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Smart Fish Feeder by Measuring the Number of Pond Water Surface Vibrations Based on the Fish Hunger Levels

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Abstract: Suboptimal fish feeding management can affect the growth rate of fish. Fish Feeding management consists of aspects of feed nutritional content, quantity, and feeding system. A system that still relies on humans or manual labor is very likely to cause human error in the process, so utilizing technology can be an option to improve the feeding system. This study aims to design and test the Smart Fish Feeder Design as an innovation in technology-based freshwater fish feeding. The fish Feeder works by providing fish feeding scheduling using the RTC DS3231 and detecting vibrations in pond water, which aims to determine the feeding process using the SW-420 Vibration Sensor. If a certain vibration is used as a parameter that the fish are still consuming feed, then the feeding process continues. The duration of the influence of sensor readings in adding feed lasts for one minute and can be adjusted according to pond conditions or the number of research subjects. The results show that the design can provide fish feed on a scheduled basis with high accuracy and can detect water vibrations as an indicator of feed consumption by fish.

Keywords: Automatic; Fish Feed; Schedulling; Vibration Sensor

Introduction

Currently, fish farming is developing very rapidly along with the increasing population. One of the main factors that affect the growth rate of fish health is feed, both in terms of nutritional content and quantity. It must be done in the right way, including how to feed. Providing proper feeding is one of the supporting factors for successful fish farming (Elfitasari and Albert, 2017; Araujo et al., 2022).

As an important factor in the success of cultivation, it is also the component that costs the most, which is around 70% of the total production (Rarassari et al., 2021). The fish feeding management system to support the success of fish farming efforts is expected so that it can be utilized by the fish effectively and efficiently to produce optimal fish growth (Mahendra, 2018; Karningsih et al., 2021; Mohan et al., 2021). Providing too much fish feed can result in an accumulation of it that is not eaten by the fish, which affects the quality of the water or makes the water more turbid. This decrease in water quality can cause parasites that can affect the health of the fish, which can even cause death in the fish. Meanwhile, if it is too little, then it will affect the nutrition and growth of the fish (Vatsos and Angelidis, 2010; Iwanowicz, D.D., 2011).

The creation of an automatic fish feeder has previously been developed by several researchers, such as making an automatic fish feeder using RTC as a timer component for the feeding schedule (Hasanuddin and Anandi, 2019; Uddin et al., 2016), developing an automatic fish feeder with a Load Cell Sensor to regulate the amount of feed to be dispensed (Putra and Pulungan, 2020), scheduling fish feeding and created a fish feeding system based on environmental temperature that can adjust the fish's appetite (Anhar et al. 2023) and IoT-Based Automatic Fish Feeder (Rathy and Jenefer, 2024). These studies all use fish feeding scheduling using RTC,

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but overall, the research was unable to determine whether the fish were full or not to stop feeding the fish. To overcome the problems stated above, use a sensor to detect vibrations or waves of pond water with the SW-420 Vibration sensor so that the fish's hunger level is known. The more water vibrations indicate that the fish are hungry, and the fish feed will come out of the feeding equipment, and vice versa. Therefore, the work of this smart fish feeder is to determine the behavior of the fish when the feed has been given. This parameter will determine whether the fish are full or not so that the feed can be given according to the needs of the fish.

This research is important because if too little feed is given, it can inhibit the growth of the fish, and if too much is given, the fish will not want to eat, so the food is left behind and can make the water cloudy, thus decreasing dissolved oxygen and disrupting the health of the fish. (Arun, 2023; Haetami et al. 2023) Therefore, this fish feeder will provide feed at the right time using the scheduling method and will provide the right portion of feed by determining the vibrations of the pond water surface.

Method

To facilitate understanding of the Smart Fish Feeder design system, the author created a block diagram as in Figure 1.

