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Auto Racking System Prototype For Forklift Replacement Industrial Goods Distribution

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***Abstract*—Automation is one of the technological developments and is an alternative to obtaining a working system that is more practical, efficient and has a low accident rate to get a high level of accuracy as well. The process of transporting and packing goods can be done by using tools to make it easier and lighten the work of humans. At this time, PLC has played an essential role in the industrial world, various applications have been developed using a PLC control system, so it is critical for us electrical engineering students to learn and understand PLC as a provision for us when we enter the industrial world. Therefore Automation This racking system can be a learning tool for electrical engineering students, especially in the PLC field. The results of research and discussion have been stated. The use of limit switches is essential in this system. To determine which motor will be active and which engine will be off. And as a determinant of the direction of the pallet will be brought. With HMI, you can monitor which components are active and count the number of pallets that go in and out. The system has been able to run properly and correctly even though the mechanical problem is not yet perfect. Before making a miniature, we must prepare the concept in advance, so it is easy to design. Understand the process and workings of the tools we make. Understand the specifications of the components that we will use.**

Keywords—Racking; Autonomous; Distribution of Goods; Forklifts; prototype.

I. Introduction

To survive in a competitive world, companies must use the latest technology. The field of automation has an important impact on various industries. Automation uses control systems and information technology to reduce human work's need to produce goods and services. A high degree of flexibility is a fundamental manufacturing requirement. The industry faces many other challenges, such as continuously increasing production volumes, reducing costs, and operating safely.

New technologies are needed to increase efficiency and increase production. Automation is one of the technological developments and is an alternative to obtaining a working system that is more practical, efficient, and has a low accident rate to get a high level of accuracy as well. The process of transporting and packing goods can be done by using tools to make it easier and lighten the work of humans. Therefore, the author tries to create a system of transporting and packing goods that can be operated manually or automatically, which is controlled using a PLC (Programmable Logic Controller) and combined with HMI (Human Machine Interface) to make it easier for us to maintain this Manual and Automatic Racking System operating system. made in a miniature form to be more efficient and does not require a lot of space, however, the workings and operations are the same as those in industries.

This Manual and Automatic Racking System has six shelves consisting of three upper and three lower shelves. Transporting and packing goods can be done in two ways, automatically and manually. In automatic operation, the machine runs automatically, and the inlet conveyor will carry the pallet to the mobile trolley. Then, the mobile trolley will fill the rack with pallets automatically, starting by filling the top shelf until all the shelves are filled. In manual operation, it can be done by selecting the part to move by choosing the HMI screen option.

At this time, PLC has played an essential role in the industrial world. Various applications have been developed using a PLC control system, so we electrical engineering students need to learn and understand PLC as our provision when we enter the industrial world.

II. Literature Review

A. PLC (Programmable Logic Controller)

PLC (Programmable Logic Controller) is a device used to replace the function of a sequential relay circuit to control a control system contained in the panel. The advantages of PLCs are pretty complex with specific sequences, which already use several relays, timers, counters, and other unique controls [1].

Meanwhile, according to M.Budiyanto & A.Wijaya Programmable Logic Controller is a control that uses programmed Logic that is intentionally designed to operate internal instructions with memory as storage to carry out logical functions, for example, counting functions, timing functions, arithmetic functions, sequence functions. In addition, processes and other parts according to the ordered program [1].

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

PLC means a programmable logic controller, but PLC is functionally no longer limited to logic functions. A PLC today can also perform relatively complex arithmetic calculations, communication functions, documentation, etc. PLC is widely used in industrial applications, for example,

in packaging, automatic assembly, and others. In addition, almost all electrical control applications require a PLC[2].

The main reason for designing PLCs is to eliminate the burden of maintenance costs and the replacement of relay-based machine control systems. Therefore, the characteristics of PLC have several aspects as follows:

a. PLC program through a programming unit, a computer terminal with a VDU (Video Display Unit), and a keyboard or with a particular portable terminal (similar to a calculator with an LCD). At this time, PLC can be programmed via PC.

b. PLC is a microprocessor-based system with a microcomputer's main functions and facilities.

c. PLC controls a device based on the input or output status of a machine and program.

So that the understanding of the PLC, which initially functioned to replace the role of the relay, can be interpreted according to the wording of the arrangement as follows:

a. Programmable, which shows the ability that can be easily changed according to the program created and its capabilities in terms of program memory.

b. Logic shows its ability to process input arithmetically by comparing, adding, multiplying, dividing, and subtracting.

c. Controller shows its ability to control and regulate the process to produce the desired output.

