

Prototype of Automatic Tobacco Chopper Using PLC Omron CPM1-A Type

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Abstract – Tobacco is the main raw material used to make cigarettes. Increasing of cigarette sales which have continued until now has led to an increasing of tobacco produced by tobacco farmers. Region of East Java has the largest percentage of tobacco producers and most of the peoples that work as tobacco farmers. Some of them still carried out the chopping process manually, thus requires more energy and longer time. This research is carried out by chopping tobacco leaves that have been dried and stacked with a thickness of 4mm. The procedure is carried out by pressing the start button, then conveyor moves to bring the container to the chopper. The container which attached to the magnet will be stop and detected by the reed switch sensor. The conveyor rotation is controlled by a DC motor gearbox and the operation of the chopper blades is controlled by a power window motor. All the chopping process is controlled using PLC

Keywords: Tobacco's Chopper, PLC, Conveyor, Sensor, DC Motor Gearbox

I. INTRODUCTION

Tobacco is the main raw material used to make cigarettes. Several cities in East Java such as Lumajang and Madura are the areas that have 85% of the population works as tobacco farmers. The results of tobacco processing will be sold to various areas within the country to abroad.

Most of the local tobacco farmers still carried out the tobacco processing by manually process from the picking, rolling, chopping, to the storing and drying of the tobacco leaves. In the manufacturing process, tobacco undergoes a slicing process, which is one of the most prioritized processes to determine the quality of tobacco chopped into cigarettes. Manually process of tobacco's chopping requires more of effort and time. Normal work of tobacco farmers is done by the tobacco chopper for 5-7 hours, then it produces 7-8 kg/hour with the quality of the chopping results according to the hand of the person who does the chopping manually.

So that, it is hoped that the manufacture of automatic tobacco choppers using sensor and conveyor become a long-term investment for tobacco farmers so that they can work more quickly, efficiently, and produce more chopped tobacco leaves to process into cigarettes..

II. BASIC THEORY

2.1 Tobacco Leaves Processing

Tobacco post-harvest handling is the handling process of tobacco leaves after they are harvested to produce the primary product in the form of chopped tobacco. There are

several stages in postharvest handling, as follows: sorting, curing, rolling, and drying. Drying is a process that must be considered because the purpose of drying is to reduce the water content until it reaches an equilibrium moisture content, so that it is easier to process into cigars/ cigarettes.

Chopping is the process of chopping tobacco leaves after ripening and drying. In order for the chopping results to be evenly distributed and bruised (not wide) the results of the chopping knife must be really sharp. The standard for tobacco to be chopped is tobacco that has a moisture content of 15 – 20% and does not get wet when squeezed, which is semi-wet tobacco (the color starts from brownish yellow).

2.2 PLC (Programmable Logic Control)

The PLC receives information from connected sensors or input devices, processes the data, and triggers outputs based on pre-programmed parameters. Depending on the inputs and outputs, a PLC can monitor and record run-time data such as machine productivity or operating temperature, automatically start and stop processes, generate alarms if a machine can't operate, and more. PLC are a flexible and robust control solution, adaptable to almost any application.

PLC can be described as a control ladder comprising a sequence program that consists of normally open (NO) and normally closed (NC) contacts connected in parallel or in series, it also has relay coils which turns ON and OFF as the state of these contacts change

Typical block diagram of PLC is show in figure below as clear from figure PLC consists of following basic parts, including: CPU (Central Processing Unit), Programming

device, Input/ output module.

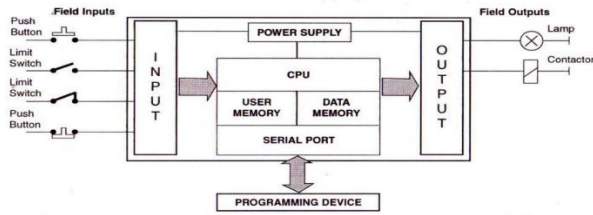


Figure 2.1 Building Blocks of PLC

The input section converts the field signals supplied by input devices/sensors to logic-level signals that the PLC’s CPU can read. The Processor Section reads these inputs, Processes the signal, and prepares the output signals. The output section converts the logic level output signals coming from processor section to high level signals and used to actuate various output field devices.

