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IMPLEMENTATION OF SMART FISH FEEDER SYSTEM IN DETERMINING FISH FEED WEIGHT USING LOAD CELL SENSOR BASED ON PROGRAMMABLE LOGIC CONTROLLER

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Abstract
Fish farming is an important sector in meeting society's food needs. One of the key factors for its success is accurate feeding management, as manual methods (handfeeding) often cause problems such as overfeeding that pollutes the water or underfeeding that hinders fish growth. This study aims to design and implement a smart fish feeder system based on the Siemens S7-1200 PLC with a half-bridge load cell sensor as a feed weight parameter. Thesystem is integrated with Node-RED as a real-time remote monitoring and control interface via Modbus TCP/IP communication. The system design includes PLC programming using ladder diagram, load cell integration for feed weight measurement, and Node-RED dashboard development. Calibration was carried out by comparing load cell readings with a standard scale to obtain accuracy levels. The test results show that the load cell can measure feed weight with an average error of 1.9–2%, resulting in a system accuracy of approximately 98%. The system also successfully executed feed dispensing according to the predefined schedule, although slight deviations occurred at smaller loads. In addition, the Node-RED dashboard effectively displayed real-time monitoring data of feed weight and system status. Therefore, the developed smart fish feeder system can improve efficiency, accuracy, and practicality in fish feeding, offering a practical solution to support the productivity of aquaculture.

Keywords: *Smart fish feeder; Siemens S7-1200 PLC; Load cell; Node-RED; Modbus TCP/IP*

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INTRODUCTION

One of the basic needs of society is in the field of food. Fisheries cultivation is one factor in meeting the needs of the community. The increasing productivity of fisheries is accompanied by a rising demand in the fisheries sector. The feeding system helps to increase productivity [1]. The feeding system used is still employing handfeeding. With the increasing market demand for fish farming products, productivity is expected to improve in various ways, one of which is by applying technology in the production process [2].

Feeding is one of the aspects that influence fish farming; high-quality feed must be provided regularly and according to the fish's needs. Providing too little feed will result in suboptimal fish growth due to nutritional deficiencies. Conversely, excessive feeding will cause pollution from leftover food. By providing adequate feed, these problems can be avoided [3].

In previous research, a study on a smart fish feeder was conducted to address the aforementioned problems. Related to research [13], which designed a fish feeder system based on a load cell and Real Time Clock (RTC) for aquaponic systems. This system functions to weigh feed using a load cell and uses an RTC to schedule feeding times. The system is connected to the Internet of Things for monitoring feeding times, feed weight, water quality, and utilizes the Autoregressive Integrated Moving Average (ARIMA) model to predict feed requirements based on fish weight growth trends. Meanwhile, in research [1], the study designed a smart fish feeder based on a load cell with an ESP32 installed on an autonomous boat with a main capacity of 2.5 kg. This research is also connected to the Internet of Things for monitoring the remaining feed capacity.

Based on the background above, to address the challenges in the aquaculture sector related to increasing production, the author will conduct research on a smart fish feeder entitled ***"****IMPLEMENTATION OF A SMART FISH FEEDER SYSTEM IN DETERMINING FEED WEIGHT USING LOAD CELL SENSORS BASED ON A PROGRAMMABLE LOGIC CONTROLLER.****"*** With this research, it is expected to become one of the solutions to improve productivity in the fisheries sector.