PLC uses a programming language with high-level Logic. Therefore, the programming language in PLC is easy to understand. The programming language used in PLCs uses ladder diagrams or mnemonics.

A ladder diagram is a diagram that is used to draw a circuit or process. The ladder diagram consists of a line on the left that extends, called the bus bar, and on the right are its branches, called the branch lines or instruction lines. Figure 2.2.1 is an example of a ladder diagram used in a PLC and entered through a computer device via software from each vendor.

Mnemonic is a language the PLC can understand to run applications/operations. In the mnemonic code, there are three standard structures, namely addresses, instructions, and operands or data, as shown in Table 2.1. The address is where the instructions are stored in program memory. The lesson in program memory is different for each instruction. Instructions are a set of programs the PLC can recognize to run applications. The number of instructions depends on the type of PLC used. The greater the capacity, the more instructions are displayed. At the same time, the operand or data is an address designation of I / O, memory location designation, or data in the form of numbers (for timers or counters).

B. PLC Omron CPM2A

The PLC used in this packing line control system is OMRON type CPM2A 30 I/O series. This selection is based on the availability of tools. OMRON CPM2A series has provided an RS232 connection. This will be very helpful in working on systems that use serial communication.

C. PLC function

PLC is designed to replace a sequential relay circuit in a control system. In addition to being programmable, this tool can also be controlled and operated by people who do not have specific knowledge of computer operations. This PLC has a programming language that is easy to understand and can be performed if the program has been created using software that is by the type of PLC that has been used.

This tool works based on existing inputs and, depending on the situation at a particular time, will turn on or off the outputs. PLC can also be applied to control systems that have multiple results. Many things can be done by the PLC, namely as follows:

1) Sequence Control

a. Relay control logic replacement

b. Replacement Controller in the form of an electronic circuit board

c. Machine and process controllers.

d. Timers/ Counters

2) Advanced Control

a. Arithmetic Operations (+,-,x,:)

b. Information Handling

c. Servo motor control

d. Stepper Motor control

, e. Analog Control

f. PID (Proportional Integrator Differentiator)

3) Supervision Control

a. Monitor and diagnose faults.

b. Process monitor and alarm.

c. Interface with the computer.

d. Interface with the printer.

e. Factory automation network.

f. Local Area Networks.

g. Wide Area Networks.

D. Advantages of PLC

Control systems using PLC have many advantages over control systems using electrically arranged control equipment such as relays and contractors, namely:

1) PLC is designed to work with high reliability and long service life in industrial environments.

2) If a control application is complex and uses many relays, it will be cheaper if we use/install one PLC as a control device.

3) PLC can be easily changed from one application to another by reprogramming it as we want.

4) PLC can diagnose and show faults in the event of a disturbance, which is very helpful in tracking disturbances.

5) PLC can communicate with other PLCs, including computers. So that the control can be displayed on the computer screen and documented, and the control image can be printed using the printer.

6) Easy to track control faults. PLC can replace the logic and operation of relay control circuits which are direct installations. The control circuit is made in software. Wiring is only required to connect input and output equipment. This makes designing and modifying the course easier because it is enough to change the PLC program.

E. Disadvantages of PLC

The control system using PLC also has several disadvantages compared to other systems. The drawbacks are as follows:

1) New Technology

2) PLC Program Applications Are Not Suitable For Static Applications (Fixed)

3) Operation With Static Circuit (Fixed)

4) PLC Vulnerable to changes in temperature and environmental conditions

III. Design

At this stage, all the prepared components will be used to manufacture tools by the parts and functions of each.

A. Tool skeleton creation

In manufacturing this automation racking system, the tool frame is made of wood and plywood measuring 80 x 65 cm.