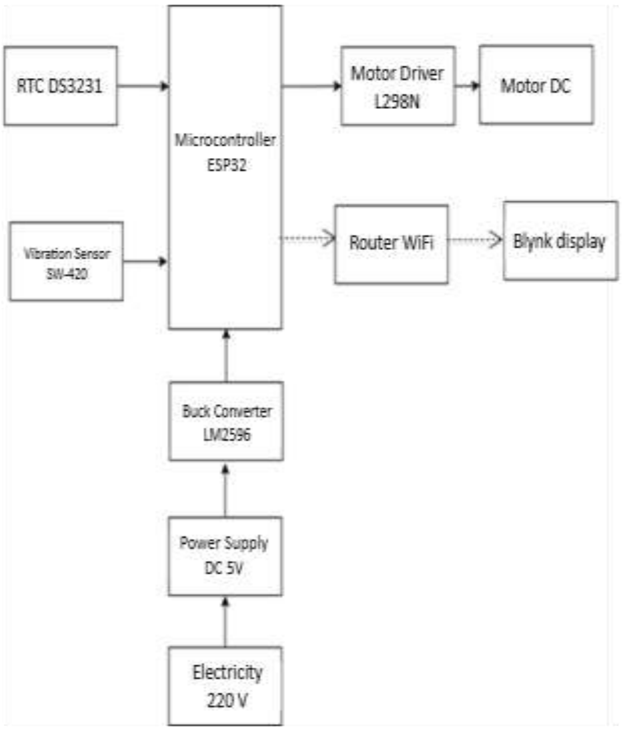


Figure 1. Research Block Diagram

In this system, the input component is the RTC DS3231 which functions as a time setting device, to determine the system's work schedule. Setting the time on the RTC DS3231 can be done in the Arduino IDE application when programming the system (Ervani, 2019). The next component that functions as an input component is the SW-420 Vibration Sensor. The function of the sensor is to provide feedback to the system by providing information in the form of water vibrations or water conditions when feeding. This sensor input is used as a parameter regarding the condition of the fish when they are full. When the fish are fed, the fish will move or swim faster to fight for food, and after the fish are full, the fish will swim slower than before and move away from the fish feeding device. The movement of the fish when eating is what causes vibrations so that at a certain vibration level, it will determine whether the feeding process is complete or not. If the vibrations during feeding or the specified time are still high, feeding will continue. However, if the vibrations have reached a calm condition, feeding will be stopped automatically. Furthermore, what functions as an output is a DC Motor that moves according to the input and commands from the program. In addition, the Blynk application will also display the history of fish feeding per day. The Smart Fish Feeder Tool Scheme can be seen in Figure 2. The SW-420 Vibration Sensor is located on the surface of the fish pond water, which is 40 cm from where the feed comes out. The Vibration Sensor that has been connected by cable to the microcontroller is fitted with a float so that it can float on the surface of the pond.

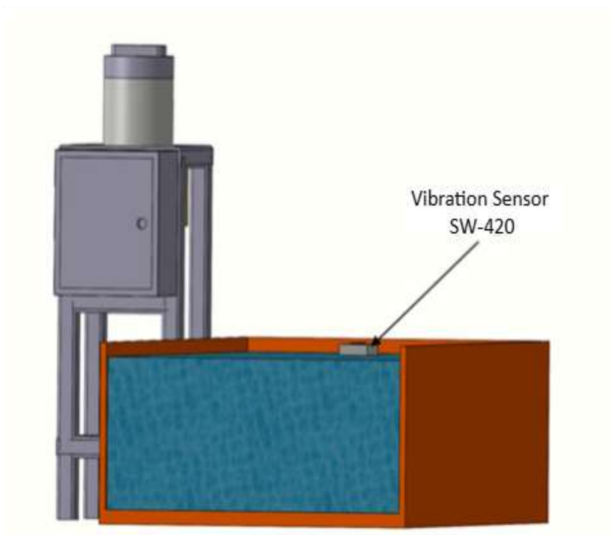


Figure 2. Smart Fish Feeder Tool Schematic

The flowchart in Figure 3 provides an overview of the working principle to make it easier to understand the working principle of the smart fish feeder system.

