OMRON CP1E-NA20DR-A PLC Based Fish Scales and Manure Cleaner Prototype

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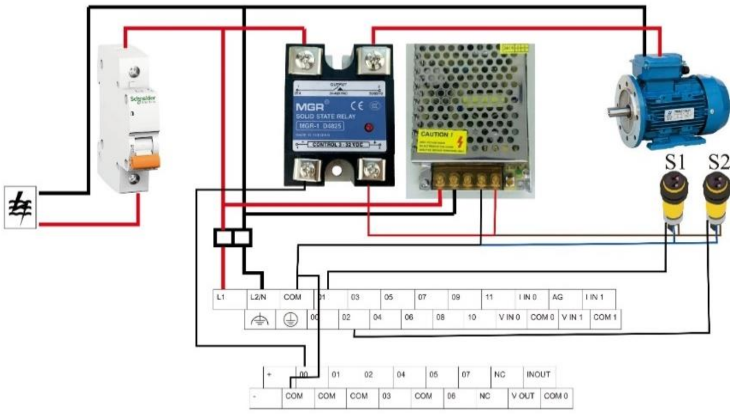
ABSTRACT



In fish removal, most of them still use manual cleaning tools whose main crust is human labor so that it can take a not fast time, especially if it is large-scale in cleaning fish and in terms of safety, it is very risky for injured hands due to manual cleaning tools. Aka it is necessary to have a fish cleaning device and clean the dirt automatically, Design and build a prototype of a fish scales and dirt cleaner based on PLC OMRON CP1E-NA20DR-A is a solution in cleaning fish scales and large-scale fish excrement. The way the tool works is that the operator will put the fish into the machine, after the fish is inserted, the sensors at the entrance of the fish will respond to the fish by sending a signal to the PLC so that the PLC will turn on the induction motor as the main crust of the machine, after the engine starts, the fish will start to clean the scales and dirt using a knife that has been designed to be used on the machine. Researchers used three fish samples in machine performance experiments to find out how efficient the process of combing and cleaning the dirt was compared to using manual cleaning. The results show that the tool has worked as a whole in scouring and cleaning the dirt as desired by the researcher.

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1. INTRODUCTION

The level of fish consumption, especially in our country Indonesia, is very high, resulting in an increased demand for fresh fish, especially in restaurants that serve fish dishes. In order to meet the needs of restaurants and customer demands, buyers usually prefer to purchase fish that have been cleaned, particularly removing the scales and dirt. If a customer orders or wants to buy a fish with scales, it would require extra effort and time to clean the scales, especially for large-scale fish orders. Therefore, there is a need for a tool that can automatically clean the fish scales and dirt to speed up the fish processing [1].

Therefore, there is a need for a fish scale and dirt remover tool that can expedite the process of cleaning fish scales and dirt, making the time used more efficient, reducing physical exertion, and minimizing accidents during the scaling process. The designed tool will be based on the PLC OMRON CP1E-NA20DR-A. The fish scale and dirt remover tool to be created will include a motor to drive the conveyor that carries the fish during the scaling process and a knife to slit the fish's belly to remove the dirt. This means that even if the fish still has scales when it is placed into the tool, it will be processed to obtain a clean and scaled fish. The tool will be designed to be enclosed so that the waste scales and fish dirt do not scatter everywhere during the cleaning process.

Previous research served as a reference for designing the tool, particularly a study on the design of a fish scale remover tool using a dynamo as the knife's driving force and battery power to facilitate scaling. In this research, they created a fish scaling tool with a dynamo as the driver for the scaling knife, which the operator manually directed to the desired parts of the fish's body [1].

Another study proposed the design and prototype of an automatic single-bore machine with a single-phase AC motor based on pneumatic control and PLC. The result of this research was the control of the single-bore machine with automation functions [2].

Similarly, another study focused on the application of proximity sensors as switches in an automatic lamp lighting system using a programmable logic controller. The result of this research was the replacement of manual switches with sensors for turning on the lights [3].

Another study proposed the design of an automatic lamp lighting system using a proximity sensor based on the PLC OMRON CP1E-E20SDRA. The result of this research was that the proximity sensor could be used as a switch replacement, and this tool could be utilized as an automatic lamp lighting system. Sensor 1 detected the presence of a metal object, causing lamp 1 to turn on, and sensor 2 detected the metal object, causing lamp 2 to turn on. The lamps would turn off after running for 10 hours or by manually resetting the system using push button 1 to turn off lamp 1 or push button 2 to turn off lamp 2 [4].

