

Trainer Module Design of Item Sorting Equipment Based on Height and PLC Based Traffic Light Prototype in the System Laboratory

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ABSTRACT

Technological developments in the industrial world have been very developed and modern. Especially for industries that use automatic or control systems in their production processes, one of them is by using a Programmable Logic Controller (PLC). The world of education today still has quite a gap or gap between the realization of the industrial world and the practice of learning carried out during lectures in the field of control or automatic systems. To minimize this gap, it is necessary to develop learning methods, especially practical learning in system laboratories so that when students have completed their education they can easily adapt to the world of industrial work that is currently developing. The system in the PLC-based Trainer Module can be used as a practical learning medium in the PLC Laboratory to increase knowledge and hone student skills in the field of control and automatic systems. In this system there are 2 variations of the application of the system using a PLC, namely Conveyors as a tool for sorting goods based on height and a prototype of Traffic Light. This research is a continuation of the previous assignment research on PLC-based Trainer Modules.

Keywords: *Module Trainer, PLC, Conveyor and Traffic Light*

1. INTRODUCTION

Engineering has become an advanced field of technology [1-3] Technological world and education are related in the terms of media developments and the tools of teaching and learning activities. Technological sophistication can make it easier for teachers to deliver material and help students to be able to master and understand the learning material presented. In addition, the industrial world still uses automatic systems that are useful for simplifying and accelerating the production process. Therefore, the demand for industrial automation systems has increased due to benefits such as ensuring the quality of the products produced, shortening production times and reducing costs for human labor.

One of the technologies commonly found in the industry today is PLC (Programmable Logic Control). PLC (Programmable Logic Controller) is a device designed to replace a series of relays found in conventional process control systems, where the PLC itself uses the memory inside which can be programmed to store instructions and to implement functions such as logic, sequencing, timers (timing), counting (counting) and arithmetic for controlling the machines and its processes [4-6]

The combination of automatic systems in industry can be applied to the world of education to improve the level and quality of learning which has not been maximized so far. Therefore, the students of the Electrical Engineering Department at the Sriwijaya State Polytechnic are required to be able to understand the PLC control system and its application in daily life and in industrial world, so that the students can get knowledge and also an overview of the control system in industry. However, in the Electrical Engineering laboratory of the Sriwijaya State Polytechnic Electronics Study Program, both lecturers and students feel the lack of equipment, materials and application variations in the practical learning process.

From the explanation of the problems that occurred in the Electrical Engineering Laboratory of the Sriwijaya State Polytechnic Electronics Study Program regarding the lack of media equipment, practical materials, and variations of PLC implementation, the authors made a study to try to solve these problems with the title "Trainer Module Design for Item Sorting Tool. based on Altitude and Prototype Traffic Light based on PLC in System Laboratory "

2. BASIC THEORY

2.1. PushButton

A switch is an electronic component that functions to connect and disconnect two or more points in an electronic circuit. One of the switches is a push button, which is a switch that will only connect two or more points when the button is pressed and when the button does not press it will decide two or more points in an electronic circuit. Wiring and the form of a Push button is shown in Figure 1 and 2.

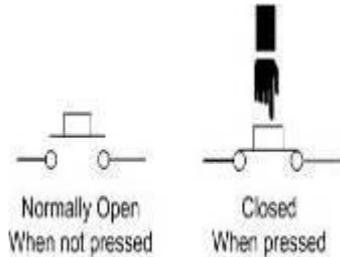


Figure 1 Wiring Push Button



Figure 2 Push Button

2.2. PLC (Programmable Logic Controller)

PLC (Programmable Logic Control) is a device used to change the function of a sequential relay circuit to control a control system contained in the panel. The advantages contained in PLCs are quite complex with certain sequences, which already use a number of relays, timers, counters and other special controls.

PLC works by observing or detecting the input status and then used to control the output. In order for the PLC to work as desired, it is necessary to enter a control program that can be programmed using a computer to give commands to the PLC in order to run a control system.

The main components (hardware) of PLC shown in Figure 3 below [12][13].

