Introduction to PLC and Design (Using GLOFA and GM6 PLC)

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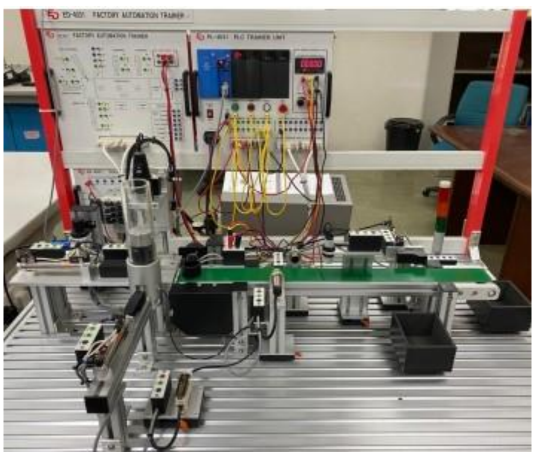
***Abstract*- This paper describes the design and results of an experiment relating to the automatic material classification system using the PLC approach. This project's production line includes transferring, movement, and processing of objects using PLC. Designing of a Ladder diagram is required to perform the required task (output) as specified. Furthermore, the experiment requires a straightforward design using the GMWIN software to monitor and control the system itself.**

***Keywords*—PLC, drill system, conveyor belt, drill, metal sensor, wiring diagram, state diagram, ladder diagram, GMWIN.**

I. Introduction



A programmable logic controller (PLC) is an industrial specialised computer that is responsible for monitoring and processing different functions for industrial purposes autonomously. PLC has proven to reduce the larger number of machines combined in a complete system to give input and produce output that can be monitored by its central processing unit. This situation improves the cost of manufacturing installations and increases efficiency in various commercial buildings as well as factories.

Generally, the PLC can be specified into these three basic components which consist of the Central Processing Unit (CPU), Memory inputs and outputs (I/O), and a Power supply. Next, PLC executes the process by receiving the data transferred in the system and processes electrical signals to control and monitor the sensors and actuators as it is programmed. The general process of PLC is initialising the inputs based on its address, solving logic circuits in the programming software by connecting the sensors with inputs and the expected output, resulting in the outputs turning on or off accordingly.

PLC is a system that acts as an advanced controller. Three of its basic controls are sensor, processor, and actuator. The combination of timer and logic circuits are used to control the full process of the material classification system. Basic I/O allocation set in the memory of GMWIN to identify inputs and outputs in the ladder diagram.

Lastly, Timer in this project is very crucial in order to make sure the system is timed correctly during movement of the objects via the motor in the conveyor belt, and the time taken for the drill motor to process synchronously with the conveyor belt.

II. TOOLS

In this experiment, we will use the following:

Components
1. Connector 2. Jumper wires 3. Pneumatic Air Tubes
Software
PLC programming software: GMWIN

III. METHODOLOGY

Using GMWIN software, a PLC editor, the factory automation system will complete a full production line of a factory in the sequence that has been specified. Every activity performed in each process should be evaluated and understood in order to replicate the operation of a full production line, as it is vital in determining the inputs and outputs of each process. This can be accomplished by creating a state diagram or flowchart that depicts the work sequence clearly. Every task completed in the production will have its own address. The address for an input will begin with %IX, and the address for an output will begin with percent
%QX. The inputs and outputs have been provided as shown in Table 1.