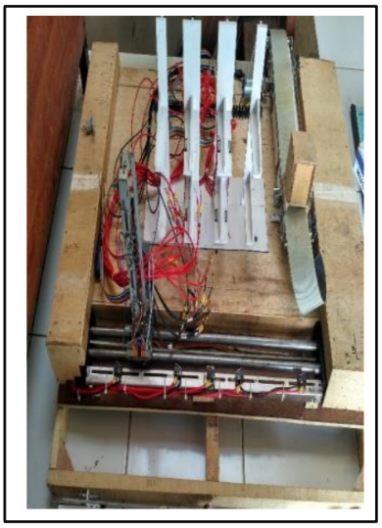

Figure 2. Framework for Automation Racking System

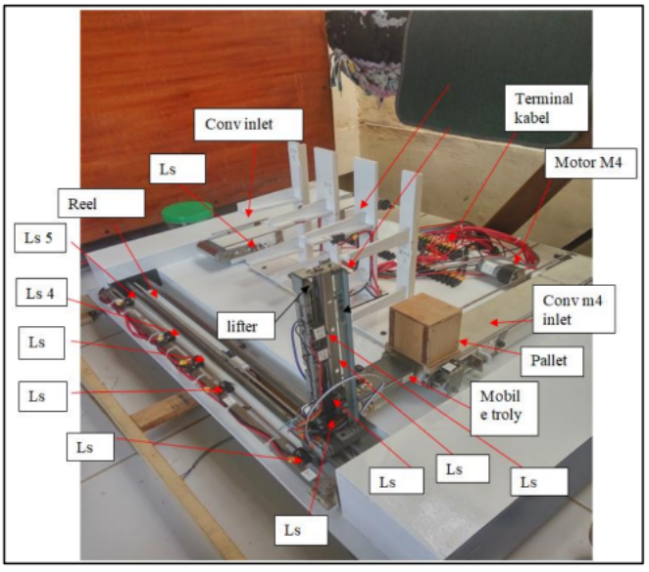

Figure 3. Automation Racking System Tool

B. Conveyor

Two conveyors are used for the pallet and outlet process, which are located on the left and right, each using a 24VDC motor. The conveyor frame is made of profile iron measuring 40x5cm, and there is also an iron roller on the front, which is fitted with ball bearings on the sides so that when the DC motor and DC motor belt rotate, the roll conveyor iron will also rotate. At the top of the conveyor, a cloth belt is used to carry goods on it [3].

C. Lifters and Trolly Cars

To carry pallets from the conveyor, a lifter is used, which is equipped with a trolley car that uses a 12VDC motor. The lifter frame is made from a used printer machine that can still be used. In this lifter, there are two 12VDC motors, and each engine is called M2 and M3. M2 is used to move the lifter up or down, while M3 is used to move the trolley car forward or backward.

D. Rail Lifter

For the lifter to move to the right and the left, a 24VDC motor is used to drive the lifter. In the rail section, there are five limit switches, which serve to stop the lifter's movement when it is in a particular position.

To store pallets carried by lifters, six shelves are used. Racks 1, 2, and 3 are at the bottom, while shelves 4, 5, and 6 are at the top. Each frame is equipped with a limit switch as a display signal on the HMI. The materials used in making the shelves are wooden planks, and the height of the frames is 250 mm.

IV. Human Machine Interface (HMI)

The main display on the touchscreen is, as shown below, the COUNTER option to see the number of incoming pallets and the number of outgoing pallets, while the MENU option is for the next operation, for example: for AUTO, MANUAL, MONITORING, and so on.

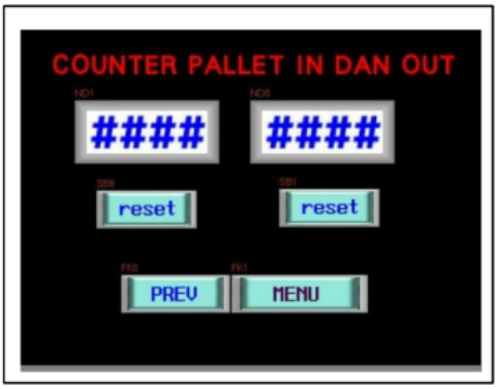

Figure 8. Counter display

The counter display can be seen in Figure 4.24. This menu shows how many pallets are entered into the rack and how many pallets are issued by the AUTOMATION RAKING SYSTEM machine. For every pallet that touches LS 18, the system will calculate how many pallets have entered. To figure out how many pallets are leaving, the pallet will handle LS 20. The reset button is used to reset the counter for the number of incoming and outgoing goods.

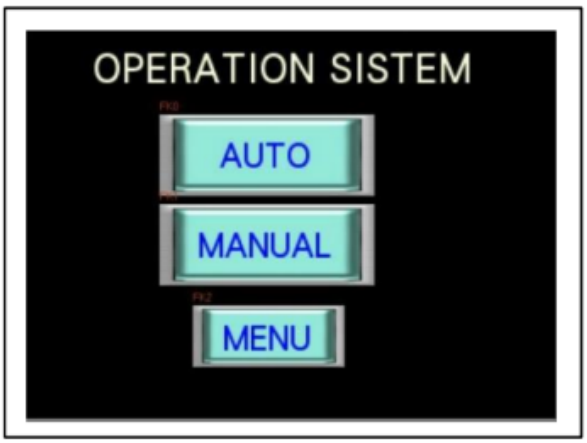

Figure 9. Display operating system

The picture above displays the operation system, and its function is to select the type of operation to be used. The process can be done in two ways, namely automatically or manually.