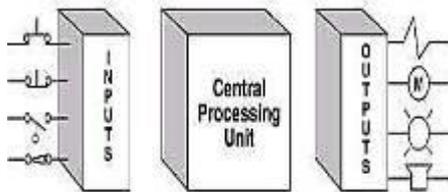


Figure 3 Block Diagram of PLC

2.3. Conveyor

Conveyor is a type of transportation tool that functions to transport material horizontally or vertically and is driven by a motor or gravity. The function of the belt conveyor is a transport aircraft used to move cargo in the form of units or bulk in a horizontal direction from one operating system to another operating system in a production process line that uses a belt as a carrier of the load.

Conveyors are basically quiet simple equipment. The tool consists of a belt that is resistant to the transport of solid objects. The belt used on this conveyor belt can be made from various types of materials, for example from rubber, plastic, leather or metal depending on the type and nature of the material to be transported. To transport hot materials, belts are used made of metal which is resistant to heat.



Figure 4 Belt Conveyor

2.4. Relay

Relay is one of the electronic components that functions to disconnect or connect one electronic circuit to another electronic circuit. Basically a relay is a switch that works based on the electromagnet principle which will work when current flows through the coil, the iron core will become a magnet and will attract the contact which is in relay [13].

Relay consists of coil and contact. It can be seen in Figure 5, a coil is a coil of wire that gets an electric current, while a contact is a type of switch whose movement depends on the presence or absence of an electric current in the coil. In simple terms, the working principle of the relay is that when the coil is energized, an electromagnetic force will arise which will attract the springing armature, and the contact will close.

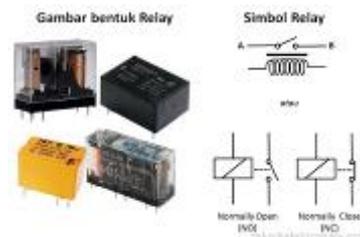


Figure 5 Shape and Symbol of Relay

2.5. Light Emitting Diode

Light Emitting Diode (LED) is a component that can emit light. The structure of an LED is the same as a diode. To get the light emitted in semiconductors, the doping used is gallium, arsenic, and phosphorus. Different types of doping will produce different colors of light. LED has various shapes, some are round, square and oval. The LED symbol is shown in Figure 6.

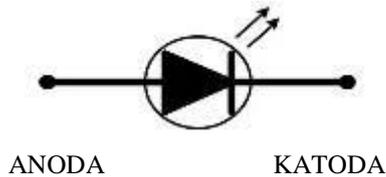


Figure 6 LED Symbol

LED is a type of diode, so it will only flow electric current in one direction only. The LED will emit light when given a voltage with a forward bias configuration. Unlike diodes in general, the ability to flow current to the LED is quite low, namely a maximum of 20 mA. If the LED is energized with a current greater than 20 mA, the LED will be damaged, so that the LED circuit is installed with a resistor as a current limiter.

3. METHOD

This study discusses the trainer module as teaching material in the Systems Laboratory of the Department of Electrical Engineering, Sriwijaya State Polytechnic. In this trainer module, there are two types of conveyor which based on height with a sorted height of 3-4 cm and traffic light 4 intersections with automatic bars.

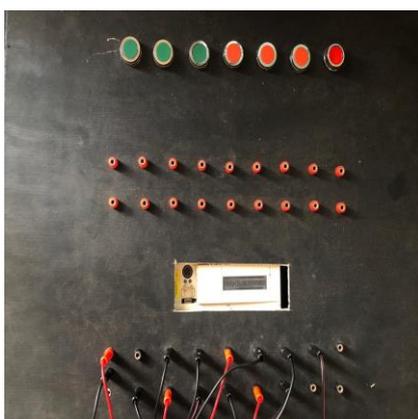


Figure 7 PLC Module and Junction Box

The stages of this research include the design stages for making a tool. The design of the tool aims to get the best possible end result as expected. The implementation of this program is divided into 4 stages, the general preparation stage, making tools, testing tools, and evaluating the entire system.

The PLC used in this study is packaged into a module accompanied by a junction box as a liaison between the PLC input and output with the input and output as shown in Figure 7 and Figure 8.