Another similar study proposed the design and construction of an automatic conveyor for an automatic sieving machine. The result of this research was that the sieving machine would move automatically when the limit switch detected the presence of sand, but it would gradually decrease in speed until it stopped if no sand was detected [5].

2. METHODS

2.1. Theoretical Framework

The fish used in this study is the tilapia, which is a freshwater fish and a significant source of animal protein, with a protein content ranging from 15.32% to 18.18%. It is highly sought after as a food source due to its wide distribution in various regions [6]. The benefits of tilapia fish include preventing prostate cancer, supporting the immune system and thyroid function, promoting heart health, aiding in growth and development, maintaining bone health, managing weight, delaying aging, and supporting brain health [7].

A proximity sensor, also commonly known as a proximity switch, is an electronic sensor that can detect the presence of an object without direct contact. In this research, a photoelectric proximity sensor is used, which detects objects using optical light elements [8].

An induction motor is an AC (alternating current) electric motor in which the rotation of the rotor is not synchronous with the rotating magnetic field of the stator. The difference in rotational speed between the rotor and the stator field is referred to as slip [9]. Induction motors operate based on electromagnetic induction between the stator winding and the rotor winding [10].

A relay is an electrical component that operates as a switch. Relays are used to control circuits with low-power signals [11]. Relays play a crucial role in electronic and electrical circuit systems by activating devices that require high current without direct connection to the low-current control device [12].

A PLC (Programmable Logic Controller) is a programmable control unit used to control various electromechanical processes, commonly used in manufacturing industries [13]. In this study, the PLC used is the OMRON CP1E-NA20DR-A [14]. In principle, a PLC works by receiving data signals from external input devices in the controlled system through input modules [15].

2.2. System Design

This research can be completed through several processes, including system design, equipment determination, and result analysis [16]. The first step is to design the system, as shown in Figure 1.

The system design in Figure 1 serves as a reference for creating the tool. The detailed explanation of the tool design is as follows: the fish entry point is indicated at number 1, and sensors will be placed there. Once the fish enters, it will undergo the scaling process. The design of the scaling knives is indicated at numbers 6, 7, and 8. To prevent the fish from being scattered or escaping during the scaling process, a fish holder is provided at number 9. The fish gutting knife is indicated at number 10. After the fish completes the scaling and cleaning process, it will exit through number 2, where another sensor is located. Number 4 represents the storage box for the control components.

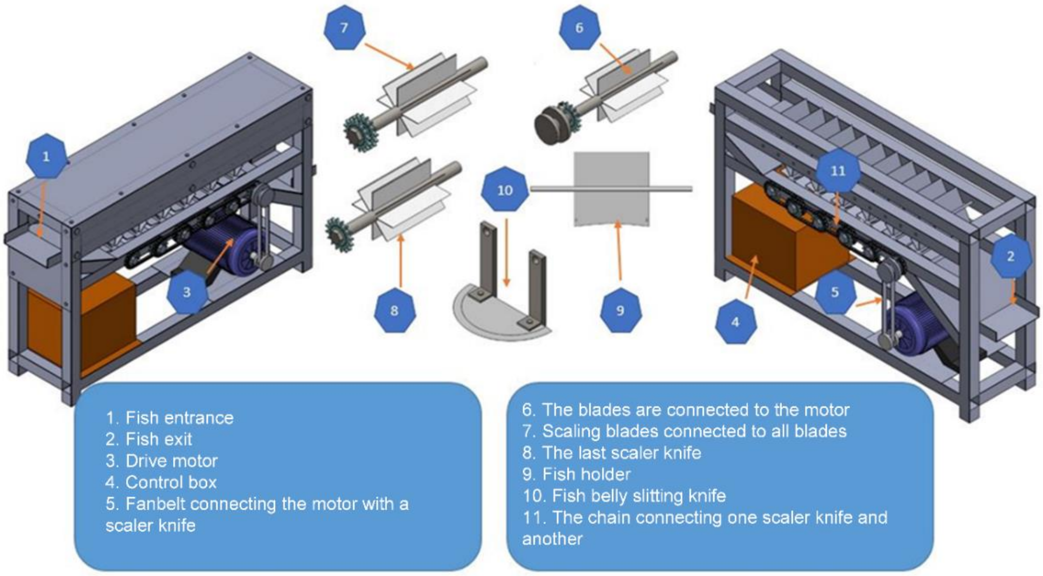


Figure 1. System Design

2.3. System Design

2.3.1. Block Diagram

The block diagram is a part of the principles and performance of a system in designing a tool. The overall functioning of the tool to be created is represented in the system's block diagram [17]. In this case, the tool will be in an active state when the sensor detects the presence of a fish passing through it. The sensor will send an ON command to the PLC, which will then activate the relay. When the relay is active, the induction motor will start rotating. Once the motor is running, the fish scaling and dirt cleaning process will begin or function until the scaling process is complete, after which the tool will automatically stop. The block diagram design can be seen in Figure 2.