The programmer/monitor is used to enter the user’s program into memory and to monitor the execution of the program.

2.3 Reed Switch Sensor

Reed Switch is a sensor that also functions as a switch that is active or connected when there is a magnetic field in its coverage area, this sensor is only consists of two plates that are close to each other. If the magnetic field is strong enough to pass through the area around the reed switch, then the two plates that are close to each other will be connected so that it will provide a closed circuit for the paired circuit.

III. METHODS

The mechanical/ hardware design is divided into 4 parts, which includes the design of a chopper using a paper cutter, design of a conveyor, and panel box which includes a 24V of power supply, relay, and regulator. Also, for software design (software) includes making flow charts using CX Programmer for PLC Omron of CPM1A type.

1.1 System Functional Block Diagram

This chapter discusses the overall design of the tool, both hardware (mechanical circuits and systems) and software. It is also explained in more detail each part or building block diagram of this tool in the form of system functional block for designing a tobacco chopper including: relays, reed switch sensor to detect the magnet, and push button as the initialization of start-stop of chopper system. System Functional block as shown in Figure 3.1 below:

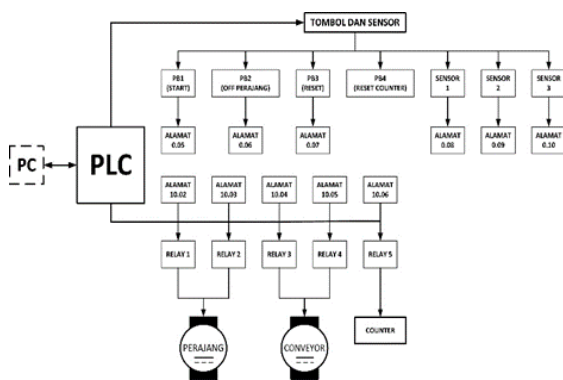


Figure 3.1 System Functional Block Diagram

Figure 3.1 above is a functional block for designing a tobacco chopper. The hardware used is a tobacco chopper machine, conveyor and panel box. Meanwhile, the software design of this system uses the CX Programmer software. From the PC it is connected to the PLC using RS232 then from the PLC to the buttons and sensors, the chopper motor and the conveyor motor using digital input-output cables.

1.2 Chopper Design

Planning design is drawn to assist in designing the module to suit what is desired. Components or materials for the design of the chopper including: paper cutter with the smallest plate size, aluminum, power windows. This tobacco chopper is designed to use a paper cutter because the chopper blade is stronger and sharper. And so that the results of chopped tobacco leaves can be the same as the results. The power window used is 24V, as shown Figure 3.2.

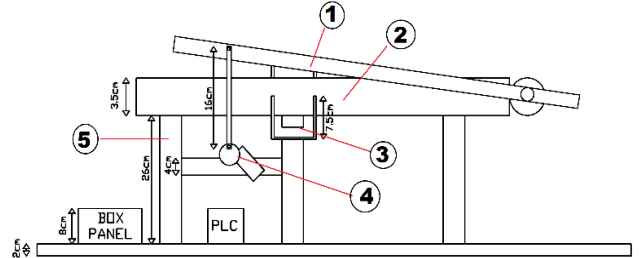


Figure 3.2 Tobacco Chopper Design

Figure 3.2 shows the design of the tobacco chopper as seen from the front with the following information: (1) Chopper knife; (2) Chopper table; (3) Tongue-chopper; (4) Power window motors; (5) Buffer plate. Installation of the power window motor, in section number (4) mounted support using aluminum (1/2 dim) as a support for the power window motor and cutting iron.

1.3 Box Panel Design

In the box panel, a 24V power supply is installed on panel box and 5 relays are installed as a series of motor and counter controllers as well as safety because there are relays in it. While the power supply is installed as a power supply for relays and power window motors. Meanwhile, 5V and 12V voltage regulators are installed for the seven-segment power supply and DC motors on the conveyor section. Box panel design circuit is shown in Figure 3.3.

