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PLC Based Industrial Conveyor Automation and Monitoring

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Abstract: ***The paper presents the automatic segregation and directing of the materials using PLC. The materials on the conveyor belt are destined to different stages of manufacturing. The idea is to automate the process of conveyor based on the material parameters using proximity sensors, colour sensors-RYB and limiting sensors. The rotating mechanism which is driven by the motor is placed at the junction of the conveyor so as to direct it to the corresponding destination. The main purpose is to replace the manual system being used in the industry and decrease the time delay. In addition to this, the status of the belt and count of the products are also determined. The project uses a ladder diagram representation for its simulation in ABB AC31 V212 PLC software and is implemented.***
Keywords: PLC-Programmable Logic Gates, RYB-Red Yellow Blue colour sensor.

I. INTRODUCTION

In today's fast moving, highly competitive industrial world, a company must be flexible, cost effective and efficient to survive . Industrial automation has acquired importance owing to the ever-increasing demand for more productivity, better quality standard, better accuracy and optimum utilization of available resources and manpower. In India, Steel Plant is one of the Navarathna company which has largest units of manufacturing with its various stages. The main aspect of the project is to automate the process of transportation of the materials to the respective destinations using Sensors and PLC.

II. EXISTING SYSTEM

In the recent times, the cranes are operated manually in the industry for the segregation and transportation of products in multiple conveyors. The process results in increased time delay for the products to reach the destination and also needs manpower to control the cranes. The operation of cranes and monitoring the status of the conveyor belt are also tedious for the workers. The efficiency may also not be stable since it depends on the efficiency of the workers.

III. LITERARY SURVEY

Several articles for our project were studied. Since the products are segregated through the conveyors, the status of the conveyor is an important factor in our project. So this is identified in the research paper " Belt Conveyor Monitoring and Fault Detecting Using PLC and SCADA", which describes that the Faults are identified using Sensors so that the safe and reliable conveyor operation be ensured. For the selection of the appropriate sensors, various studies were made and in the journal "Automatic Speed Control System by the Colour Sensor for Automobiles -An Innovative Model Based Approach" where the colour sensor register items by contrast, true colour, or translucent index. Since our project is fully automated using PLC and automated cranes are also have significant role, many studies were done and one of the research paper "PLC Based Industrial Crane Automation & Monitoring" helped us. From this research, it was found how PLC can be effectively designed for a wide variety of control tasks with the simple ladder logic to control the crane.

IV. PROPOSAL SYSTEM

This proposed system gives the efficient way of automatically directing the products in the conveyor using plc for high reliability and fast operation without delay. It consists of hardware and software modules.

V. PROGRAMMABLE LOGIC CONTROLLER

The term 'programmable logic controller' is defined as a digitally operating electronic system which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing,

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timing, counting and arithmetic to control through digital or analogue inputs and outputs, various machines or process. A PLC retains its operating system, user programs, and some data in retentive (non-volatile) memory.PLC has not only replaces the relay but has also extended the logic capabilities of the system. ABB's automation devices deliver solutions with high performance and flexibility to be effectively deployed within diverse industries and applications.

A. Programming In Plc

Every PLC has associated programming software that allows the user to enter a program into the PLC. Before a PLC can perform any control task, it must be programmed to do so. The Software used for the PLC is ABB AC31 V212 Programming Language. The controller offers two programming languages such as:

1) Ladder Language (LD)
2) Function Block Diagram (FBD)
3) Sequential Flow Chart (SFC)
4) Structured Text (Higher level languages such as C)

The common program language of PLC is ladder diagram is used here.

B. Ladder Language

The Ladder logic is widely used in programming PLC where sequential control of a process or manufacturing operation is required. It is a graphic Language and can be used to transcribe relay diagrams, and is suited to combinational processing. It provides basic graphic symbols, contacts, coils, and blocks. Specific calculations can be executed within the operation blocks. Any control task modifications are done by changing the program.

VI. SYSTEM ARCHITECTURE

The system consists of many functional units such as ultrasonic sensor, Colour sensor, Conveyor belts, Crane and is as shown in figure1. Here PLC plays vital role i.e. it is heart of this proposed system. The PLC is burnt with program that is necessary to control the sensors and relays, and conveyors interfaced to it. The interfaced units are controlled by the PLC in an efficient and faster manner, thus providing the system to be reliable than the existing ones.

