The project Automation of Conveyor System and Process Control along with Power Reduction using Efficient PLC Programming and SCADA deals with the production of automobiles with the aid of PROGRAMABLE LOGIC CONTROLLERwhich makes the production process less complex and mainly concentrates in the power reduction concept. Here the PLC is used for controlling purpose where each process is controlled individually and are linked with each other. The various process which are present at various remote location are controlled using a single PLC that is been linked with the human machine interface SCADA. The feeder rate of the conveyor process is been effectively maintained for the purpose of reduction in failure. Thus the entire car manufacturing process can be controlled and maintained with less power by the implementation of efficient programming of PLC using Siemens Simantic Manager and WinCC Flexible.

KEYWORDS: Siemens Simantic S& 317, Win CC Flexible, HMI (Human Machine Interface)– SCADA 3200, PLC Step 7 Drive, Feeder Rate Control.

I.INTRODUCTION TO PROGRAMMABLE LOGIC CONTROL

A programmable logic controller, PLC or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. [1]PLCs are designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in batterybacked-up or non-volatile memory. [2]A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.Before the PLC, control, sequencing, and safety interlock logic for manufacturing automobiles was mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers. Since these could number in the hundreds or even thousands, the process for updating such facilities for the yearly model change-over was very time consuming and expensive, as electricians needed to individually rewire the relays to change their operational characteristics.[4]Digital computers, being general-purpose programmable devices, were soon applied to control of industrial processes. Early computers required specialist programmers, and stringent operating environmental control for temperature, cleanliness, and power quality. Using a general-purpose computer for process control required protecting the computer from the plant floor conditions. [5]An industrial control computer would have several attributes: it would tolerate the shop-floor environment, it would support discrete (bit-form) input and output in an easily extensible manner, it would not require years of training to use, and it would permit its operation to be monitored. The response time of any computer system must be fast enough to be useful for control; the required speed varying according to the nature of the process. Since many industrial processes have timescales easily addressed by



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millisecond response times, modern (fast, small, reliable) electronics greatly facilitate building reliable controllers, especially because performance can be traded off for reliability.



II.PROGRAMMABLE LOGIC CONTROOLER STRUCTURE



SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) is a system operating with coded signals over communication channels so as to provide control of remote equipment (using typically one communication channel per remote station). [6]The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions. It is a type of industrial control system (ICS). Industrial control systems are computer-based systems that monitor and control industrial processes that exist in the physical world.



IV. INTRODUCTION TO HMI

A HUMAN-MACHINE INTERFACE (HMI) is the input output device through which the human operator controls the process, and which presents process data to a human operator. [7]HMI(Human Machine interface) is usually linked to the SCADA system's databases and software programs, to provide diagnostic data, and management information such as scheduled maintenance procedures, detailed schematics for a particular sensor or machine, and expert-system troubleshooting guides.[8]The HMI system usually presents the information to the operating personnelgraphically, in



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the form of a mimic diagram. This means that the operatorcan see a schematic representation of the plant being controlled.



V. SIMANTIC S7 317 PLC

The most sophisticated units of the PLC family. They have up to 8192 I/O's and memories up to 750 Kbytes. It can control individual production processes or entire plant.



VI. CONVEYOR SYSTEM – (FEEDER RATE MAINTAINED)

Scientific automation includes integration of additional functions in the software PLC. In addition to sequential control, motion control and control technology, the software PLC also includes measurement technology and other components. Here with the advanced technology, the conveyor systems are been used with PNEUMATIC Control for Automatic and Time Consumption Process. By reducing the Feeder Rate the failures in conveyor is reduced and also by proper logic design so that the sensors doesn't relocate. This whole system is operated by proximity sensor, motor and PLC in this project we use capacitive type of proximities sensor to sense the material at which position and it gives the signal towards the PLC .The PLC depends on the number of input output module and analog signal.



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VII.COMPLETE PRODUCTION CONTROL USING SINGLE PLC AND SCADA



PLANT & EQUIPMENT RELOCATION

The sensors used here detect the presence of the car on the conveyer. When the car is detected the sensor transmits an activation signal which starts the process. The conveyer moves and stops across each Shop where the required process is performed. After the process is completed the conveyer moves to the next stage until all the steps are completed.

STAGE 1- WELDING PROCESS

- The welding process is the initial stage where the parts of the car are welded properly
- For this process three different welding are performed on one single car

• The PLC is programmed to activate its completion signal only when all the three welding process are completed

• When the sensor gets three completed signal the conveyer will start running and moves to the next stage

PROGRAM STEPS

Sensor I0.0 detects the presence of the car ready for welding and indicates the presence of the car with the indicator Q0.0



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- Using the indicator Q0.0, the first welding portion is initiated which is indicated by the indicator Q0.2
- > Once the initial welding part is completed the second welding portion is started by using the previous indicator Q0.2 and this action is indicated by Q0.3
- \blacktriangleright The same logic is using Q0.3 the final welding portion is completed indicated by Q0.4
- After the completion of the final welding portion Q0.5 is set ON to indicate the completion of process