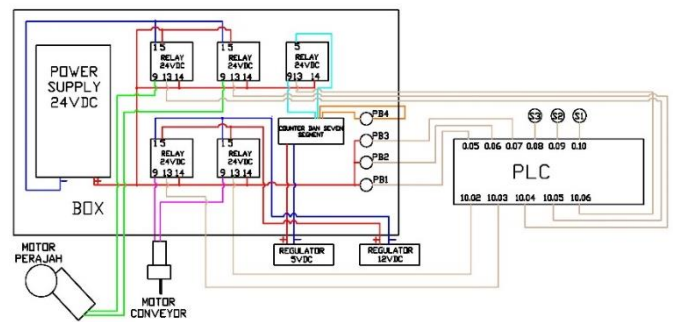


Figure 3.3 Box Panel Design

The motor output is included in one of the common for NC (close) on the relay. The output of the common NC is exposed to the positive source. Whereas, negative source is entered into the NO (open) of the connected common relay.

Positive coil of the relay is exposed to the positive 24V source and for the negative coil, it goes to the PLC output.

3.5 Voltage Regulator Design

The installation design of a regulator to be used as a voltage step down to adjust the rotation speed of a DC motor and as a source to adjust the input voltage to the seven-segment. This is because the 24V power supply connected to the relay in the panel box can only be changed to 22V.

Table 3.4 Voltage Regulator Parameters

Adjustable Voltage Parameters	
220V AC	Reduced to 25V AC using transformer
25V AC	Reduced to 25V AC using 2 diode 6A
25V DC	Changed to 18V using IC LM7818
	Changed to 15V using IC LM7815
	Changed to 12V using IC LM7812
	Changed to 5V using IC LM7805

Output voltages of 5V, 12V, 15V, and 18V are used to supply the seven segment and DC motors on the conveyor to adjust the speed. Schematics of regulator is shown below:

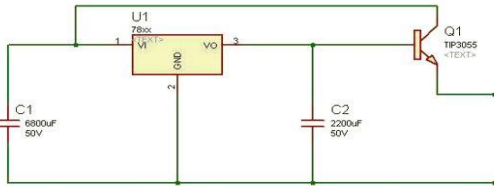


Figure 3.4 Regulator Schematics of 12V, 15V, and 18V

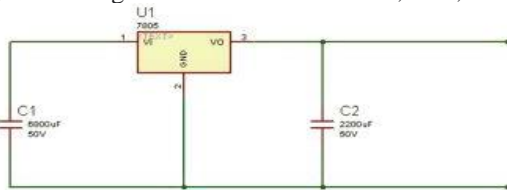


Figure 3.5 Regulator Schematics of 5V

Figure above is a schematic design of the regulator that purpose is only designed to be used to control the speed of a DC motor on a conveyor and also as a feeder for seven segments.

3.6 Flow Chart of System

Figure 3.6 above can be seen the flow chart design for the overall of tool working process which the order of how the flow chart works are as follows:

1. Initial start is to press the PB I button and motor I advances until it touches sensor 2 then motor-I stop and motor II running
2. PB II is pressed, then motor II stops and the timer will be start counting for 3 seconds. If not running, motor II continues to run until PB II is depressed
3. PB II is pressed, motor II stops and the timer start to counting for 3 seconds. If not running, motor II continues to run until PB II is depressed

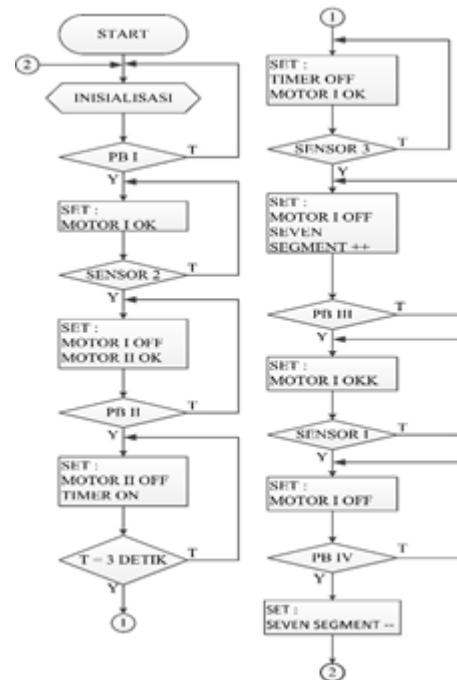


Figure 3.6 Flow Chart of Chopper System

4. When finished calculating the time, motor I running.
5. Motor I forward until it touches sensor 3, then motor I stop and the seven-segment will count forward. If not, motor I continues to run until it hits sensor 3
6. PB IV is pressed then the seven-segment will be reset.
7. PB III is pressed then the motor I runs backwards. If not, then motor I remains in a stopped condition
8. Motor I runs backwards until touches sensor 1, then motor I stop and the system has run for one chopping process. If not, motor I will continue to run backwards until touches sensor 1.