RESEARCH METHODS

This research was conducted from April to August 2025. This system is designed to automatically weigh, regulate, and distribute fish feed. The working process is modeled to include feed weight detection using a half-bridge load cell, data processing by a Siemens S7-1200 PLC, and smart fish feeder control according to the predetermined schedule. Sensor reading data is sent to Node-RED via Modbus TCP/IP communication for real-time monitoring. This design uses Siemens S7-1200 CPU 1211C PLC hardware as the main controller, a half-bridge load cell for weight measurement, JY-S60 weight amplifier as the signal amplifier, 24 VDC power supply, relays, and Raspberry Pi as the Node-RED server. In this study, to calibrate the load cell sensor based on the PLC, in the Scale on Normx to determine the maximum Normx value, use the following equation:

$$\boldsymbol{NORM_X} = \frac{(\boldsymbol{Value-MIN})}{(\boldsymbol{MAX-MIN})} \text{.............................(1)}$$

NORM_x = Value output from *NORM_x*
Value = Value output sensor
MIN = Value minimum output sensor
MAX = Value maximum output sensor

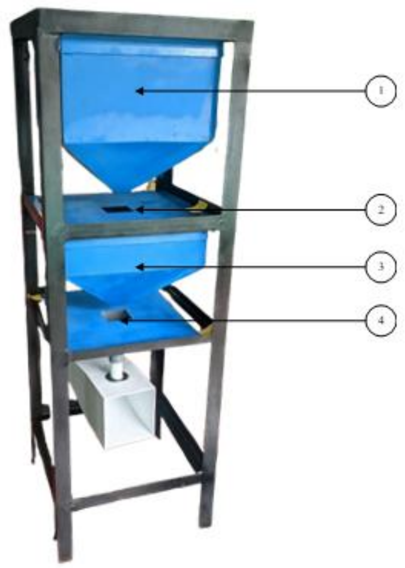
In this study, for the comparison of load cell calibration values with a standard digital scale. Using equation (2) to determine the error value, as follows:

$$\boldsymbol{Error}\ (\%) = \frac{\boldsymbol{Actual\ Load - Reading\ Result}}{\boldsymbol{Actual\ Load}}\ \boldsymbol{x}\ \boldsymbol{100}\% \text{.....(2)}$$

RESULT AND DISCUSSION

A. Sistem Design smart fish feeder

In this study, a smart fish feeder was successfully designed to determine the portion based on the feed weight. The following is the design of the smart fish feeder that was created:

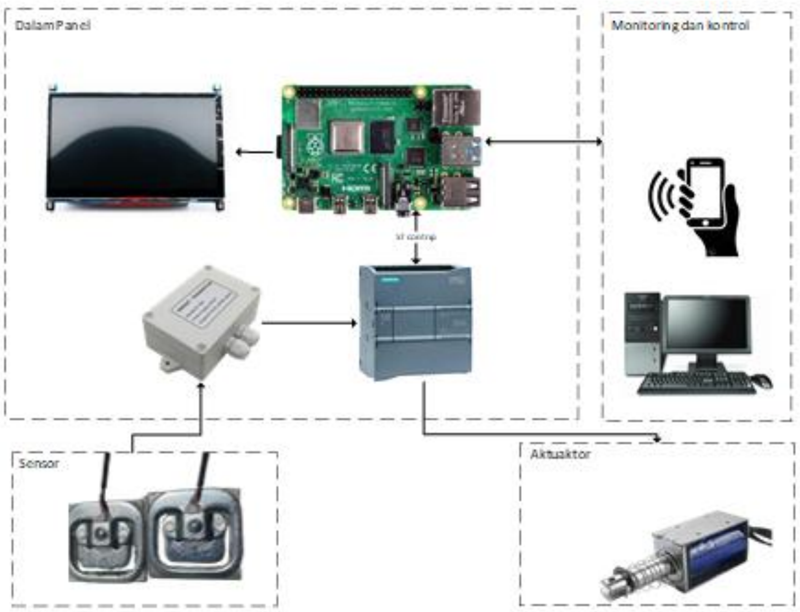


Gambar 1. Desain smart fish feeder

JMM :
Journal of Mechanical and Manufacture
[Vol. 4, No. 2, April, 2025, pp. 75-83]