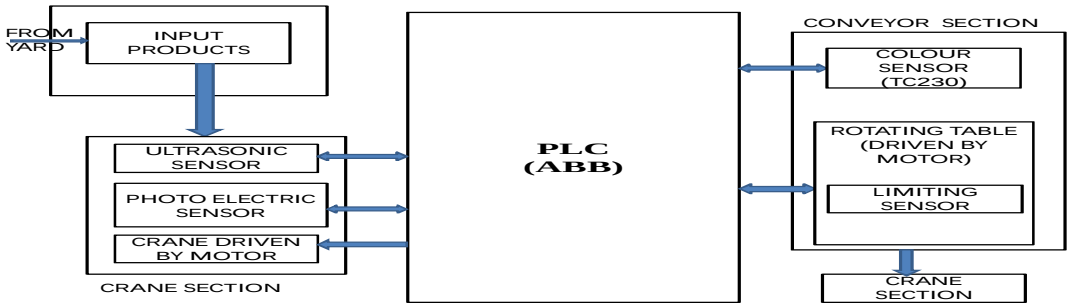

Figure1:Block Diagram

VII. DESCRIPTION OF PROPOSED SYSTEM

A. Programmable Logic Circuit

A digital electronic device that uses a programmable memory to store instruction and to implement the function such as logic, sequencing, timing, counting and arithmetic in order to control machine and processes. The term logic is use primarily concerned with implementing logic and switching operations .Input devices sensors, and output devices motors, being controlled are connected to the PLC and then the controller monitors the inputs and outputs according to the program stored in the PLC by the operator and so controls the machine and its process.

1) *PLC Operation:* A PLC works by sensor inputs and controls the motor relays and cranes based on the inputs. Generally the operation of PLC consists of 3 important steps. They are
   a) Analysing the Input Status
   b) Execution of the Program

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c) Updating the output Status

B. Main Conveyor And Segregating Conveyors

The raw materials from the yard is placed on the main conveyor belt for transporting those materials to various stages. Then the material undergoes scanning or sensing process by sensors placed at appropriate places. After sensing the products the PLC automates the segregating conveyors to direct the products into the respective stages.

C. Sensors

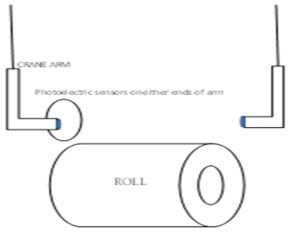
In this automation sensors play a major role in segregating the products based on the respective parameters to various stages. The sensors used are height sensor which helps to find the midpoint of the rolls which is moving on the conveyor .This sensor finds the midpoint by using the high level and the low level signals send by the sensor to PLC. The midpoint identification is to latch the roll by the crane handles perfectly to pick up and drop that in another conveyor. Then the photoelectric sensors are used.

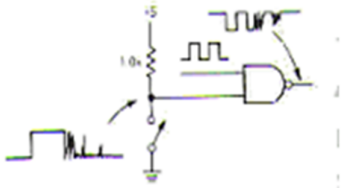
D. Rotating Mechanism

This proposed model consists of rotating mechanism which makes the conveyor belt very flexible to transport the products to various stages. The conveyors are connected to the rotating mechanism in various directions to transport the directed the products efficiently.

E. Cranes

The crane mechanism is used in both existing and the proposed model. The crane catches the objects based on the instruction from the PLC using Ultrasonic sensors and Photoelectric sensors. The Ultrasonic Sensor senses the height of the object and the centre of the object is calculated and the crane is instructed to move to that corresponding level. The photoelectric sensor which is placed on the arms of the crane establishes its beam and is indicated as low level in PLC. As it is interrupted by the object it moves to higher level. The debouncing circuit eliminates the ripples and the sensor detects the centre gap of the roll and has a falling edge to lower level. This change in digital level is monitored and the PLC instructs the crane to latch the object.





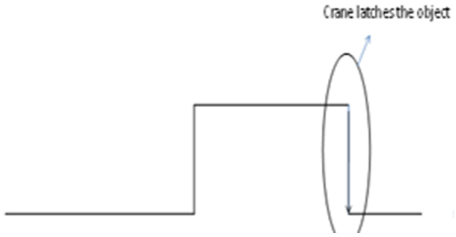


Figure2(a):Cranes approaching the roll
Figure2(b):Debouncing circuit
Figure2(c): Detection of falling edge

VIII. OBSERVATION AND RESULTS

The figure3 shows the output screen of simulation software of ABB. The operation of Motor relays and cranes are interfaced and the segregation of the products and transportation to various processing stages were done successfully.