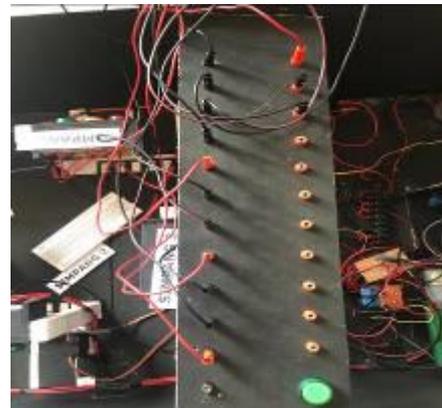


Figure 8 Junction Box 2

3.1 Block Diagram of Item Sorting Conveyor

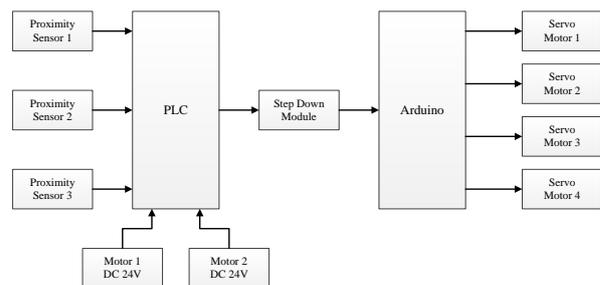


Figure 9 Block Diagram of Object Sorter Conveyor

The explanation of block diagram above is:

1. Proximity Sensor
The sensors in the design of this tool are located in 3 parts on each conveyor. Sensor 1 serves to detect the presence of object. Then sensors 2 and 3 function to detect the thickness of the object. Then for sensor 4 detects the object when it is in the final position.
2. PLC
PLC used as a controller and as a program storage medium, where all programs used to activate all devices that are stored in it.
3. Arduino Mega 2560
Arduino used as a controller and as a program storage medium, where all programs used to activate all devices that are stored in it.
4. Servo Motor
There are 4 servo motors that used in this design, and each of it used as the driving force of arm robot
5. DC Motor 24V

In DC motor used, there are 2 parts that functions as an actuator or driving force from conveyor 1 and conveyor 2

3.2 Flowchart of Object Sorter Conveyor

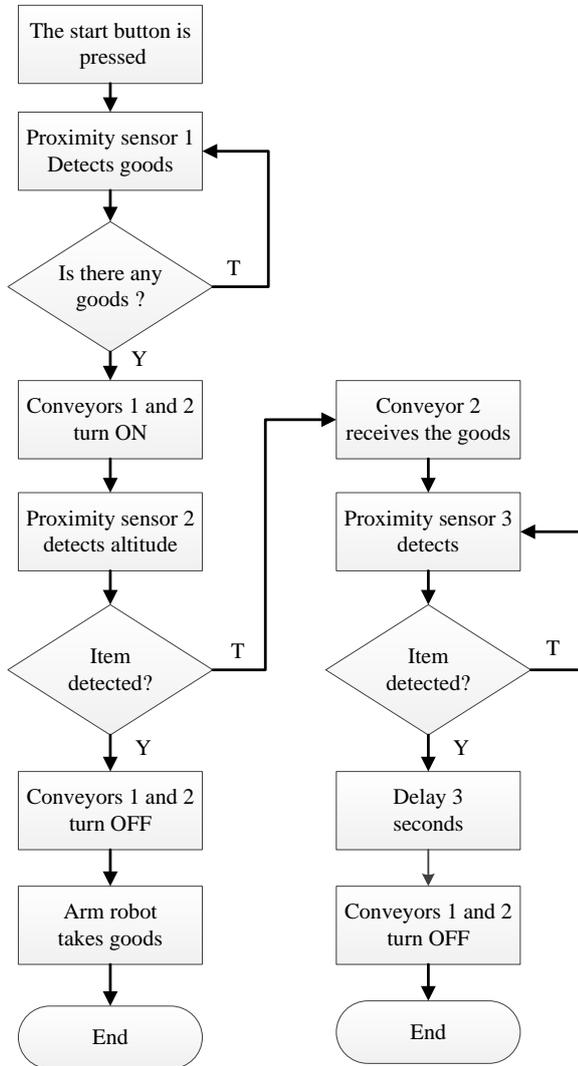


Figure 10 Flowchart of Object Sorter Conveyor

The flowchart of the sorting conveyor design can be seen in Figure 3.4. Where this sorting conveyor starts working when the on start button is pressed, the system will turn on. The conveyor will run when the proximity sensor 1 detects an object. Proximity sensor 1 will detect object above 3 cm in size, apart from that, the proximity sensor 1 will not detect object and the conveyor will not run. When the proximity sensor 1 detects an object, the item will run on conveyor 1 to the proximity sensor 2.