3.7 PLC OMRON CPM1-20CDR-A

The PLC used is the OMRON CPM1-20CDR-A PLC. This PLC is a compact PLC where there are 20 I/O, namely 12 inputs and 8 outputs. And this PLC can also add input output with extra expansion. In this project, input from PLC is a push button (PB) and reed switch sensor. As well as the output are conveyor motor and chopper motor. For PLC I/O connections can be seen in Figure 3.7.

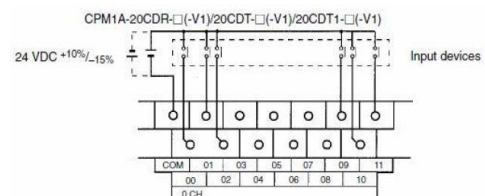


Figure 3.7 Input of PLC OMRON CPM1-20CDR-A

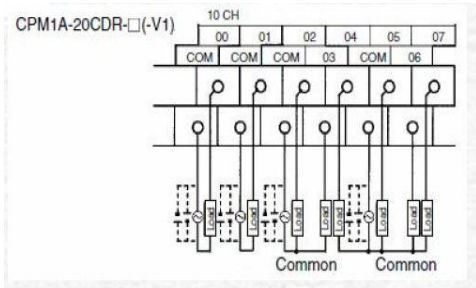


Figure 3.8 Output of PLC OMRON CPM1-20CDR-A

From the picture above can be seen that the input pins get a positive 24V source. Likewise, the output pins get a positive 24V source. While the common from the output and input gets a negative 24V source.

IV. RESULT AND DISCUSSION

4.1 Regulator Test

Regulator testing is intended as a voltage reduction so that it can adjust the rotational speed of the DC motor on the conveyor using a regulator IC to adjust the input voltage to the motor and the voltage can be adjusted. The regulator test is carried out by selecting the input voltage that has been specified and it will be used on the transformer, then activating the deep switch to produce an output voltage.

Regulator testing is carried out at a voltage of 5V using LM7805, 12V using LM7812, 15V using LM7815, and 18V using LM7818. The range used as the input voltage is 18V, 25V, and 32V. In testing this regulator produces an output voltage as shown in the following table:

Table 4.1 Regulator Test Result

IC	Voltage Range	Vin (VAC)	Vout (VDC)
LM7805	5V	18V	4,93V
		25V	4,92V
		32V	4,93V
LM7802	12V	18V	12,01V
		25V	12,01V
		32V	12,01V
LM7815	15V	18V	14,58V
		25V	14,58V
		32V	14,57V
LM7818	18V	18V	17,82V
		25V	17,82V
		32V	17,82V

Table 4.1 shows that testing measurement of the voltage regulator uses a regulator IC, this caused by the previously it used a potentiometer to adjust the voltage change, but the results are not precise so that the LM type IC is in series to produce a more precise voltage. From the results of the regulator measurement data as shown in Table 4.1, the output voltage results are close to the input voltage and this output voltage is used as a power window motor speed controller.

4.2 Chopper Test Result

The test was carried out by calculating the rpm of the power window motor to control the speed of the chopper blades and the number of chopped pieces on the chopper blade in 1 minute. The test is carried out by observing the rotation of the power window motor and calculating the number of chopper blades per 10 seconds, so that later it can produce motor rpm values as shown in the table below:

Table 4.2 Number of Pieces and Rpm

Voltage	Numb. of Counts per 10s	Speed (rpm)
6V	6	36
10V	13	78
18V	20	120
22V	31	186
24V	34	204

Table 4.2 above shows that from this chopper testing is obtained from the analysis that the highest rpm is selected, namely at 204 rpm in 1 minute with a voltage of 24V. This is due to the highest voltage, the tobacco slicing process will be faster.