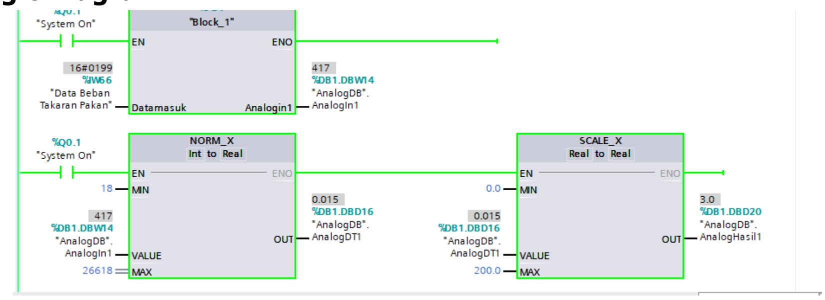
No	Description	Funition
1	Main feed storage	To store fish feed
2	*Solenoid push-pull*	To channel feed from the main container to the dispenser
3	Measuring Container	To measure feed output as desired
4	*Solenoid push-pull*	To channel feed from the measuring hopper to the dispenser

B. Design Bolck Diagram



Fictue 2. *Design Block Diagram*

C. Ladder Logic Diagram

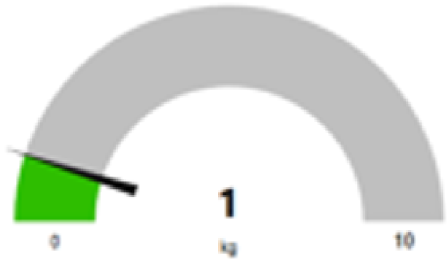


Ficture 3. Hasil *scaling* sensor *load cell*

By using equation (1), the maximum value of $Normx_x$ is obtained, which is 26618

Load cell sensor calibration results on the main container.

In this calibration, a standard weighing instrument was used to determine the accuracy of the load cell sensor



Ficture 4. Main tank calibration result

Thus, the calibration results for the load cell sensor on the main container are obtained in Table 1:

No	Actual Load (kg)	Value sensor (kg)	Difference(kg)	*Error* (%)
1	1	1	0	0,0
2	2	2,2	0,2	10,0
3	3	3	0	0,0
4	4	4	0	0,0
5	5	5,2	0,2	4,0
6	6	6,1	0,1	1,7
7	7	7,2	0,2	2,9
8	8	8,2	0,2	2,5
9	9	9,3	0,3	3,3
10	10	10,3	0,3	3,0
11	11	11,2	0,2	1,8
12	12	12,3	0,3	2,5
13	13	13,3	0,3	2,3
14	43	43,1	0,1	0,2
15	46	46,2	0,2	0,4
16	49	49,3	0,3	0,6
17	56	56,2	0,2	0,4
18	59	59,5	0,5	0,8
19	62	62,6	0,6	1,0
20	95	95,2	0,2	0,2
Average Error				1,9

Table 1. Calibration results in the main reservoir

In Table 1. To determine the error value, equation (2) is used. The following is the graph comparing the actual values with the load cell sensor readings in the main container in Figure 5:

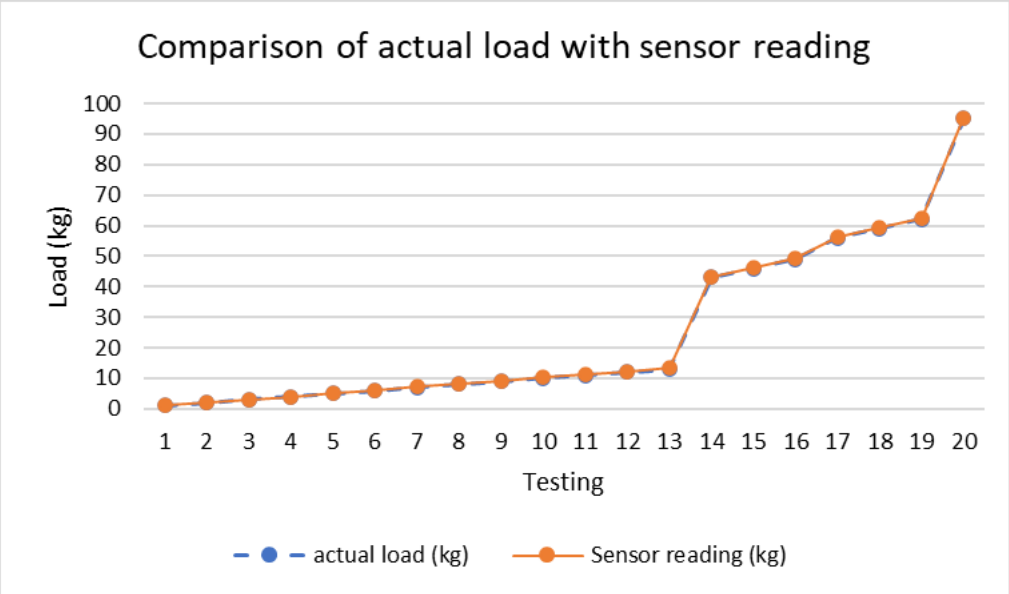


Figure 5. Comparison graph of actual load with sensor readings

In Figure 5, the load cell sensor shows fairly consistent performance, especially under medium and heavy loads, with an average error of 1.9%. The comparison of error values is shown in Figure 6:

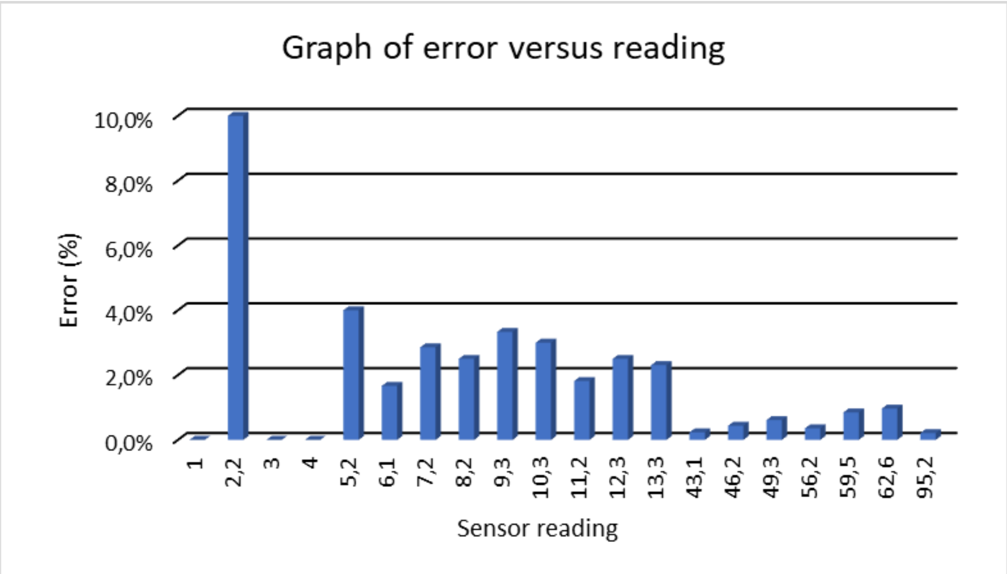


Figure 6. Error graph in readings

In Figure 6, it shows that the sensor reading tends to have a high error value at small loads.

D. Load cell sensor calibration results on the scale

During the load cell sensor calibration, the scale matches the container.