The proximity sensor 2 detects the height of the object, when the height of the object exceeds 4 cm, conveyors 1 and 2 will be off, then the arm robot will take the object and remove it from conveyor 1. Then when the

proximity sensor 2 does not detect the object, it means the object is sized 3-4 cm. then the object will be transferred to conveyor 2, after that conveyor 2 will put the object into the storage box. For the proximity sensor 3 functions to detect object that have entered the storage box and other functions, to counter so that when the object have been entered, there are four, the system will not work again before the reset button is pressed.

Hardware implementation aims to determine whether the hardware used on the device is working properly or not. Some of the hardware that has been designed in the sorting conveyor can be seen in Table 1 below:

Table 1 Hardware Implementation of Object Sorting Conveyor

No	Picture	Explanation
1		The initial position when the object is detected by the proximity sensor 1
2		Position when the object is detected by the proximity sensor 2
3		Position when the robot arm picks up the object
4		Position when the object is detected by the proximity sensor 3

3.3 Block Diagram of Traffic Light

Block diagram of Traffic Light 4 Barriers based on PLC Schneider TWDLCDE40DRF can be seen in Figure 3.5.

The following is the function of each block in the block diagram in Figure 11

1. Power Supply

Power supply supplies electrical power to operate the tool.

2. Push Button

Push Push Button used as a contact breaker or power supply connector to the appliance, it can also function as an input.

3. PLC

PLC functions as a controller and as a storage medium for programs. Almost all programs used to activate all devices are stored on it.

4. Intersection LED

The intersection LED functions as an output as well as an input to activate data input on the Arduino.

5. Stepdown

Stepdown functions as a voltage reduction from the 24V PLC output to 5 V as input for the Arduino..

6. Arduino

Arduino functions as a data processing place to activate the Servo Motor for each deviation as an output..

7. Servo Motor

Servo motor functions as an output that will open and close roadblocks when the tool is operated.

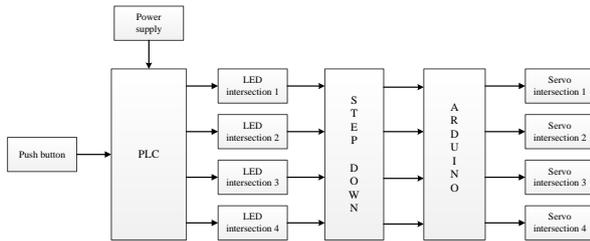


Figure 11 Block Diagram

3.4 Flow Chart Traffic Light 4

In Figure 12, it is a program workflow on the PLC. With the Flow Chart, it can help to make it easier to understand the direction of the program. The flow chart of the Traffic Light 4 intersection with barrier can be seen in Figure 12.

4. RESULTS AND DISCUSSION

4.1. Object Sorting Conveyor

In this study, there are 2 sizes of object being tested, Which are the height of the object 3.5 cm and 4.5 cm. Tests were carried out on 3 types of object with different materials, which are metal, wood and paper. For sensor 1 is placed at the beginning of Conveyor 1 as a detection of the presence of object, sensor 2 is placed at the end of Conveyor 1 as a size sorter, and sensor 3 is placed in the container box at the end of Conveyor 2 as a detector that the object have entered the container box.