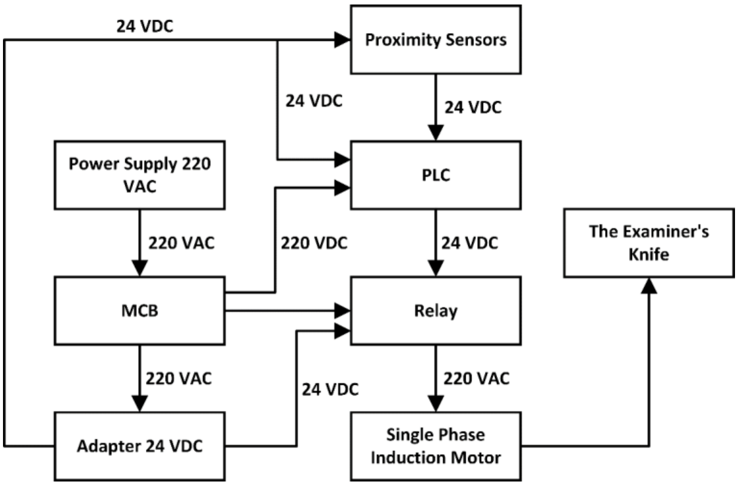


Figure 2. Block Diagram

2.3.2. Wiring Diagram

The hardware components, consisting of sensors as input and an induction motor as output, are connected to the PLC, as shown in Figure 3.

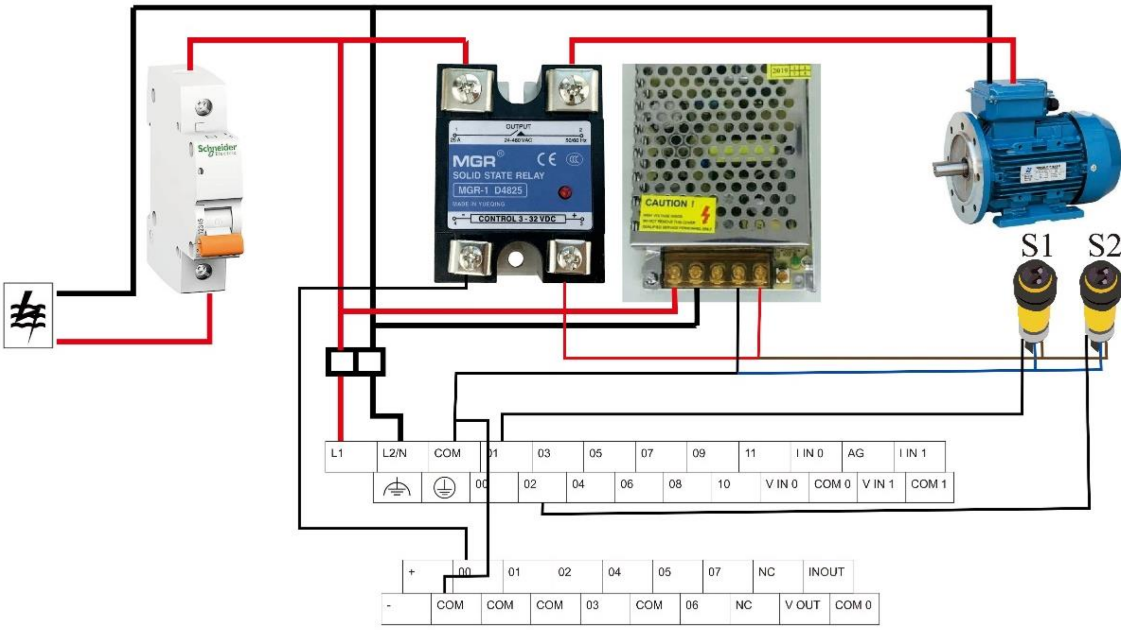


Figure 3. Wiring Diagram

2.4. Algorithm

A flowchart, also known as a flow diagram, is a type of diagram that represents the sequence of algorithmic or instructional steps in a system [18]. The system algorithm is shown in Figure 4, where if the first sensor detects the presence of a fish, the scaling knife motor will start rotating. Conversely, if the second sensor detects the presence of a fish, the motor will stop rotating, causing the scaling knife to stop as well.