INPUT			OUTPUT		
%IX0.0.0	PB1	Start S/W	%QX0.1.0		
%IX0.0.1	LS1	Product supply cylinder backward	%QX0.1.1	Y1	Product supply cylinder forward
%IX0.0.2	LS2	Product supply cylinder forward	%QX0.1.2	Y2	Product supply cylinder backward
%IX0.0.3	LS3	Drill working supply cylinder backward	%QX0.1.3	Y3	Drill working supply cylinder forward
%IX0.0.4	LS4	Drill working supply cylinder forward	%QX0.1.4	Y4	Product transfer cylinder forward
%IX0.0.5	LS5	Product transfer cylinder backward	%QX0.1.5	Y5	Defective extraction cylinder forward
%IX0.0.6	LS6	Product transfer cylinder forward	%QX0.1.6	M2	Conveyor Belt foward
%IX0.0.7	LS7	Defective extraction cylinder backward	%QX0.1.7		
%IX0.0.8	LS8	Defective extraction cylinder forward	%QX0.1.8	Y6	Defective extraction cylinder 2 forward
%IX0.0.9	S1	Part Sensor	%QX0.1.9	M1	Drill Rotation motor
%IX0.0.10	S2	Defective Sensor	%QX0.1.10	L1	Warning Light 1(green)
%IX0.0.11	S3	Material Arrival Sensor	%QX0.1.11	L2	Warning Light 2(yellow)
%IX0.0.12	S4	Metal Sensor	%QX0.1.12	L3	Warning Light 3(red)
%IX0.0.13	LS9	Defective extraction cylinder 2 backward	%QX0.1.13		
%IX0.0.14	LS10	Defective extraction cylinder 2 forward	%QX0.1.14		
%IX0.0.15	PB2	Stop S/W	%QX0.1.15		

Table 1: Basic I/O allocation set to the hardware of the PLC

The sequence of the operation is as the flowchart in the methodology part. There should be two(2) cases in our experiment in inspecting the actual product:

- Case 1: Detects metal
- Case 2: Detects no metal (Defect)

IV. PROCEDURE

1. <u>Flow chart</u>

The first step to undertake after understanding the requirements of this experiment was to create a flowchart to represent the system's functionality. In short, flowchart is implemented for the following reasons:

1. It eases the understanding and traces the required task step by step.
2. It is a familiar and common design used to demonstrate the flow of a process.

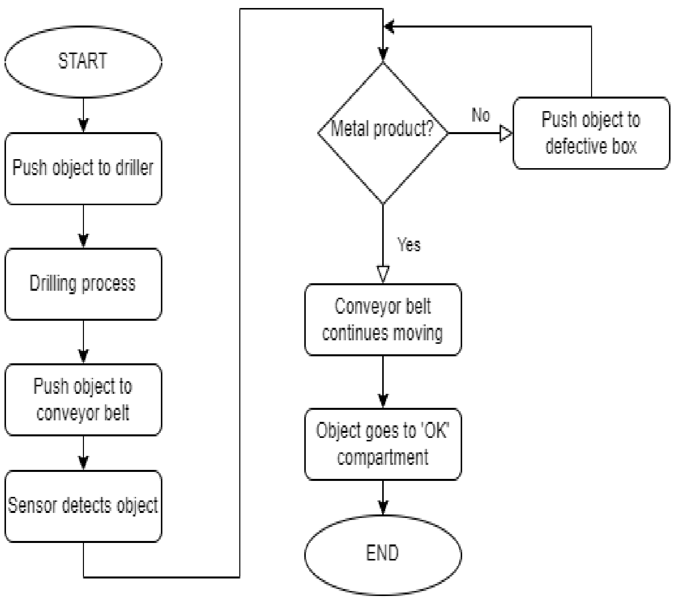
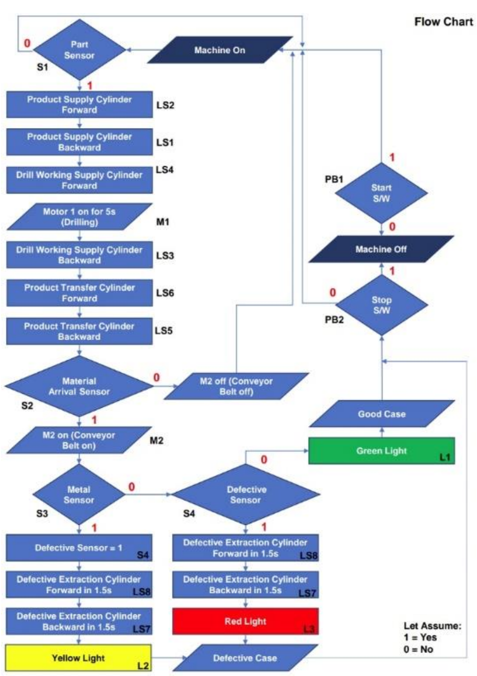


