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Design A Real-Time Fish Feeding Control System on The Internet of Things

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Abstract: Scheduled feeding is very important in fish farming. Proper and scheduled feeding will increase yields and pond water quality. Fish farmers often ignore feeding according to fish needs. So that it worsens the water quality, as a result the yield and survival of fish decreases. This problem can be overcome by creating a system that can provide feed based on the ideal dose of feed to fish, in order to reduce pollution of pond waters and increase fish survival. This study aims to determine the specifications of accuracy and precision of laboratory scale systems and specifications of accuracy of field test scale systems. The research method used is engineering research method. The data obtained is measured by direct and indirect measurement techniques. This system uses wemos D1 mini, arduino cc, blynk software, RTC DS3231, load cell, DS18B20 and servo. The laboratory scale accuracy and precision specifications of the feeding control system on the measurement of the weight of the system tube feed are 99.70% and 99.80%, on the system container are 98.87% and 98.87%, while on the system temperature measurement are 98.10% and 97.96%**.** The accuracy value of the field test scale is 98.38%.Based on the results of testing the accuracy and precision of the fish feeding device, it is found that the design of a real time fish feeding system based on the internet of things can be used in monitoring and automatic feeding activities.

Keywords: Blynk, Control System, Fish Feeding, Internet of Things

1. Introduction

Fish farming activities are one of the profitable business prospects, especially if cultivation is carried out in the right way and process according to applicable rules and regulations. Proper feeding and according to the needs of fish, will help in increasing yields. In Indonesia, fish commodities that are widely cultivated are tilapia, catfish, and goldfish [1,2]. In fish farming activities, feeding must pay attention to the feed schedule. In addition, pond cleanliness and pond maintenance must also be maintained [3]. This will affect the yield and survival rate of fish.

Feed is an important element needed in fish farming. Feed is one of the food sources needed in the growth and survival of fish [4]. Fish survival is influenced by water quality [5]. One of the physical parameters monitored in the fish farming process is temperature. The temperature factor affects the metabolic process of fish. If the temperature is not ideal, it will affect fish survival such as death [6]. The temperature range that provides optimal growth in freshwater fish is 25ºC-30ºC [7]. If the water is polluted it will interfere with the growth of cultured fish [6]. Polluted water can be caused by leftover feed and fish waste. leftover fish feed and feces deposits can increase organic compounds in the water [8].

An increase in organic compounds causes high levels of ammonia which indicates polluted waters [8]. Organic compounds that precipitate can affect fish appetite, due to reduced oxygen binding capacity in the blood [9]. Decreased appetite will result in slow fish growth [10]. Ways that can be done to reduce levels of organic compounds can be done by providing appropriate feed based on the percentage of fish feed requirements. the percentage of fish feed requirements is adjusted to the biomass of the fish. Each type of fish has a different percentage of ideal feed. Tilapia is given as much as 3% with a frequency of feeding twice a day [11]. The feeding rate for goldfish is 3% in one feeding [12]. As for catfish, feeding 5% of the fish biomass is the best dose and produces a fish survival rate of 100% [13] with the frequency of feeding done three times a day [14].

In previous research, an Android-based automatic fish feeder has been designed. This tool uses the ESP8266 MCU Node as IoT to work remotely with feed that is given automatically based on the feeding schedule. In addition, this research can determine the amount of feeding and the level of fish satiation using a load cell and ADXL335 accelerometer sensor. The weakness of this tool is that fish satiation can occur incompletely, so that feed will continue to be given as long as the fish are still actively moving. In addition, this tool cannot work automatically based on the feed schedule [15]. Another study also created a system that can provide feed based on feed time. However, feeding is not carried out based on the percentage of fish feed requirements [4].

Based on the disadvantages of previous research, a system was developed that can control feeding based on the percentage of feeding. The research was conducted by designing a real time fish feeding control system based on the internet of things (IoT). The system is designed to be able to provide feed based on the percentage of feeding and fish biomass. In addition, there is a measurement of temperature variables that play a role in helping the metabolic process of the fish body and increasing fish survival. The purpose of this research is to determine the performance specifications, accuracy specifications and precision of the system on a laboratory scale and the accuracy specifications of the system design of a real time fish feeding control system based on the internet of things (IoT) on a field test scale.