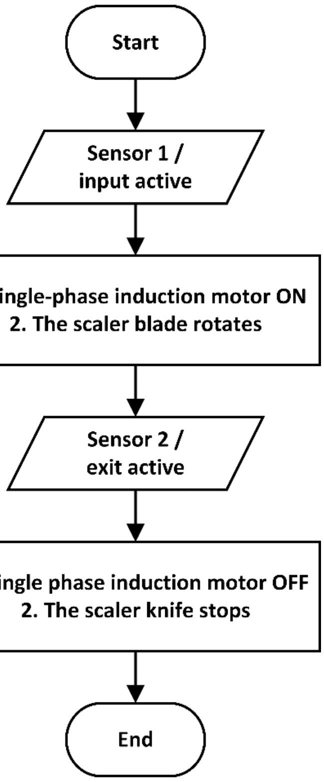
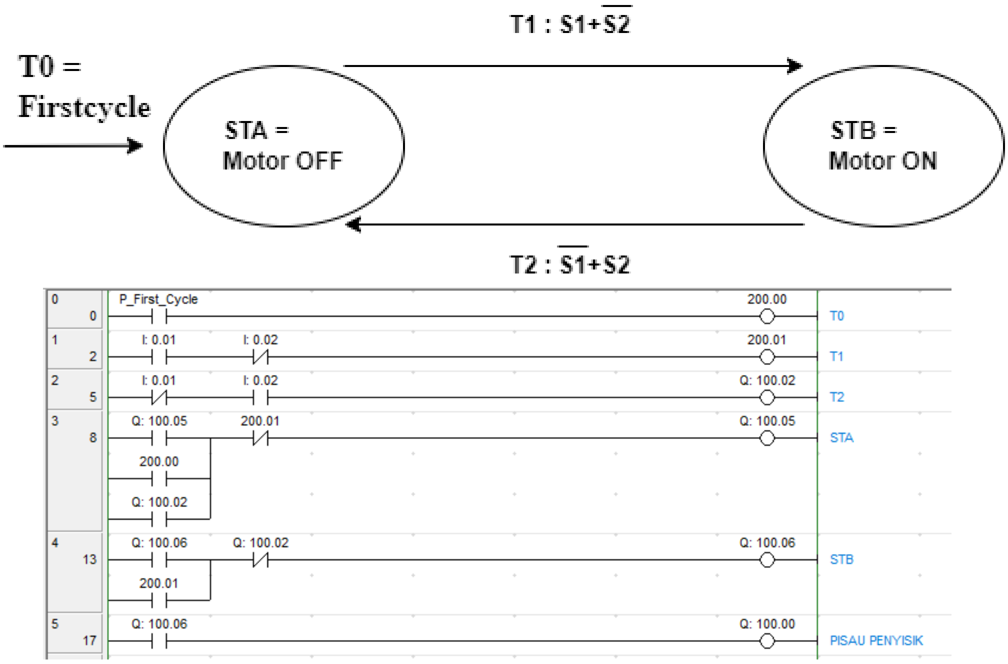


Figure 4. Flowchart of Fish Scale and Dirt Cleaner

After designing the flowchart, the next step is to design a state diagram. A state diagram is a graph that represents the events or states of a system in the form of circles. These circles are referred to as "states". Each state contains input and output information of the system [19][20]. The result of the state diagram design is shown in Figure 5. There are two conditions used in the state diagram: the OFF state (STA) and the ON state (STB) of the motor. The T0 condition represents the initial state to start the system. T1 represents the active state of sensor 1, where it detects the presence of a fish and switches the motor from OFF to ON. T2 represents the active state of sensor 2, where it detects the presence of a fish and switches the motor from ON to OFF.



Gambar 5. Program PLC

3. RESULT AND DISCUSSION

3.1. Proximity Sensor Testing

The proximity sensor is used to detect the presence of fish. The testing of the infrared proximity sensor aims to determine whether the sensor can function to detect the presence of fish or not, as well as to test the sensor's sensitivity to light and its impact on the performance of the infrared proximity sensor. The sensor testing can be seen in Figure 6 (a) and (b).