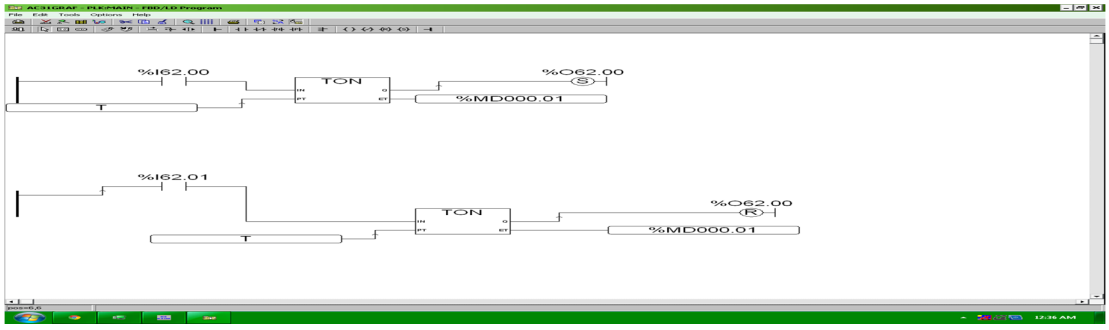


Figure3: Ladder Diagram of ABB

IX. CONCLUSION

PLC today are advancing in terms of applicability and capability. The System works during normal operation and greatly improved the automation processes with the use of the PLC ladder diagram. The wiring and installation procedure are also improved because the PLC input and output devices are assigned with specific addresses, and thus; further simplifies troubleshooting. Cost reduction mainly on the man-power or personnel cost is achieved in this paper. Hence, only one or two personnel are needed for the operation and maintenance with the automated system. After a thorough investigation, the researchers highly recommends extending the other automation processes such as adding input, adding output devices, and also the expansion of the ladder program. The utilization also of the other PLC brands and models may be suggested depending on the need and specifications of different processes. Belt conveyor in STEEL Plant will be controlled using Programmable Logic Controller, sensors and Rotating mechanism, etc. In the point of view of reducing human efforts, PLCs are important part to design with more reliable and less power consumption for conveyor control operations. This proposal gives better accuracy, reliable operation in Real-time. This proposal is to segregate the products on the conveyor effectively. Thus the control and monitoring process is done.

X. FUTURE ENHANCEMENT

The system can be improved so as to increase the number of coils per rotation to increase the speed of transportation of coils. Features like material composition and weight can also be sensed and guided to transport more efficiently.

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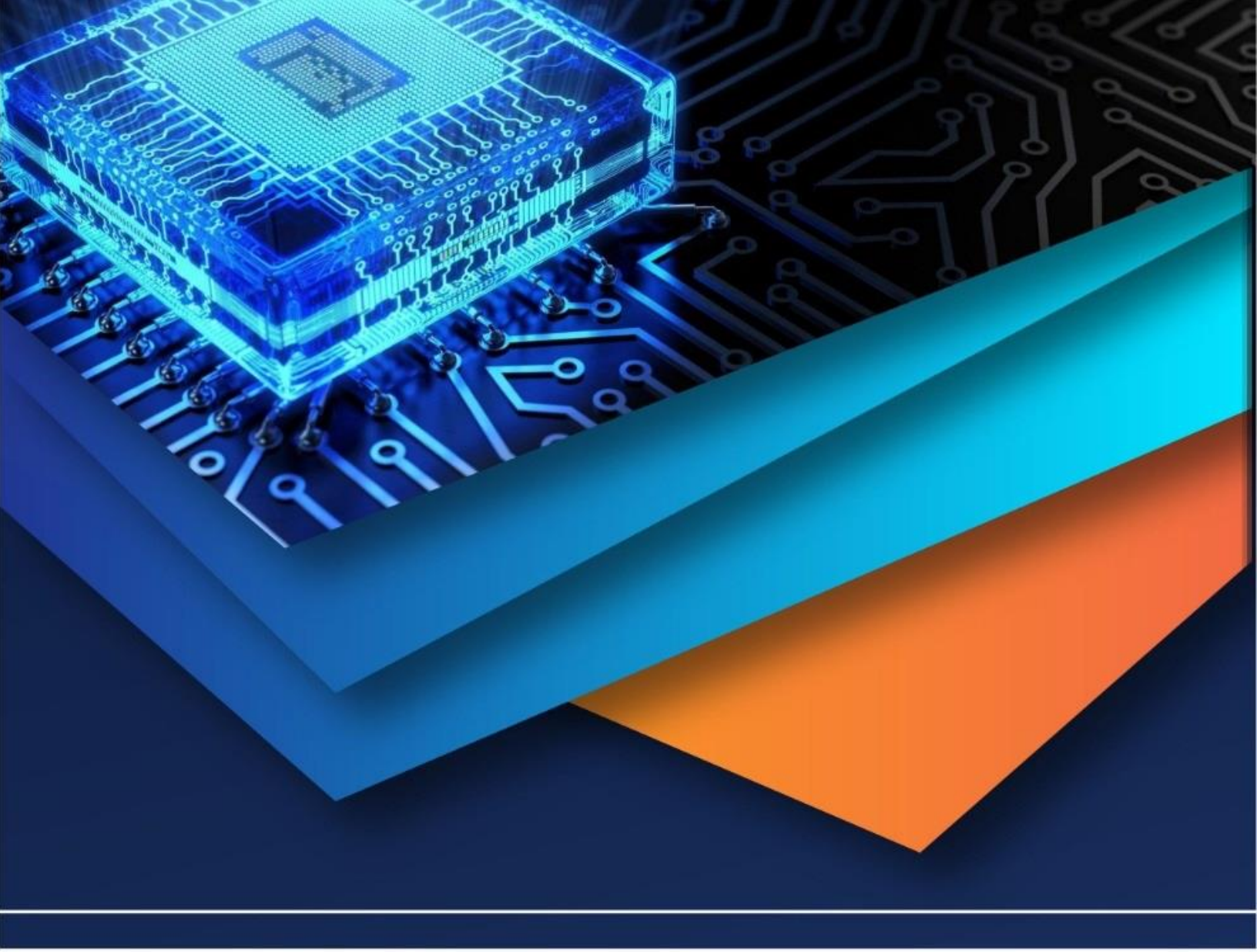

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