The system is designed to measure feed weight and water temperature in the pond. The feed can be fed automatically based on the feeding schedule. The results of the feed issued are adjusted based on the percentage of feed requirements. The percentage of feed given is based on the weight of the fish and the stocking density of the fish. the design of the real time fish feeding system based on the Internet of Things, is composed of the Wemos D1 mini microcontroller, RTC DS3231, load cell, servo, DS18B20 and Blynk software.

2. Materials and Method

The research was conducted using the engineering method. The engineering method is a method used to design a system that has a new contribution in its form or process and apply science into a design in order to obtain system performance in accordance with the specified requirements [25,26]. The stages of research implementation start from literature search, research design, data collection and data analysis. In research design, the system is designed in such a way that it can work in accordance with the research objectives. System testing was carried out at CV. Family Pisces Group Padang Utara. System testing was carried out at CV Family Pisces Group North Padang. The experiment was conducted by selecting catfish as samples. The feed given was 5% of the average weight of the sample and stocking density with a frequency of feeding three times a day at 09:00, 14:00 and 19:00. The experiment was conducted for 4 days at CV. Family Pisces Group. The system is built from several components. For details of the components used can be seen in Figure 1.

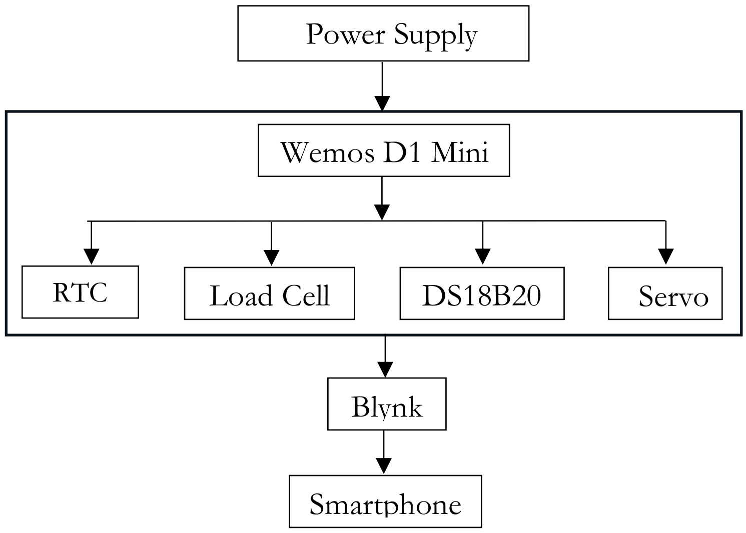

Figure. 1 System Block Diagram

In Figure 1, it can be seen that the system components work in the presence of a power supply. The supporting components such as RTC, load cell, DS18B20 and servo are programmed into the wemos D1 mini. After the hardware components work in accordance with the expected purposes, then the blynk IoT library is included so that the system can work with an internet connection. The internet connection used between the system and the smartphone must be equalized, so that data or information can be sent and displayed on the smartphone. The circuit components and microcontroller are placed in a small box under the system tube. The system is designed to be controlled and monitored via a smartphone. The circuit component and microcontroller can be seen in Figure 2.