Figure 7. Measurement calibration results

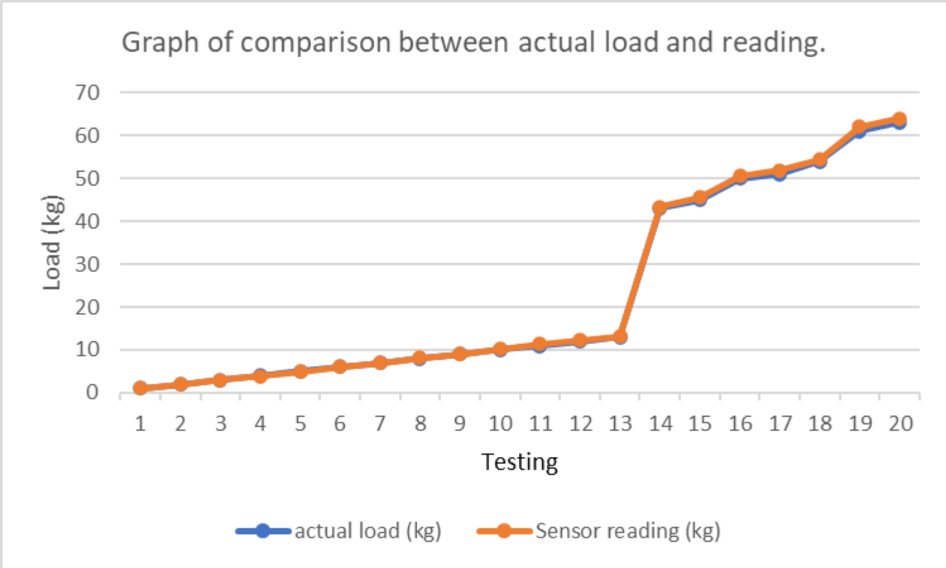
Thus, the calibration results for the load cell sensor on the scale are obtained in Table 2:

Table 2. Calibration results on the scale

No	Actual Load (kg)	Value sensor (kg)	Difference (kg)	*Error* (%)
1	1	1,1	0,1	10
2	2	2	0	0
3	3	3	0	0
4	4	3,8	-0,2	5
5	5	4,9	-0,1	2
6	6	6	0	0
7	7	7	0	0
8	8	8,1	0,1	1
9	9	9	0	0
10	10	10,2	0,2	2
11	11	11,3	0,3	3
12	12	12,2	0,2	2
13	13	13,2	0,2	2
14	43	43,4	0,4	1
15	45	45,6	0,6	1
16	50	50,5	0,5	1
17	51	51,9	0,9	2
18	54	54,3	0,3	1
19	61	62	1	2
20	63	64	1	2
Average *error*				2

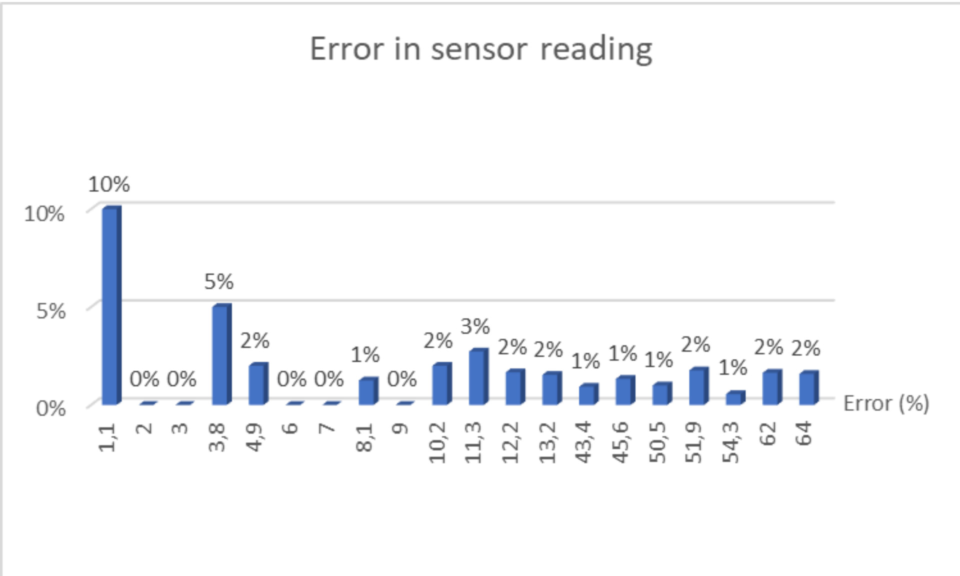
In Table 2. To determine the error value, equation (2) is used. The following are the comparison graph results of the actual values with the load cell sensor readings on the scale in Figure 8:

JMM :
Journal of Mechanical and Manufacture [Vol. 4, No. 2, April, 2025, pp. 75-83]



Ficture 8. Comparison chart of actual load with sensor readings

Based on Figure 8, the sensor readings and actual load are not significantly different; however, at low loads, the error value is higher compared to high loads. The following is the error graph in Ficture 9:



Ficture 9. Comparison graph of actual weight and error

Testing the time and performance of the smart fish feeder system

In testing the time and performance of the smart fish feeder, the system was tested for automatic active times at 10:00, 12:00, and 15:00. The test results are shown in Table 3:

NO	EXECUTION TIME	SET POINT (kg)	MEASURMENT RESULT (kg)
1	10.00	0,5	0,6

2	12.00	0,5	0,7
3	15.00	0,5	0,8

Table 3. Performance test of smart fish feeder

Based on a thickness of 3. The performance test results are shown in Figure 10:

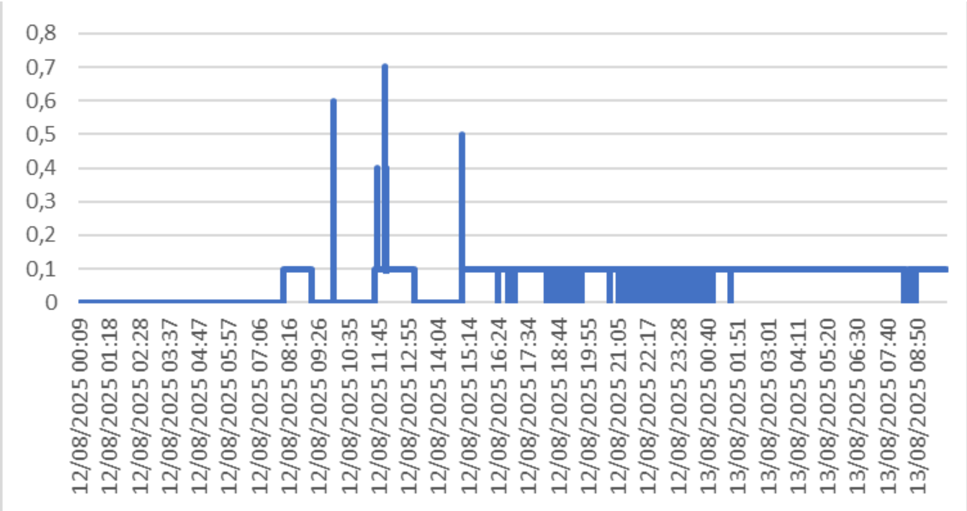


Figure 10. Performance test results of the smart fish feeder

Figure 10 shows that the lower part tends to have measurement results exceeding the specified set point and noise when unloaded.

CONCLUSION

ConclusionBased on the results of the research that has been discussed, it can be concluded that:1. The implementation of this smart fish feeder can determine the feed weight using a half-bridge type load cell sensor based on PLC.2. The testing results on the half-bridge type load cell sensor obtained an accuracy of around 98% with an average error of 1.9%-2%.3. Monitoring and control of fish feed on the smart fish feeder are carried out using the Node-RED dashboard.B. SuggestionsTo further develop this smart fish feeder system in future research, several suggestions are as follows:1. Replace the actuator for dispensing feed with one that can be adjusted to open and close, and has strong opening/closing power.2. The half-bridge type load cell sensor is less suitable for low loads; use a different type of sensor for low loads.

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JMM :
Journal of Mechanical and Manufacture [Vol. 4, No. 2, April, 2025, pp. 75-83]

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