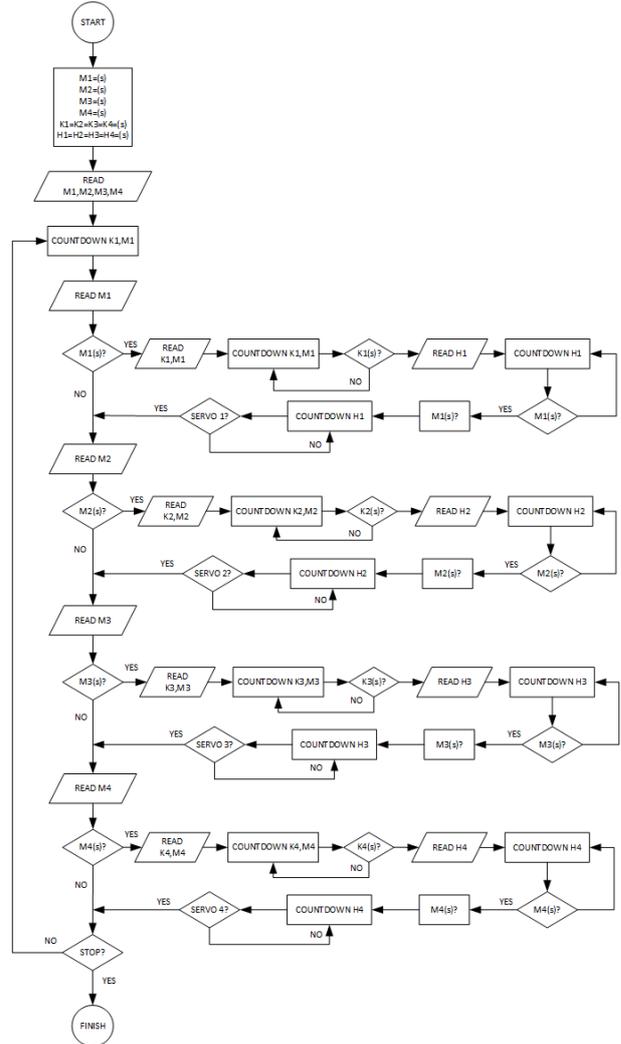


Figure 12 Flowchart of Traffic Light System 4 Barred Intersection Using PLC

4.1.1. Results of Experiment the Object Sorting Conveyor

a. Metal

In the experiment with metal object, the experiment has been done 10 times with 5 times for those measuring 3.5 cm and 5 times for those measuring 5.5 cm. The test results are shown in Table 2.

From the experiment results that have been obtained in Table 2, it is stated that the proximity sensor 2 is able to detect well in sorting objects with metal materials. When metal object measuring 3.5 cm pass in the sort, they enter the collection box. Then for the size of 5.5 cm, the object are sorted by the proximity sensor 2 then the objects are taken by the robot arm and the objects are removed from the conveyor 1.

Table 2 Experiments with Metal Materials

Experiment	Size (cm)	Sorted	
		Yes	No
1	3,5	-	√
2	5,5	√	-
3	3,5	-	√
4	5,5	√	-
5	3,5	-	√
6	5,5	√	-
7	3,5	-	√
8	5,5	√	-
9	3,5	-	√
10	5,5	√	-

b. Wood

In the experiment with object made of wood, the test is carried out 10 times with 5 times for those measuring 3.5 cm and 5 times for those measuring 5.5 cm. The test results are shown in Table 3.

Table 3 Experiments with Wood Materials

Experiment	Size (cm)	Sorted	
		Yes	No
1	3,5	-	√
2	5,5	√	-
3	3,5	-	√
4	5,5	√	-
5	3,5	-	√
6	5,5	√	-
7	3,5	-	√
8	5,5	√	-
9	3,5	-	√
10	5,5	√	-

From the experiment results that have been obtained in Table 3, stated that the proximity sensor 2 is able to detect well in sorting object with wood. When wooden object measuring 3.5 cm pass in the sort, they enter the storage box. Then for the size of 4.5 cm, the objects are sorted by the proximity sensor 2 then the objects are taken by the robot arm and the objects are removed from the conveyor 1.

c. Paper

In the experiment with objects made of paper, the experiment is done 10 times with 5 times for those measuring 3.5 cm and 5 times for those measuring 5.5 cm. The test results are shown in Table 4.

From the experiments results that have been obtained in Table 4, it is stated that the proximity sensor 2 is able to detect well in sorting objects with paper material. When the 3.5 cm paper objects pass in the sort, they enter the storage box. Then for the size of 5.5 cm, the objects are sorted by the proximity sensor 2 then the objects are taken by the robot arm and the objects are removed from the conveyor 1.

Table 4 Experiments with Paper Materials

Experiment	Size (cm)	Sorted	
		Yes	No
1	3,5	-	√
2	5,5	√	-
3	3,5	-	√
4	5,5	√	-
5	3,5	-	√
6	5,5	√	-
7	3,5	-	√
8	5,5	√	-
9	3,5	-	√
10	5,5	√	-

4.1.2. Comparison of Output Voltage from Proximity Sensor to Datasheet

This comparison data refers to the table of the output voltage measurement from the proximity sensor. The data in the table is compared with the data on the datasheet from the proximity sensor. From this comparison, the error value is obtained through the following equation:

$$\%Error = \frac{TKD - TKP}{TKD} \times 100 \dots \dots \dots (4.1)$$

Ket:
TKD = Tegangan keluaran *Datasheet* (V)
TKP = Tegangan Keluaran Pengukuran (V)

4.1.2.1. Measurement Results Using a Multimeter

a. Metal

In the measurement test using a multimeter with objects made of metal, tests are carried out 5 times on the output voltage generated by the proximity sensor 2 when there is no object detected and when the objects are detected. The test results are shown in Table 4.4.