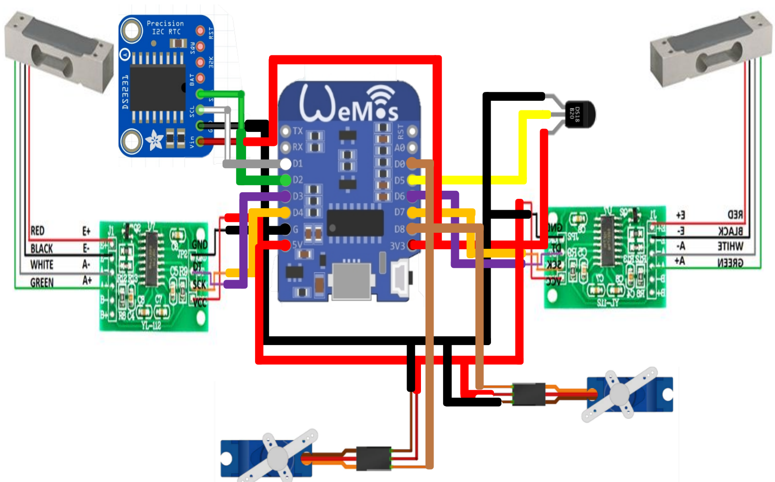

Figure 2. Fish Feeding Control System Component Circuit

In Figure 2 The components of the tool are assembled in accordance with the research objectives. Furthermore, components that have previously been programmed separately will be combined with all component programmes and blynk programmes. The system is designed to be controlled and monitored via a smartphone. The information and component output data displayed on the smartphone can be seen in Figure 2.

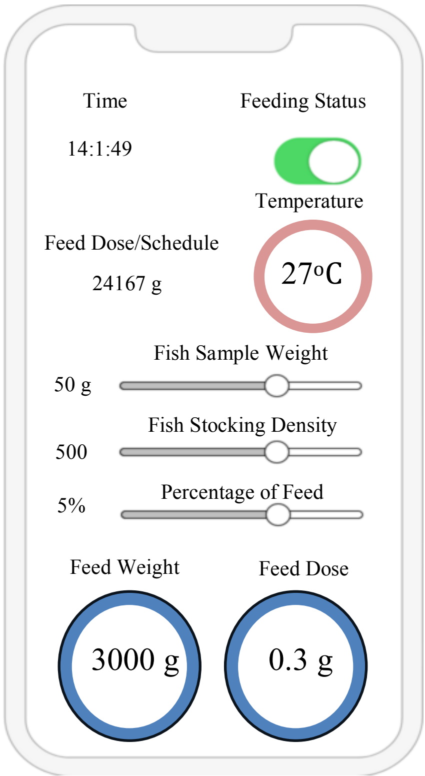

Figure 3. System Display on Smartphone

Based on Figure 3, the feeding system can be controlled via a smartphone. When the time has been set, the system automatically releases the required feed according to the results of the calculation of the ideal feed dose/schedule. The provision of ideal feed doses in the system is based on the percentage of feeding, the average weight of the sample and the stocking density of fish in the pond. Before entering the feeding schedule, the features of fish sample weight, fish stocking density, and feeding percentage must first be set so that the system releases feed in accordance with the calculation of the ideal feed rate. The feed that is released will be measured by weight using a load cell that has been installed in the system container. Feed availability information is displayed according to the weight measured by the system tube load cell. In a separate feed weight measurement, the system also displays the current pond water temperature.

The system works starting with input the value of the weight of the sample fish in the fish sample weight, input the amount of fish stocking solids in the pond, input the percentage of fish feeding required, and finally input the amount of feed weight required in the feed dose. This information is entered before entering the feed schedule. next will be processed when the feed time is appropriate. The system work automation process starts if the feed schedule time is in accordance then the system status on feed in the feed supply tube will fall on the feed container. the feed container will measure the required feed. When the weight of the feed is in accordance with the required amount, the container will automatically drop the feed according to the amount of feed that has been entered previously in the feed dose. The falling feed will correspond to the value of the calculation results of ideal feeding. after the feed is dropped, the system will be OFF.

After the system design works well, the next steps are data collection and data analysis. The results of testing data from the system are collected in the form of data tabulation. The data collected is testing data specifications of accuracy and precision of laboratory scale systems and specifications of accuracy of field test scale systems. The data obtained is then processed through the calculation of the accuracy and precision of the system. The accuracy and precision test are carried out to see how much the percentage of similarity and closeness of the system measurement data with the data obtained from standard measuring instruments. Accuracy and precision data is obtained through comparison of system measurement results with standard tool measurement results[18].