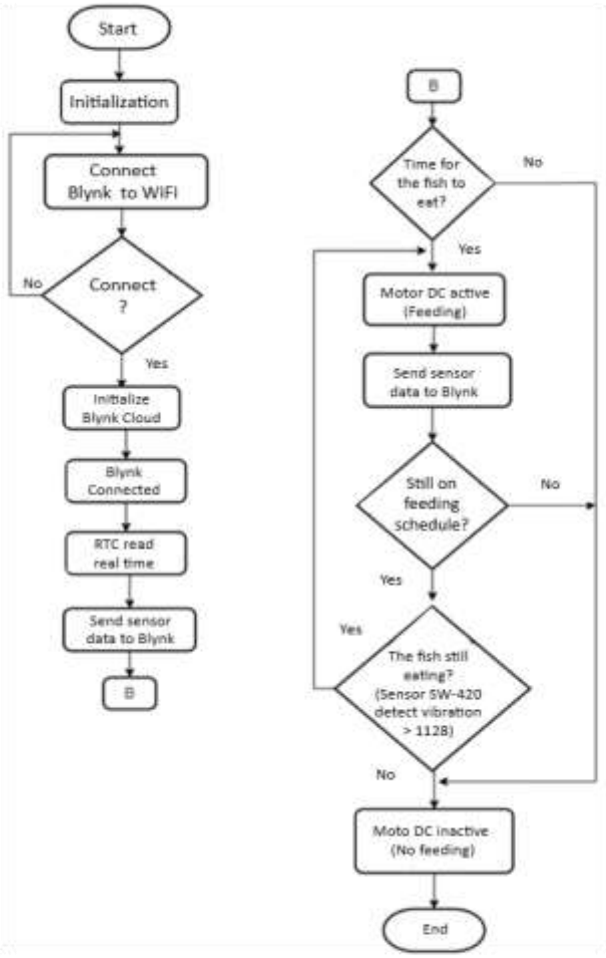


Figure 3. Flowchart of Working Principle

The work of the system is that first, the smart fish feeder system will schedule fish feeding in the morning around 7 am and in the afternoon around 5 pm. After the time arrives (twice a day) the program will order the servo motor to open to the maximum (90^o), the fish that are time to eat will chase the food that falls into the pond so that vibrations occur on the surface of the water, the vibrations are read by the sensor. After the fish eat the fish food, some are full so they leave the fish food little by little so that the water vibrations gradually decrease and will be read on the vibration sensor and order the opening of the fish food outlet to decrease with the servo motor making a smaller angle ($<90^o$) until finally the fish are full all the water will return to calm then the fish exit door closes or the servo motor forms an angle of 0o.

Result and Discussion

Functionality Test of DC Motor Against Feed Quantity

The DC Motor functionality test on the amount of feed was conducted to determine the amount of feed that came out compared to the DC motor rotation time. The test was conducted 16 times with 8 variations of duration samples.

Table 1. The result of the Functionality Test of DC Motor on the Feed

No	Duration (ms)	Test feed quantity 1 (gram)	Test feed quantity 2 (gram)	Average feed (gram)	Difference (gram)
1	200	0.43	0.45	0.44	0.02
2	300	0.68	0.71	0.69	0.03
3	500	1.11	1.08	1.09	0.03
4	1000	1.97	2.01	1.99	0.04
5	2000	3.85	3.89	3.87	0.04
6	3000	4.78	4.80	4.79	0.02
7	4000	5.69	5.63	5.66	0.06
8	5000	6.58	6.57	6.58	0.01
Standard Deviation (%)					0.014

From the data in Table 1, it can be seen that the standard deviation result of this test is 0.014%. This indicates that the test results of the amount of feed that comes out based on the duration of the DC Motor movement indicate that the system created has a low level of data distribution, or in other words, the system in the feed dispensing process based on the DC Motor movement has high stability and has a low level of deviation. So, it can be used in this Smart Fish Feeder system.

Functionality Test of RTC DS3231

RTC DS3231 functionality testing is done by comparing real time or time on the world clock for the western Indonesian region with the time on the RTC DS3231. Testing is done 10 times with different time variations. Data collection on the RTC DS3231 is done by turning the RTC DS3231 on and off 10 times at the time used for the sample. This is done to determine the effect of time calculations on the RTC DS3231 when power is given to the RTC DS3231. The RTC test results can be seen in Table 2.

Table 2. The Result of the Functionality Test of RTC DS3231

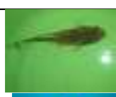
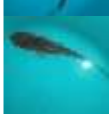
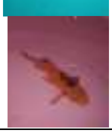
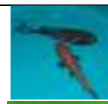
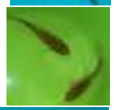
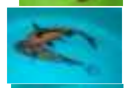
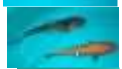
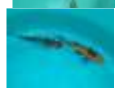
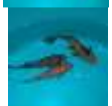
No	Real time	Time on RTC	Difference (s)
1	12:59:09	12:58:48	15
2	13:07:14	13:06:53	15
3	13:17:37	13:16:59	16
4	13:20:33	13:20:12	15
5	13:31:37	13:31:16	15
6	13:41:16	13:41:55	15
7	13:47:21	13:47:00	15
8	14:03:13	14:02:51	16
9	14:12:33	14:12:12	15
10	14:22:01	14:21:40	15
Average Difference (s)			15.2
Standart Deviation (%)			0.4