4.3 Reed Switch Sensor Test Result

The box used to hold the chopped tobacco results is given a magnet to determine whether the sensor function is active or not. The sensors are placed in 3 conditions and it will detect the magnet in the box when the conveyor rotates as shown in Figure 4.1 and Table 4.3

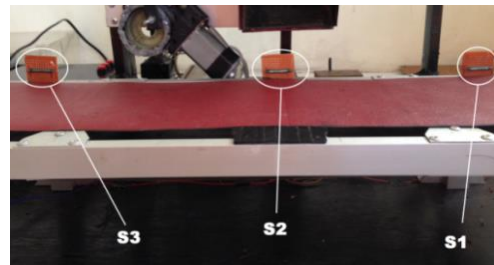


Figure 4.1 Reed Switch Sensor Position

Table 4.3 Reed Switch Sensor Test Result

Reed Switch Position	Result
S1 Stop right under the chopped tobacco	Active
S2 Final position of the conveyor, for the off position	Active
S3 When the system reset, the conveyor and container run backwards to the starting position	Active

Table 4.7 is the result of testing the reed switch sensor which shows that the three reed switch sensors are actively working to detect the magnet installed in the box

4.4 Ladder Diagram Test Result

Ladder diagram on PLC OMRON CPM1A using CX programmer software. Before starting programming, you must set the type of PLC and CPU used. The input and output addresses used in the CX Programmer software can be seen in Table 4.4. System process of the ladder diagram program is shown in Figures 4.2 to Figure 4.5.

Table 4.4 I/O Address on Ladder Diagram

Input Address	Description	Output Address	Description
0.05	Start	10.02	Conveyor (Reverse)
0.06	Stop	10.03	Conveyor (Forward)
0.07	Reset/ Stop	10.04	Chopper (Right)
0.08	Sensor-3	10.05	Chopper (Left)
0.09	Sensor-2	10.06	Seven Segment
0.10	Sensor-1	-	-

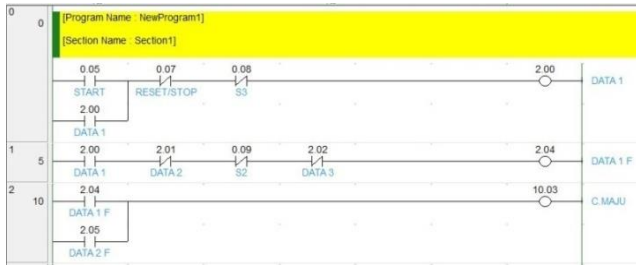


Figure 4.2 Conveyor Forward

Figure 4.2 shows the start button as initial conditions at address of 0.05 (START) is activated, current flows to coil 2.00 and activates coil 2.00 (DATA 1), 2.00 becomes active (closes) and self-holding. Coil 2.00 active, current flows to coil 2.04 (DATA 1 F), 2.04 active (close) and activates coil 10.03 (C FORWARD) so that coil 10.03 (C FORWARD) is active and the conveyor goes forward.

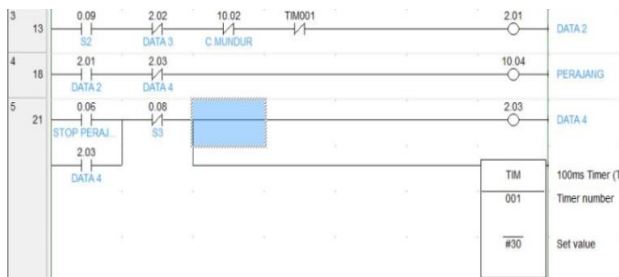


Figure 4.3 Timer and Chopper

The conveyor forward (C FORWARD) to the chopping touches address of 0.09 (S2), and the conveyor stops. Coil 0.09 (S2) active (close), the current flows towards the 2.01 (DATA 2). Coil 2.01 activates (close) and activates coil 10.04 (Chopper). The chopper blade actively until the chopping process is complete, then pressing the stop button to stop the chopping process. When the address is 0.06 (STOP), current flows to coil 2.03 (DATA 4), coil 2.03 is active (close) and activates the timer (TIM 001) to count for 3 seconds.