Figure 1: Flowchart of the system

2. <u>Program flow</u>



V. Data and Results

This flowchart depicts an automated manufacturing or inspection system that operates based on sensor inputs and control mechanisms to manage product flow and quality. The process begins with the start switch (PB1) activating the machine if the part sensor (S1) detects a part. Product supply cylinders move forward and backward, followed by the drill working cylinder and motor performing drilling operations. The material arrival sensor (S2) then ensures the material reaches the conveyor belt (M2). As the product moves, the metal sensor (S3) checks for metal presence, while the defective sensor (S4) identifies any defects. If a defective part is detected, extraction cylinders remove it, indicated by a yellow light (L2). Good parts, passing all checks, are indicated by a green light (L1), while defective parts are marked by a red light (L3). The stop switch (PB2) can halt the machine at any point, ensuring controlled and efficient operation..

VI. Discussion

The flowchart presents a sophisticated automated system for managing a manufacturing or inspection process. Each stage of the system is designed to ensure efficient handling and quality control of the products. The process begins with the detection of a part by the part sensor (S1), which triggers the machine's operations. The product supply cylinders move the part into position, followed by the drilling operation controlled by the drill working cylinder and motor. This stage highlights the importance of precise mechanical movements and timing, as indicated by the specific sequences for moving cylinders forward and backward.

As the part progresses, the material arrival sensor (S2) and the conveyor belt (M2) ensure smooth transition through the system. This step underscores the role of synchronization in maintaining a continuous flow of materials. The metal sensor (S3) checks for the presence of metal, an essential quality control measure to identify potentially harmful or defective parts.

The defective sensor (S4) adds another layer of quality assurance by identifying defective parts. The subsequent activation of the defective extraction cylinders and the illumination of the yellow light (L2) demonstrate the system's capability to segregate defective parts, ensuring only high-quality products proceed further. This feature is crucial in industries where product integrity is paramount.

The system's feedback mechanisms, such as the green light (L1) for good parts and the red light (L3) for defective parts, provide immediate visual cues for operators, enhancing monitoring and control. The integration of start (PB1) and stop (PB2) switches allows for manual intervention, adding flexibility and safety to the automated process.

Overall, the flowchart illustrates a well-structured and efficient system for product handling and quality control. It highlights the interplay between various sensors, mechanical components, and control switches to ensure that the manufacturing process is both efficient and reliable. The system's ability to detect and segregate defective products before they proceed further in the production line is a testament to its robustness and effectiveness in maintaining high standards of product quality. Detection regardless of being defective or non-defective. Apart from that, relays are mainly used in our PLC programming to ease the process of troubleshooting without any changes that might occur if not handled carefully.

VII. CONCLUSION

In conclusion, the flowchart represents an intricately designed automated manufacturing or inspection system that leverages a series of sensors, mechanical components, and control mechanisms to ensure efficient and high-quality product handling. Each stage, from initial part detection to final quality checks, is meticulously structured to maintain a seamless flow of operations while integrating critical quality control measures. The system's ability to detect and segregate defective parts, combined with its immediate feedback mechanisms and manual intervention options, highlights its robustness and reliability. This comprehensive approach ensures that only high-quality products proceed through the production line, underscoring the importance of precision and synchronization in automated manufacturing processes. Overall, this system exemplifies how automation can enhance efficiency, consistency, and quality in industrial operations.