From the measurement results using a multimeter found in Table 5, when measuring metal materials, it is known that the value of the output voltage from the proximity sensor 2 when the object is not detected is 4.9 VDC on average, while the value of the output voltage from the datasheet when the object is not detected is 5 VDC with an error value of 2%. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of this output voltage is the same as the value of the output voltage from the datasheet when the object is not detected, which is 0 VDC

Table 5 Measurement Results Using a Multimeter with Metal Materials

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

b. Wood

In the measurement test using a multimeter with objects made of wood, tests are carried out 5 times on the output voltage generated by the proximity sensor 2 when nothing is detected and when the objects are detected. The test results are shown in Table 6.

Table 6 Measurement Results Using a Multimeter with Wood

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

From the measurement results using a multimeter shown in Table 6, when measuring the wood material, it is known that the value of the output voltage from the proximity sensor 2 when the objects are not detected is 4.9 VDC on average, while the value of the output voltage from the datasheet when the objects are not detected is 5 VDC with an error value of 2%. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of this output voltage is the same as the value of the output voltage from the datasheet when the object is not detected, which is 0 VDC.

c. Paper

In the measurement test using a multimeter with items made of paper, tests are carried out 5 times on the output voltage generated by the proximity sensor 2 when nothing is detected and when the objects are detected. The test results are shown in Table 7.

From the measurement results using a multimeter found in Table 7 when measuring the paper material, it is known that the value of the output voltage from the proximity sensor 2 when the object is not detected is 4.9 VDC on average, while the value of the output voltage from the datasheet when the item is not detected is 5 VDC with an error value of 2%. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of

this output voltage is the same as the value of the output voltage from the datasheet when the object is not detected, which is 0 VDC.

Table 7 Measurement Results Using a Multimeter with Paper material

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

4.1.2.2 Measurement Results Using an Oscilloscope

a. Metal

In the measurement test using an oscilloscope with metal objects, the test is carried out 5 times on the output voltage generated by the proximity sensor 2 when nothing is detected and when the object is detected. The test results are shown in Table 4.7.

From the measurement results using an oscilloscope which is shown in Table 8 when measuring metal materials, it is known that the value of the output voltage from the proximity sensor 2 when the objects are not detected on average is 5 VDC, this output voltage value is the same as the output value from the datasheet when the objects are not detected, which is 5 VDC. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of the output voltage is also the same as the value of the output voltage from the datasheet when the object is not detected, which is 0 VDC.

Table 8 Measurement Results Using an Oscilloscope with Metal materials

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

b. Wood

In testing measurements using an oscilloscope with objects made of wood, tests are carried out 5 times on the output voltage generated by the proximity sensor

2 when nothing is detected and when the objects are detected. The test results are shown in Table 9.

Table 9 Measurement Results Using an Oscilloscope Made of Wood

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

From the measurement results using an oscilloscope in Table 9, when measuring the wood material, it is known that the value of the output voltage from the proximity sensor 2 when the objects are not detected on average is 5 VDC, this output voltage value is the same as the output value from the datasheet when the objects are not detected, which is 5 VDC. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of the output voltage is also the same as the value of the output voltage from the datasheet when the object is not detected, which is 0 VDC.

c. Paper

In testing measurements using an oscilloscope with objects made of wood, tests are carried out 5 times on the output voltage generated by the proximity sensor 2 when nothing is detected and when the objects are detected. The test results are shown in Table 10.

Table 10 Measurement Results Using an Oscilloscope with Paper material

Experiment	Output Voltage (V)			Error (%)
	Data-sheet of object and no object (v)	Measurement when detecting no object (v)	Measurement when detecting object	
1	(5/0)	4,9	0 V	0
2	(5/0)	4,9	0 V	0
3	(5/0)	4,9	0 V	0
4	(5/0)	4,9	0 V	0
5	(5/0)	4,9	0 V	0

From the measurement results using an oscilloscope which is shown in Table 10, when measuring the paper material, it is known that the value of the output voltage from the proximity sensor 2 when the objects are not detected on average is 5 VDC, this output voltage value is the same as the output value from the datasheet when the objects are not detected, which is 5 VDC. Then for the value of the output voltage from the proximity sensor 2 when the average object is detected is 0 VDC, where the value of the output voltage is also the same as the value of the output

voltage from the datasheet when the object is not detected, which is 0 VDC.