STAGE 2-PAINT PROCESS

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From the interface the operator selects the required colour for the car. When the push button is pressed, the valve "A" initially opens the 1st basic colour and the required proportion for the selected colour will be programmed in the plc.With the help of the timer the valve "A" operation will be momentarily shut off which will open valve "B".The same process will be initiated for valve B as done for valve A and using the timer, valve B will be shut off .When both the valves are closed the mixer will be made to run for a specific period of time which can be programmed using an Timer. After the mixing operation is completed the desired paint is been produced in the tank container. This condition leads to open valve C which contains a pressure controller which leads to spray the paint

PROCESS STEPS

- > I1.0 detects the presence of car and makes Q1.0 ON showing start of proces
- ▶ I1.3 or I1.4 or I1.5 is selected which makes Q1.2 or Q1.3 or Q1.4 ON respectively
- ▶ If Q1.2 is ON timers T1 and T2 are ON. T1 makes Q1.5 ON
- > T2 makes Q1.6 ON and timer T3 ON. After specific amount of time T3 makes Q1.6 go to OFF state and
- indicator Q2.0 ON
- > Q2.0 makes timer T10,T11 ON, which makes Q2.4 ON
- After a specified amount of time T11 Makes Q2.4 ON

STAGE 3-HEATING PROCESS



The Oven is the most important process in the car manufacturing industry as it is responsible to settle the paint on car. The processed car from the paint shop is bought inside the oven by the conveyers. The presence of the car is detected



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by the sensor in the oven which automatically starts the process. The heating source starts heating the paint on the car at a very high temperature which is programmed in the PLC. The temperature sensors sense the present temperature in the room and give the controlling signal to the heating source.Based on the received signals from the sensors the temperature in the room will be increased or decreased to the specified range.

PROGRAM STEPS

- \triangleright I2.0 detects the presence of the car and activates the indicator O2.0 which indicates start of process
- ⊳ Q2.0 starts the process by activating Q2.2
- I2.3 picks up the variations of heat in the oven and gives the current oven temperature to an comparator
- AAA The comparator initially compares the value with the specified temperature range
- If the temperature is above the desired range, then Q2.6 turns ON and Q2.4 turns OFF the heater
- \triangleright If the temperature is below the desired range ,then Q2.5 turns ON and Q2.3 turns OFF the heater
- If the temperature is in the desired range then Q2.2 gets turned ON

STAGE 4- WASHING PROCESS



This process is the last process of an manufacturing company. The product(Car) after completing the process is sent to the shower room where the car is washed at a very high pressure and flow rate. The water sprayer obtains its input(Water) from the water tank. The water tank will contain level sensors which detects the level in the tank. Based on the signal obtained from the level sensor the motor runs the pump on varying speed levels for keeping the tank always full.

PROGRAM PROCESS

- \triangleright I3.0 detects the presence of the car and activates the indicator Q3.0 which indicates start of process
- The indicator Q3.0 is used to activate the motor Q3.2
- AAA If the water level in the tank is at an minimal range then Q3.6 makes the motor run at a high speed
- If the water level in the tank is half through then Q3.7 makes the motor run at a medium speed
- ≻ If the water level in the tank is near full then Q4.0 makes the motor run at an minimal speed
- when the tank level is full I1.3 makes the motor to go to OFF stage



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VIII.SELF - WRITTEN AND IMPLEMENTED PLC PROGRAMMING FOR COMPLETE PROCESS WITH LESS POWER REQUIREMENT

Power flows through these contacts when they are closed. The normally open (NO) is true when the input oroutput status bit controlling the contact is 1. The normally closed (NC) is true when the input or output status bit controlling the contact is 0. Coils represent relays that are energized when power flows to them. Boxes represent various instructions or functions that are Executed when power flows to the box. [9]Some of these Functions are timers, counters and math operations.

AND GATE:Each rung or network on a ladder program represents a logic operation. In the rung above, both inputs A and B must be true (1) in order for the output C to be true (1). OR GATE:In the rung above, it can be seen that eitherinput A or B is be true (1), or both are true, then the output C is true (1).

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The figures here been shown above and the following images (a) to (g) show the implementation of the PLC programming and been designed with the Supervisory Control of Data and Acquisition. The Simulation results (h) to (l) show the working nature of the program for the successful run and along with the result of the process in the system view.







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IX. RESULTS OF BOTH PLC AND SCADA IMPLEMENTATION





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X.CONCLUSION

Thus by developing an efficient programmable logic control program with the consideration of existing flaws and by using the jump mechanism in program we will be able to obtain an error free car production process and for the continuous process without any delay in between each section of process and with the use of SCADA the process becomes user friendly. And also we can attain much LESS POWER REQUIREMENT for the entire production process.

REFERENCES

[1] ABB Robotic Control guide Siemens Simantic programming Booklet version S7

[2] Basics of Programmable logic control book by Allen Bradly

[3] Fanuc's Manual on PLC and Robot Control

- [4] Fundamentals of SCADA and its processing –Bentely
- [5] Idc-online.com/technical_references/pdfs/instrumentation/IntrotoPLCs.pdf
- [6]Introduction to Programmable Logic Controllers (PLC's)Industrial Control SystemsFall 2006

[7] Literature.rockwellautomation.com/idc/groups/literature/documents/um/ag-um008_-en-p.pdf

[8]Nfiautomation.org/Technical%20Documents/PLC/Basics_of_PLC_Programming.pdf

[9] Scadahacker.com/library/Documents/ICS_Basics/SCADA%20Basics%20-%20NCS%20TIB%2004-1.pdf