3. Results and Discussion

Measurement and analysis data obtained from the design of a real time fish feeder control system based on the Internet of Things is in the forms of data on the specifications of the accuracy and precision of laboratory-scale systems and the specifications of the accuracy of system measurements in field tests at CV. Family Pisces Group. In the specification of the accuracy and precision of the laboratory scale system, the system measurement test data is compared with the measurement results of standard measuring instruments. In the specification of the accuracy of the field scale test system, the test results obtained in the field are compared with standard measuring instruments. The data obtained is then calculated to get the percentage value of the accuracy and accuracy of system measurements. The results of the system design can be seen in Figure 3.

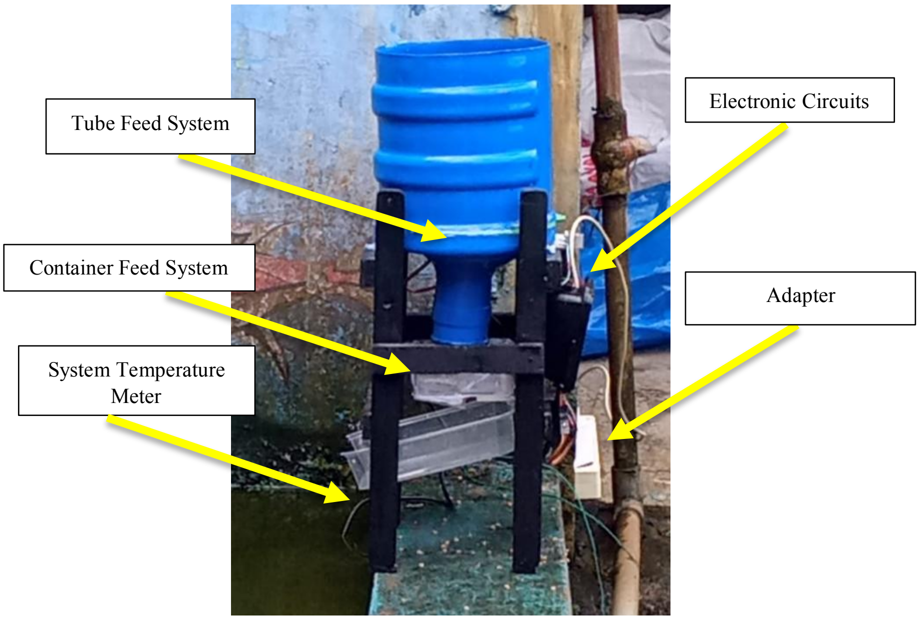

Figure 4. Design of a Fish Feeder System

Based on Figure 4, the system is designed with a length of 18 cm, a width of 17 cm and a height of 50 cm. the system is divided into a support part made of wood. The tube part of the system is made of 0.05 cm plastic. The feed container part of the system is made of plastic with a thickness of 0.05 cm and is 10 cm long, 9.8 cm wide and 4.5 cm high. the electronic circuit is placed in a plastic box measuring 11 cm long, 8.5 cm wide and 4 cm high. adapters are used to connect the system with the power supply so that electronic components can work. The system can measure the temperature of the pond water using DS18B20 and display it on the smartphone screen. Fish feed supplies can be put into the system feed supply tube, the weight of the feed supply is measured using a load cell and the results of the measurement data can be seen on a smartphone. The feed in the system container will be measured based on the amount of feed needed according to the amount of calculation using the load cell. The results of the calculation or the amount of feed required can be seen on the smartphone display in the feed dose/schedule section.

When the feed has not reached the set time, the system is off. As long as it has not entered the feeding schedule, it will input the total weight of the fish sample, which is 21 grams, the number of fish stocking density is 150 fish and the percentage of feeding is 5%. Information on temperature, weight of feed supply and feed dose will continue to be displayed on the smartphone. When the time is in accordance with the feed schedule, the system automatically turns on so that the feed status becomes on. The valve on the feed tube moves to open, so that the feed in the system tube falls into the system container. When the feed in the system container weighs the ideal amount of feed, the system tube valve closes and the valve on the system container opens, then delays for 5 seconds and closes again.

The specification of the accuracy and precision of the system components on a laboratory test scale is carried out to determine the comparison of the system output value with standard measuring instruments. From the results of laboratory scale tests, data on the accuracy and precision of system components are obtained. Laboratory scale testing is carried out on the measurement of feed weight with digital scales and DS18B20 temperature measurements with mercury temperature thermometers.