4.2. Traffic Light

The analysis is divided into 4 parts, which are analysis at 1-way intersection, 2-way intersection, 3-way intersection and 4-way intersection. This system uses input in the form of a push button start and a push button stop, 8 timers on which function as a traffic light timer with each timer given a time of 5 seconds to get the ratio of time Red: Yellow: Green = 15: 5: 5. The output is in the form of 12 pilot lamps as traffic light and 4 servo motors to drive the barrier bars at each intersection.

4.2.1. 1-way Intersection

In Figure 13 below is the condition at 1-way intersection. When the red light is ON, the servo motor will move the barrier bar at an angle of 0° for 15 seconds to close the road section at intersection 1 following the length of time the red light is ON. When it reaches 15 seconds, the red light will be OFF, the green light will be ON and the servo motor will move the barrier bar at an angle of 90° to open the road at junction 1 as shown in Figure 13 (a) below. After the green light is on for 5 seconds, then the green light is OFF and the yellow light is ON for 5 seconds as in Figure 13 (b). After 5 seconds, the yellow light will OFF and the red light will be ON so the servo motor will move the barrier bar again to close the road section at 1-way intersection as in Figure 13 (c).

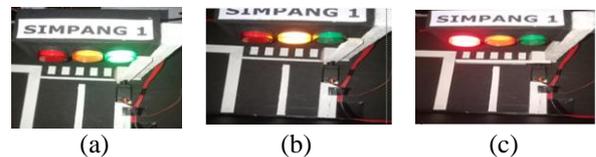


Figure 13 1-way intersection

4.2.2. 2-way Intersection

In Figure 14 below is the condition at 2-way intersection. When the red light is ON, the servo motor will move the barrier bar at an angle of 0° for 15 seconds to close the road section at intersection 2 following the length of time the red light is ON. When it reaches 15 seconds, the red light will be OFF, the green light will be ON and the servo motor will move the barrier bar at an angle of 90° to open a road at intersection 2 as in Figure 14 below. After the green light is on for 5 seconds as shown in Figure 14 (a), then the green light is OFF and the yellow light is ON for 5 seconds as shown in Figure 14 (b). After 5 seconds, the yellow light will OFF and the red light will be ON (Figure 14 (c)) so that the servo motor will move the barrier bar again to close the road section at 2-way intersection.

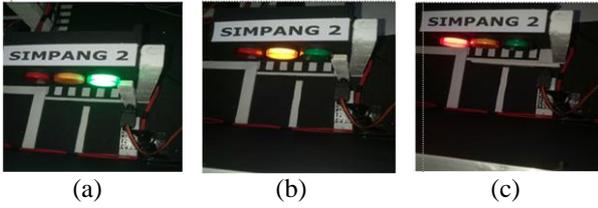


Figure 14 2-way intersection

4.2.3. 3-way Intersection

In Figure 15 below is the condition at 3-way intersection. When the red light is ON, the servo motor will move the barrier bar at an angle of 0° for 15 seconds to close the road section at intersection 3 following the length of time the red light is ON.

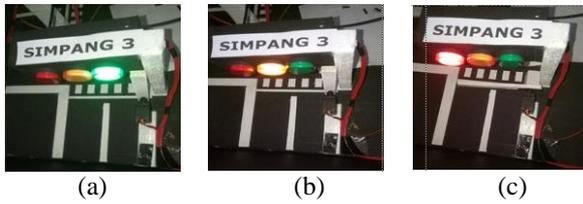


Figure 15 3-way intersection

When it reaches 15 seconds, the red light will be OFF, the green light will be ON and the servo motor will move the barrier bar at an angle of 90 to open the road at junction 3 as shown in Figure 15. After the green light is on for 5 seconds (Figure 15 (a)), then the green light is OFF and the yellow light is ON for 5 seconds as shown in Figure 15(b). After 5 seconds, the yellow light will OFF and the red light will be ON as in Figure 15 (c), so that the servo motor will move the barrier bar again to close the road section at 3-way intersection.