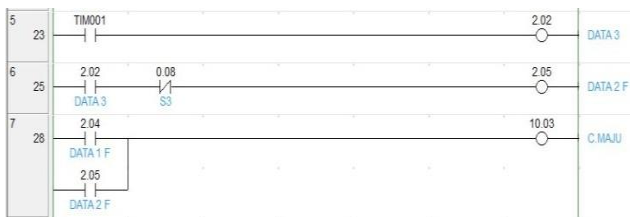


Figure 4.4 Timer and Conveyor Forward

After the timer of TIM 001 finishes counting for 3 seconds, the timer of TIM 001 close and coil 2.02 (DATA 3) activated. Coil 2.02 (DATA 3) is active, then current flows to coil 2.05 (DATA 2 F) and coil 2.05 activated. Coil 2.05 is active (close) and current flows towards the coil 10.03 (C FORWARD), so the coil 10.03 (C FORWARD) is active and the conveyor advances towards (S3).

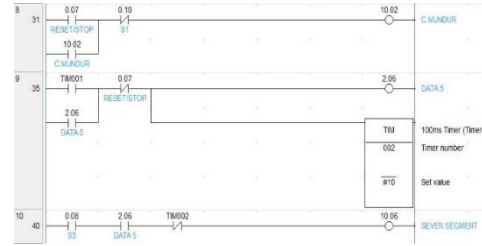


Figure 4.5 Seven Segment and Reset

When the conveyor stops after passing through the sensor 3 (S3), then simultaneously activates the coil 10.06 (seven segment). The reset/stop button at address of 0.07 (RESET/STOP) is activated to reset the current flowing to coil 10.02 (C REVERSE) is active (close). Then the conveyor reverses until sensor (S1) is active, so that the conveyor will be stop and the tool returned to its initial position.

After the ladder diagram program is tested, a time chart can be made to find out the overall work system of the ladder diagram program. Time chart is shown in Figure 4.6.

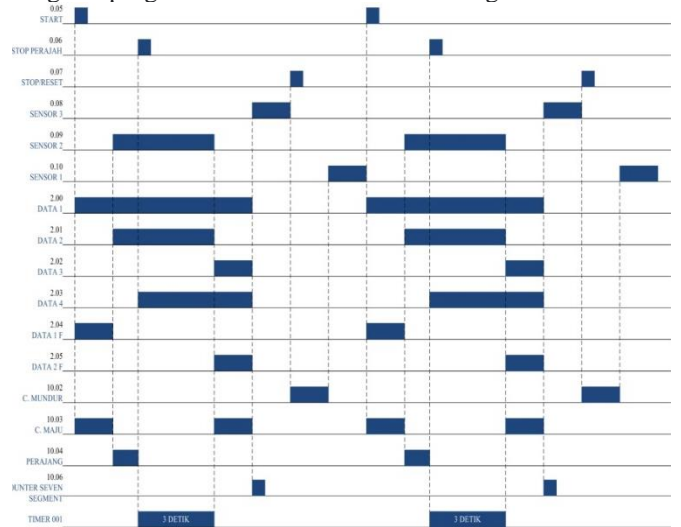


Figure 4.6 Time Chart System

The testing of overall tools shows that all the devices used can work normally according to their functions. It is explained that for one chopping process it takes 6 minutes 2 seconds to produce a chopping capacity of 30 grams. Then another chopping is done to find out the length of the chopping process and the chopping capacity with the parameter 1 basket full. Photos of tools and results of chopped tobacco can be seen in Figure 4.7



Figure 4.7 Chopper Prototype and Tobacco Products

CONCLUSION

The voltage regulator affects the rotational speed of the conveyor. The greater the tension, the faster the conveyor rotates. A rotational speed that is too high also affects the detection of reed switch sensor, where the reed switch sensor will be in trouble to read the passing magnets at a conveyor rotational speed. So that, the 12V voltage is chosen which is quite stable for the conveyor rotation. The operation system of PLC using CX-programmer software shows a good of accuracy results even though this type of PLC is still conventional.

The thickness of the tobacco leaves affects the tobacco products. The thicker the pile of tobacco leaves, the smaller the percentage of similarity in the results of the tobacco products. In this chopping process, the thickness of 4mm tobacco was chosen because the resulting chopping was better.

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