Data collection of weight measurements on the system feed tube and system container was carried out five times with three weight variations. The weight variations used to measure the weight of feed in the feed tube are 265.60 grams, 110.60 grams and 103.60 grams. The weight variations used for testing weight measurements on the system container are 38.00 grams, 26.60 grams, and 18.70 grams. Table 1 is the measurement results will be compared with the weight measurement results using digital scales. The following is data on the accuracy of the measurement results of weight variations on the system tube.

Table 1. Measurement Accuracy Data of System Tube

No	Weight 1		Relative Accuracy (%)	Weight 2		Relative Accuracy (%)	Weight 3		Relative Accuracy (%)
	System (grams)	scales (grams)		System (grams)	scales (grams)		System (grams)	scales (grams)	
1	265.90	265.60	99.88	110.30	110.60	99.73	103.60	103.60	100.00
2	265.20	265.60	99.85	111.10	110.70	99.64	103.80	103.60	99.81
3	265.30	265.70	99.85	110.80	110.60	99.82	103.10	103.50	99.61
4	267.00	266.10	99.66	111.30	110.60	99.37	103.90	103.70	99.81
5	266.40	265.90	99.81	111.90	110.60	98.84	103.80	103.60	99.81
$\overline{m}$	265.96	266.18	99.81	111.08	110.62	99.48	103.64	103.94	99,80

Based on Table 1 the accuracy of weight measurement on the system tube has good measurement accuracy. Measurement of the weight of the system tube using a load cell sensor, the load cell works because of a change in position caused by changes in the resistance of the strain gauge instability due to the provision of output. The more measured objects, the smaller the change in resistance of the material tension[19]. Measurements were made with weight variations divided into weight 1, weight 2 and weight 3. In weight variation 1 the average relative accuracy value is 99.81%. In weight variation 2 the average relative accuracy value is 99.48%. In weight variation 3 the relative accuracy value is 99.80%. Weight measurement data 1 has the highest relative accuracy value with an average weight value of 265.96 grams. From the accuracy data that is almost approximating the actual measurement value. It can be indicated that the weight reading results of the system tube are approximating the weight reading results on the scales with an average relative measurement accuracy of 99.70%.

Table 2. Measurement Accuracy Data of System Container

No	Weight 1		Relative	Weight 2		Relative	Weight 3		Relative
	System (grams)	scales (grams)	Accuracy (%)	System (grams)	scales (grams)	Accuracy (%)	System (grams)	scales (grams)	Accuracy (%)
1	37.90	38.00	99.74	25.90	26.60	97.29	18.70	18.70	100
2	37.10	37.90	97.84	26.20	26.60	98.47	18.50	18.60	99.45
3	37.80	38.00	99.47	26.50	26.60	99.62	18.40	18.70	98.36
4	37.10	37.90	97.84	26.30	26.70	98.47	18.40	18.60	99.46
5	37.80	38.00	99.47	26.20	26.70	98.09	18.60	18.70	99.46
$\overline{m}$	37.54	37.96	98.87	26.22	26.64	98.39	18.52	18.66	99.35

Based on Table 2 the accuracy of weight measurement on the system container has a relatively good measurement accuracy. Measuring the weight of the system tube using a load cell sensor, when there is a change in the compressive force of the object, the load cell will read the change in position. Data on the accuracy of measuring the weight of the system container is obtained by comparing the measurement results of the weight of the system tube with the measurement results of the digital scale. The average relative accuracy value of the system container measurement at weight 1 is 98.87%. The average relative accuracy value of weight 2 is 98.39%. The average relative accuracy value of weight 3 is 99.35%. Of the three measured weight variations, the highest average relative accuracy value is in weight variation 3. The small value of the measured weight affects the calculation of the relative accuracy data. The average value of the relative accuracy of weight measurement on the system container is 98.87%.