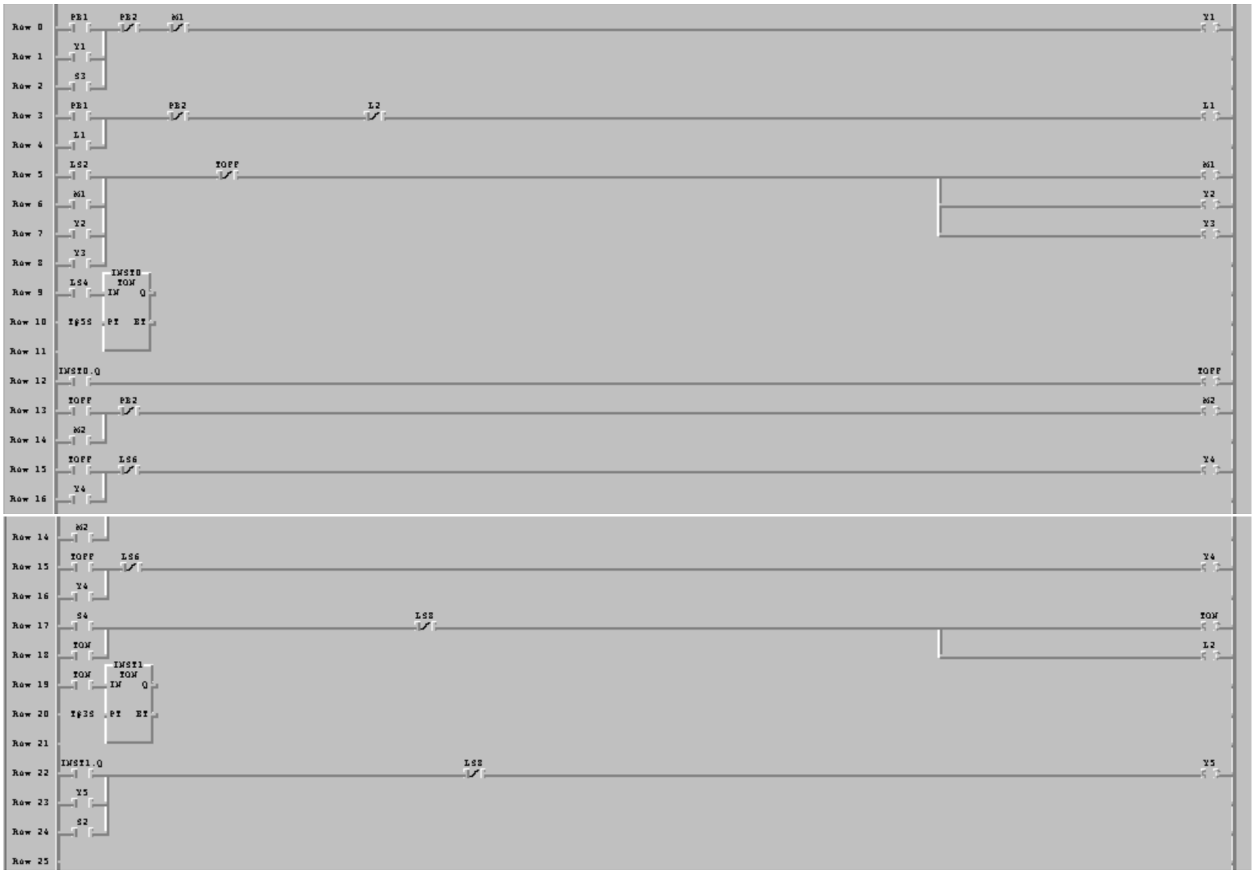
VIII. REFERENCES

[1] https://bit.ly/3yiPZnC

[2] Borden, T., & Cox, R. A. (2012). Technician's guide to programmable controllers. Cengage Learning.

[3] De Silva, C. W. (2007). Sensors and actuators: control system instrumentation. CRC Press.

IX. APPENDICES


Row 0 PB1 PB2 M1 Y1
Row 1 Y1
Row 2 S3
Row 3 PB1 PB2 L2 L1
Row 4 L1
Row 5 LS2 TOFF M1
Row 6 M1 Y2
Row 7 Y2 Y3
Row 8 Y3
Row 9 LS4 INST0 TON IN Q
Row 10 T#5S PT ET
Row 11
Row 12 INST0.Q TOFF
Row 13 TOFF PB2 M2
Row 14 M2
Row 15 TOFF LS6 Y4
Row 16 Y4
Row 14 M2
Row 15 TOFF LS6 Y4
Row 16 Y4
Row 17 S4 TON
Row 18 TON L2
Row 19 TON INST1 TON IN Q
Row 20 T#3S PT ET
Row 21
Row 22 INST1.Q Y5
Row 23 Y5
Row 24 S2
Row 25