A. Process racking display

When you run the AUTO system, a display like the image below will appear.

Figure 10. Display Auto Rating Process

The number of objects on the shelf is still empty, and the indicator is white. When the auto button is pressed, the PLC will execute the command. Each pallet carried by the inlet conveyor will automatically be moved into the rack until it is complete. Note: at the beginning of the AUTO process, the machine must be in the original position, namely the condition of M1 in the LS 1 position, M2 in the LS12 place, and M3 in the LS 16 position. This is intended as a safety for the movement of the machine so as not to hit the track or the pallet. If the machine position is not in the original post, we can move it manually first so that the engine position becomes actual. The /touch button on PREV and NEXT changes the display on the touchscreen screen (next or previous display).

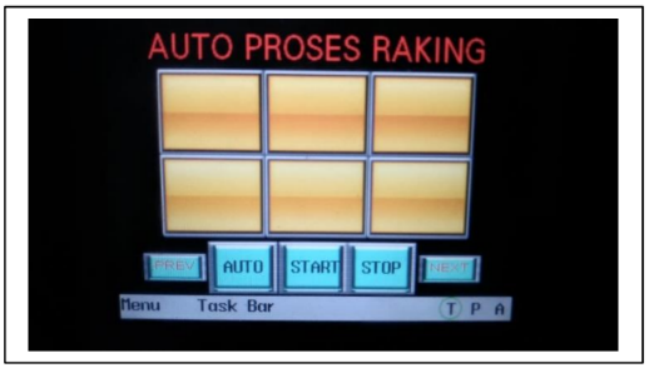

Figure 11. Fully loaded shelf

Manual operation can be done by clicking the button/touching manual on the operating system (figure 9), then the display will change to a manual operation process, see pictures 10.

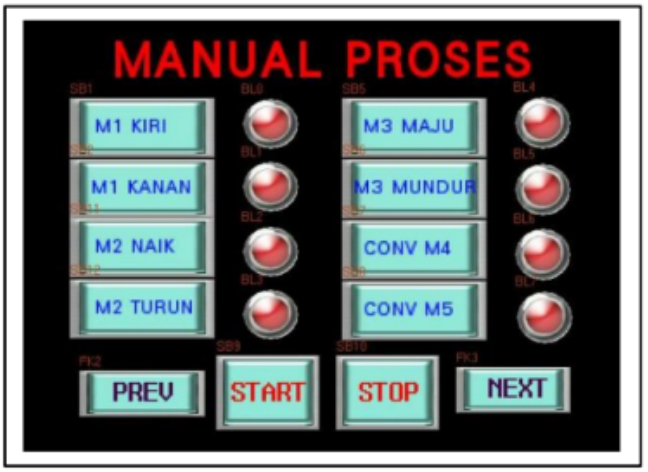

Figure 12. Display of the process manual operation

The manual operation process can be done by clicking START and then clicking left M1 for left M1 movement. , clicking the suitable M1 to move the right M1. then to move M2, by clicking M2 up, to move M2 up. It was connecting M2 down to move M2 down. Then to move M3, by clicking M3 forward, M3 forward, and clicking M3 backward, to move M3 backward. To activate the M4 inlet conveyor can be done by clicking CONV M4. And to start the M5 conveyor outlet, it can be done by clicking CONV M5. Note: if we want to do a manual operation, the AUTO process must be stopped first because if the AUTO process is still active, the manual process cannot be done. This aims to protect the movement of the machine.

B. Display auto loading process

The function of the loading process is to remove the pallets that have been stored in the rack to the conveyor outlet. To carry out the loading process, you can click NEXT (in Figure 11, the auto ranking process). Then the display below will appear, picture 13.