Table 3. Measurement Accuracy Data of System Temperature

No	System Temperature Measurement (°C)	Temperature Measurement with a Mercury Thermometer (°C)	Relative Accuracy (%)
1	29.20	30.00	97.26
2	29.20	30.00	97.26
3	29.20	30.00	97.26
4	29.20	30.00	97.26
5	29.10	30.00	96.90
6	29.00	29.50	98.27
7	29.00	29.20	99.31
8	29.00	29.20	99.31
9	28.90	29.20	98.96
10	28.80	29.00	99.30
$\overline{T}$	29.06	29.61	98.10

Based on Table 3 to get data on the accuracy of system temperature measurements is made by comparing the system temperature measurement value with the measurement results using a mercury thermometer. From the measurements taken 10 times, the average accuracy value of the system temperature measurement is 98.10%. The temperature measurement value in Table 3 has decreased due to the measurement of water temperature carried out in the laboratory with the air conditioner on. So that it affects the value of the system temperature measurement results. however, the system temperature measurement reading can work properly.

Table 4. Measurement Precision Data of System Tube

No	Weight 1		Precision (%)	Weight 2		Precision (%)	Weight 3		Precision (%) (%)
	System (grams)	scales (grams)		System (grams)	scales (grams)		System (grams)	scales (grams)	
1	265.90	265.60	99.86	110.30	110.60	99.56	103.60	103.60	99.96
2	265.20	265.60	99.86	111.10	110.70	99.65	103.80	103.60	99.96
3	265.30	265.70	99.90	110.80	110.60	99.56	103.10	103.50	99.86
4	267.00	266.10	99.94	111.30	110.60	99.56	103.90	103.70	99.94
5	266.40	265.90	99.97	111.90	110.60	99.56	103.80	103.60	99.96
$\bar{m}$	265.96	266.18	99.90	111.08	110.62	99.56	103.64	103.94	99.94

Based on Table 4 the accuracy of the fish feeder system tube has good enough precision. The measurement results on weight variation 3 have a high percentage of precision compared to other weight variations. At weight 1 the precision is 99.90%. The precision of the weight variation 2 is 99.56%. The precision of weight variation 3 is 99.94%. From the calculation of the precision value of the system tube measurement obtained from the load cell output and comparing it with the scales measuring instrument. The average accuracy value of the weight measurement on the system tube is 99.80%. from the average results of the calculation of accuracy it can be said that the measurement of feed weight on the system tube is quite precise.

Table 5. Precision of Weight Measurement on System Containers

No	Weight 1		Precision (%)	Weight 2		Precision (%) (%)	Weight 3		Precision (%)
	System (grams)	scales (grams)		System (grams)	scales (grams)		System (grams)	scales (grams)	
1	37.90	38.00	98.77	25.90	26.60	98.55	18.70	18.70	99.03
2	37.10	37.90	99.04	26.20	26.60	98.55	18.50	18.60	99.56
3	37.80	38.00	98.77	26.50	26.60	98.55	18.40	18.70	99.03
4	37.10	37.90	99.04	26.30	26.70	98.17	18.40	18.60	99.56
5	37.80	38.0	99.30	26.20	26.70	98.17	18.60	18.70	99.03
$\bar{m}$	37.54	37.96	98.98	26.22	26.64	98.40	18.52	18.66	99.24

Based on Table 5, data on the precision of the weight measurement results of the feed container is obtained. From the results of measuring the weight of the system container, the average percentage value of the highest relative precision is 99.24%. The highest average percentage value of relative precision is at weight 3. At weight 1 has an average relative percentage of 98.98%. At weight 2 the percentage value of relative precision is 98.40%. From the calculation of the precision of weight measurement on the system container has a measured value close to the actual weight value. The average precision value of the feed weight measurement on the system container is 98.87%.