4.2.4. 4-way Intersection

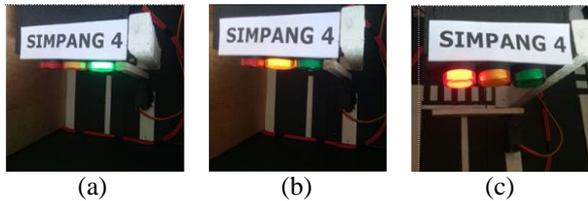


Figure 16 4-way intersection

In Figure 16, it is the condition at 4-way intersection. When the red light is ON, the servo motor will move the barrier bar at an angle of 0° for 15 seconds to close the road section at intersection 4 following the length of time the red light is ON. When it reaches 15 seconds, the red light will be OFF, the green light will be ON and the servo motor will move the barrier bar at an angle of 90 to open a road at junction 4 as shown in Figure 16 below. After the green light is on for 5 seconds (Figure 16 (a)), then the green light is OFF and the yellow light is ON for

5 seconds as in Figure 16 (b). After 5 seconds, the yellow light will OFF and the red light will be ON, as in Figure 16 (c), so the servo motor will move the barrier bar again to close the road section at 4-way intersection.

The overall results of the 4 intersection traffic lights above can be seen in Table 11 below:

Table 11 Test Result Data

Time	Simpang 1			Simpang 2			Simpang 3			Simpang 4		
	H	K	M	H	K	M	H	K	M	H	K	M
1	Green					Red			Red			Red
2	Green					Red			Red			Red
3	Green					Red			Red			Red
4	Green					Red			Red			Red
5	Green					Red			Red			Red
6		Yellow				Red			Red			Red
7		Yellow				Red			Red			Red
8		Yellow				Red			Red			Red
9		Yellow				Red			Red			Red
10						Red			Red			Red
11						Red			Red			Red
12				Green		Red			Red			Red
13				Green		Red			Red			Red
14				Green		Red			Red			Red
15				Green		Red			Red			Red
16					Yellow	Red			Red			Red
17					Yellow	Red			Red			Red
18					Yellow	Red			Red			Red
19					Yellow	Red			Red			Red
20					Yellow	Red			Red			Red
21						Red	Green		Red			Red
22						Red	Green		Red			Red
23						Red	Green		Red			Red
24						Red	Green		Red			Red
25						Red	Green		Red			Red
26						Red	Green		Red			Red
27						Red		Yellow	Red			Red
28						Red		Yellow	Red			Red
29						Red		Yellow	Red			Red
30						Red		Yellow	Red			Red
31						Red		Yellow	Red	Green		Red
32						Red		Yellow	Red	Green		Red
33						Red		Yellow	Red	Green		Red
34						Red		Yellow	Red	Green		Red
35						Red		Yellow	Red	Green		Red
36						Red		Yellow	Red		Yellow	Red
37						Red		Yellow	Red		Yellow	Red
38						Red		Yellow	Red		Yellow	Red
39						Red		Yellow	Red		Yellow	Red
40						Red		Yellow	Red		Yellow	Red

4.2.5 Servo Motor mg99r Working Voltage Measurement Results

The results of measuring the working voltage on the mg996r servo motor at work can be seen in Table 4.11 below:

Table 4.11 MG996r Servo Motor Working Voltage Measurement Results Data Using a Digital Multimeter

No.	Condition	1 Section	2 Section	3 Section	4 Section
1.	Servo Motor in Red lamp	4.94 Volt Closed	4.94 Volt Closed p	4.94 Volt Closed	4.95 Volt Closed
2.	Servo Motor in Yellow lamp	0 Volt Opened	0 Volt Opened	0 Volt Opened	0 Volt Opened
3.	Servo Motor in Green lamp	0 Volt Opened	0 Volt Opened	0 Volt Opened	0 Volt Opened

5. CONSLUSION

This trainer module can be used as a medium for learning from a variety of applications from using PLC as a control system. Where in this trainer module there are two variations of application, which are a conveyor sorting goods based on the height of the goods and a traffic light 4 intersections with automatic door latches. Both of these variations can be used as another alternative to application in the learning process of PLC theory and

practice in the system laboratory in the Department of Electrical Engineering, Sriwijaya State Polytechnic.

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