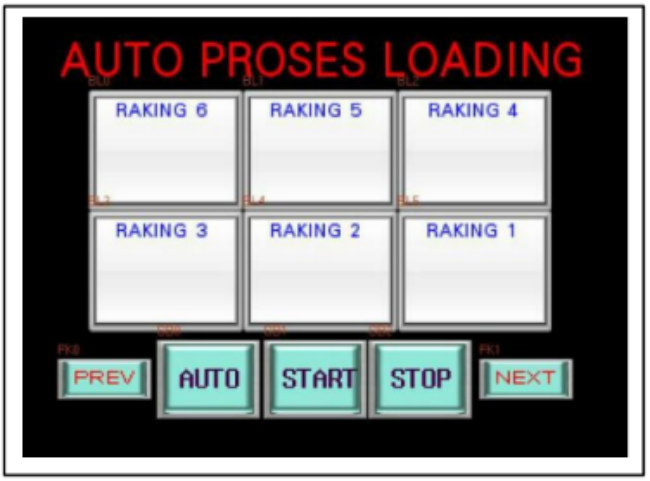

Figure 13. Display of auto loading process

The steps are the same as the ranking process, we click AUTO then START, if we want to stop the loading process click STOP.

C. Testing of Automation Racking System

At this stage all components will be tested whether they are in accordance with the program created [4][5].

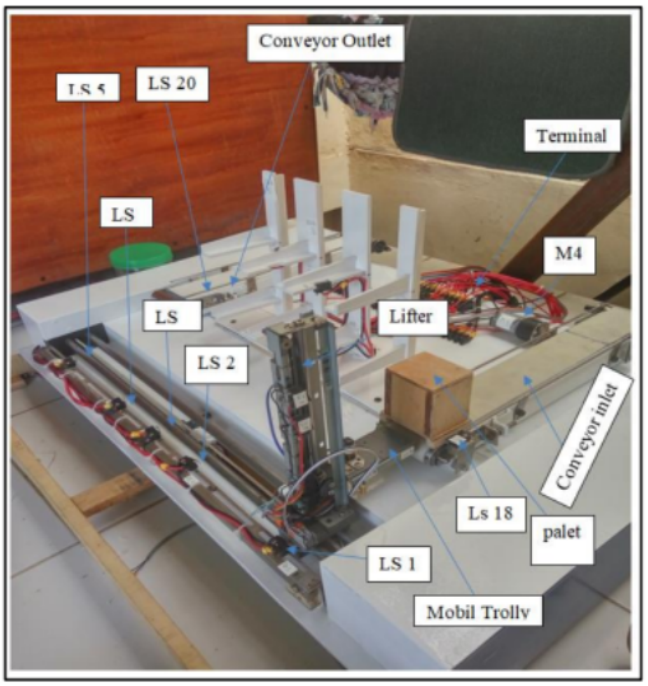

Figure 14. Automation Racking System

The picture above shows all the components used in the automation racking system.

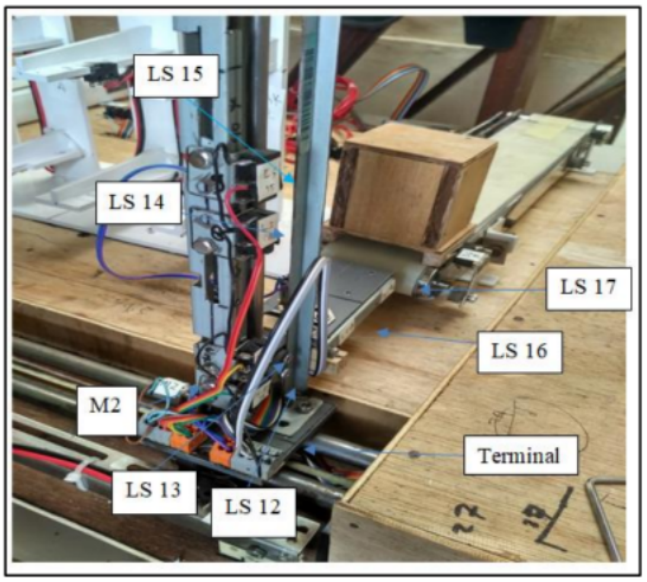

Figure 15. Lifter and Trolly Car

V. Conclusion

Based on the results of the research and discussion that has been started, the conclusions that can be drawn are as follows:

1. The use of limit switches is essential in this system. To determine which motor will be active and which engine will be off. And as a determinant of the direction of the pallet will be brought.

2. HMI can monitor which components are active and count the number of pallets that enter and leave.

3. The system has been able to run properly and correctly even though the mechanical problem is not yet perfect.

4. Before making a miniature, we must prepare the concept in advance, so it is easy to design.

5. Understand the process and workings of the tools we make.

6. Understand the specifications of the components that we will use.

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