Table 6. System Temperature Measurement Precision Data

No	System Temperature Measurement (°C)	Temperature Measurement With a Mercury Thermometer (°C)	Precision (%)
1	29.20	30.00	96.76
2	29.20	30.00	96.76
3	29.20	30.00	96.76
4	29.20	30.00	96.76
5	29.10	30.00	96.76
6	29.00	29.50	98.48
7	29.00	29.20	99.17
8	29.00	29.20	99.17
9	28.90	29.20	99.17
10	28.80	29.00	99.79
$\overline{T}$	29.06	29.61	97.96

Based on Table 6, the system temperature measurement is repeated 10 times. From the results of system temperature measurements and the average system measurement results, the percentage value of the relative precision of system temperature measurements is 97.96. The calculation of the relative precision value indicates that the system temperature measurement is approximating the temperature measurement value using a standard mercury thermometer.

Table 7. System Measurement Results Field Test Scale

Day	Feed Schedule (WIB)	Feeding Status	System Temperature (°C)	Feed on Tube (grams)	Feed Rate Ideal (grams)	Feed rate of the system (grams)	Results Measure Standard Device (grams)	System Test Accuracy (%)
	09:00	*On*	25.00	806.90	52.00	52.70	53.20	99.05
1	14:00	*On*	29.00	753.80	52.00	52.60	53.50	98.28
	19:00	*On*	24.00	700.20	52.00	52.90	53.40	99.06
	09:00	*On*	25.00	645.70	52.00	52.30	51.10	97.71
2	14:00	*On*	27.00	592.40	52.00	52.00	51.70	99.42
	19:00	*On*	24.00	543.90	52.00	52.20	52.10	99.81
3	09:00	*On*	25.00	479.10	52.00	52.20	51.40	98.47
	14:00	*On*	29.00	426.60	52.00	52.60	54.60	96.20
	19:00	*On*	25.00	372.30	52.00	52.10	51.10	98.08
4	09:00	*On*	26.00	318.50	52.00	52.30	53.60	97.51
	14:00	*On*	30.00	263.30	52.00	52.20	51.80	99.23
	19:00	*On*	24.00	208.20	52.00	52.10	53.30	97.70

Table 7 is a tabulation of the system test data on a field test scale. Field scale testing is done by comparing the weight of feed released by the system with standard measuring instruments. The measurement results of the weight of the feed released by the system experience a considerable difference in value. This can occur due to external influences, namely pressure and vibration caused when moving the system. The weight measurement system is very sensitive to movement and displacement. The results of measuring the accuracy of the system cannot be done repeatedly using the same weight sample, so the accuracy measurement is only done once for each feed issued.

The amount of feed released by the system is based on the ideal amount that has been calculated in the system microcontroller program. The weight of the ideal dose of feed is obtained from the calculation of entering the total weight of the fish and the total stocking density of the fish in the pond multiplied by the percentage of feeding. The percentage of feeding is given at the rate of 5% for a day to one-month-old fish. Feeding as much as 5% of fish biomass is the best dose and gets 100% fish survival percentage [13].

Of the measurement data collected, data analysis is carried out through tabulation of measurement data. The results of the accuracy specification of the field scale testing of the real time fish feeder control system based on the internet of things (IoT) were carried out at CV. Family Pisces Group. System accuracy data is obtained by comparing the feed that is ready to be dropped with a measuring instrument scale. The accuracy value of testing the weight of the feed released is 98.38%.

4. Conclusion

Based on the results of tests and measurements carried out on the design of a real time fish feeder control system based on the internet of things (IoT), it can be concluded that the system can work with the research objectives. The test results of the accuracy and precision of the laboratory scale system are in the form of accuracy and precision values from measuring the weight of the tube and system container and measuring the system temperature. Accuracy and precision data are obtained by comparing the system measurement results with the measurement results using standard measuring instruments. The results of the percentage of accuracy and precision of the average variation of the weight of the system tube are 99.70% and 99.80%. The percentage results of the average accuracy and precision of the weight variation of the system container are 98.87% and 98.87%. The percentage results of the accuracy and precision of system temperature measurements are 98.10% and 97.96%. Based on the results of the system accuracy and precision test, it is shown that the system output can work accurately. The results of the system accuracy test on a field scale are on the amount of feed dropped based on the ideal dosing calculation operation in the system microcontroller program. The feed that is released is compared with the standard tool. From the comparison results, the accuracy value of the feed weight measurement issued by the system is 98.38%.

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