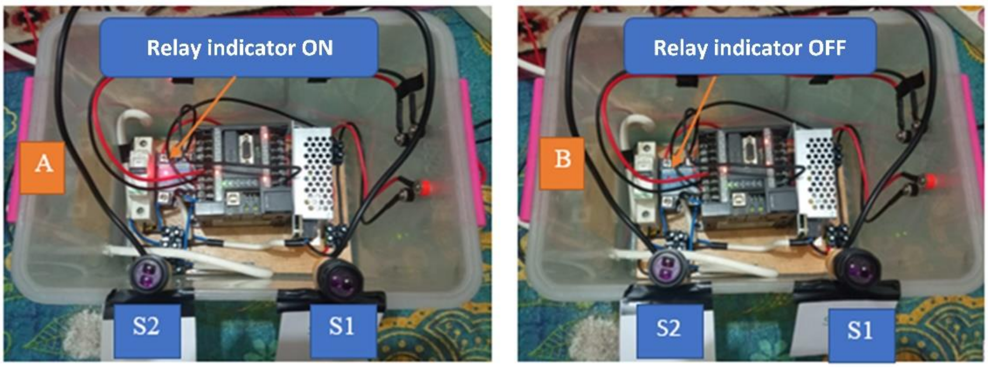


Figure 6. The sensor detects an object (fish)

3.2. System Testing

The system testing aims to determine whether the device functions properly or if there are any errors. This testing involves three samples of tilapia fish that will be cleaned of scales and dirt can be seen in Figure 7.

Based on the experiments in Tables 1-8, with three samples of tilapia fish, it was found that for the first fish, three rounds of the cleaning process were needed to achieve optimal results. Similarly, the second fish required three rounds of cleaning to achieve maximum results, while the third fish only required two rounds of the cleaning process to achieve maximum results.

Figure 7. Fish scale and dirt cleaner device

Table 1. Experiment Results for the First Fish, Side 1

No	First fish side 1	Size (cm) L	Size (cm) W	Clean	Time (s)
1		22	8	60%	3
2		22	8	80%	2
3		22	8	95%	3

Table 2. Experiment Results for the First Fish, Side 2

No	First fish side 2	Size (cm) L	Size (cm) W	Clean	Time (s)
1		22	8	70%	3
2		22	8	80%	3
3		22	8	95%	3

Table 3. Experiment Results for the First Fish, Side 3

No	First fish side 3	Size (cm)		Clean	Time (s)
		L	W		
1		22	8	10%	3
2		22	8	15%	2
3		22	8	20%	3

Table 4. Experiment Results for the Second Fish, Side 1

No	Second fish side 1	Size (cm)		Clean	Time (s)
		L	W		
1		21	9	60%	3
2		21	9	80%	2
3		21	9	95%	3

Table 5. Experiment Results for the Second Fish, Side 2

No	Second fish side 2	Size (cm)		Clean	Time (s)
		L	W		
1		22	8	65%	3
2		22	8	70%	2
3		22	8	95%	3

Table 6. Experiment Results for the Second Fish, Side 3

No	Second fish side 3	Size (cm) L	Size (cm) W	Clean	Time (s)
1		22	8	50%	3
2		22	8	80%	2
3		22	8	85%	3

Table 7. Experiment Results for the Third Fish, Side 1

No	Third fish side	Size (cm) L	Size (cm) W	Clean	Time (s)
1		19	8	80%	3
2		19	8	95%	2

Table 8. Experiment Results for the Third Fish, Side 2

No	Third fish side 2	Size (cm) L	Size (cm) W	Clean	Time (s)
1		19	8	80%	3
2		19	8	95%	2

4. CONCLUSIONS

Based on the test results, the collected data, and observations, the prototype of the fish scale and dirt cleaner device was successfully designed and implemented using the previously created state diagram and ladder programming with the PLC OMRON CP1E NA20DR-A. The device was able to work automatically with the assistance of an operator who inputs the fish. During the testing, three fish were used, and for the first fish, the maximum result was achieved by performing the insertion and cleaning process three times on each side of the fish. The second fish also required three rounds of insertion and cleaning on each side for optimal results. As for the third fish, two rounds of insertion into the machine yielded maximum results. The time required for each insertion and cleaning process was 2-3 seconds, making it highly efficient in terms of time. The device has a high level of safety as it is designed with enclosed framework in all its parts.

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