From the data in Table 2, it can be seen that the difference between real time and time on the RTC DS3231 is 15.2 seconds with a deviation of 0.4%. This average deviation value is very small, namely 0.4%, so we can conclude that the difference between the time on the RTC DS3231 and real time is 15 seconds. This difference is influenced by the SRAM or memory on the RTC DS3231 which stores programming data that adjusts the initial programming data with the device used when programming (laptop/computer). The laptop used in this test has a time difference with the actual time of 14 seconds. However, this difference does not have a major effect on the schedule setting, because the RTC DS3231 time calculation program calculates for 24 hours and adjusts to the date so that it only has a small difference with the actual time. In addition, this experiment also proves that if the main voltage source on the RTC DS3231 is not connected, it does not affect the calculation of the RTC DS3231 time, this is because the RTC DS3231 has a CR2032 battery that will supply the RTC DS3231 module when the main voltage source is off so that the time calculation continues. The RTC DS3231 time can be programmed manually by entering the time and date yourself (not affected by the device) in the Arduino IDE programming.

Functionality Test of SW-420 Vibration Sensor

The SW-420 Vibration Sensor functionality test aims to determine the water vibrations that occur when feeding caused by the movement of fish when taking food. The test was carried out in a 37 cm diameter basin and was carried out with several samples. The research subjects in this experiment were comet fish or comet ornamental fish. The results of this vibration measurement will be used to determine the lower limit of vibrations that occur when feeding and are used as working parameters on the Smart Fish Feeder tool. The test result data is shown in Table 3.

Table 3. The *Test Result of SW-420 Vibration Sensor*

No	Fish Name	Fish weight (gram)	Fish Figure	Number of Average Vibration
1	Fish A	34		1128
2	Fish B	35		1174
3	Fish C	35		1179
4	Fish D	38		1218
5	Fish A & B	69		1281
6	Fish A & C	69		1275
7	Fish B & C	70		1292
8	Fish A & D	72		1325
9	Fish B & D	73		1330
10	Fish C & D	73		1328
11	Fish A,B& C	104		1317
12	Fish A,B& D	107		1325
13	Fish A,C&D	107		1331
14	Fish B,C& D	108		1356
15	Fish A,B,C and D	142		1403

The measured vibration intensity influenced by the more massive fish movement due to reduced feeding from the usual feeding. The vibration intensity by the movement of 4 fish when first fed until the fish did not want to eat the fish feed because they were full can be seen in Figure 4.

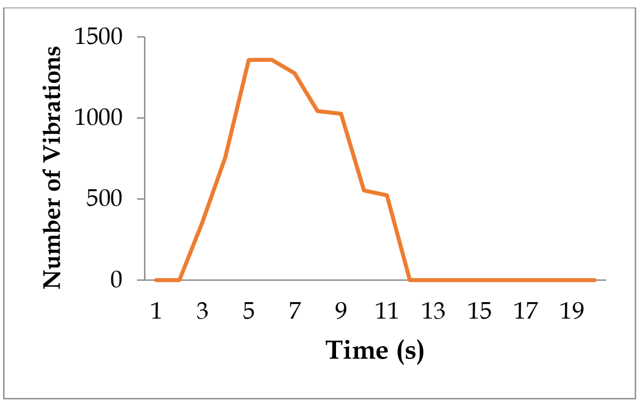


Figure 4. Smart Fish Feeder Vibration Intensity Graph

Feeding occurs by opening the servo motor at the output of the feed container at the start of scheduling or at 2 seconds and the servo motor opens to a maximum (90^o) at 5 seconds and gradually decreases as the water vibrations decrease due to the fish leaving the fish feeding place because they are full and finally the servo motor closes at 12 seconds when there are no water surface vibrations or all the fish are full.

Conclusion

The design of the Smart Fish Feeder system uses the RTC DS3231 as a feed scheduler and the SW-420 Vibration Sensor, which functions to measure vibrations after the feeding schedule as a reference to determine the condition of the pond and fish and as a reference for adding fish feed. From the results of the DC Motor functionality test, the DC Motor that functions to dispense feed based on the duration of the DC Motor rotation produces an average deviation value of 0.014%. From the results of the RTC DS3231 functionality test, the RTC DS3231, which functions to provide time input for feeding scheduling, produces a standard deviation of 0.4% for each experiment conducted. From the results of the SW-420 Vibration Sensor functionality test, the number of wave vibrations in the pond with 1 - 4 fish is 1128 - 1403 vibrations.

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Author Contributions
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Conflicts of Interest
The authors confirmed that there is no conflict of interest in this article.

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