

DEVELOPMENT OF AN AUTOMATED CONTROL FISH FEEDER DEVICE USING A BLOWER SYSTEM

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ABSTRACT

This study developed an automated fish feeding machine for the dispensing of feeds in fish aquaculture. Farmers have historically experienced losses due to fish death caused by irregular feeding of fishes at the expected time. The automated fish feeder machine eradicates this problem because it involves little human intervention and makes feeding of fishes easier. The body of the machine is made from mild steel and it is powered by a 20V D.C blower. The machine is automatically controlled by an Arduino microcontroller and a relay switch. The Arduino microcontroller controls the relay switch, and based on the written program on the Arduino board, the relay controls the blower, which discharges the feed into the pond. The machine, when switched on discharge the feeds into the pond for 10 seconds and automatically turns off after another 10 seconds. The ON and OFF period of the machine can be changed by rewriting the program on the Arduino board. The machine was tested with different sizes of fish feeds (6 mm, 4 mm and 3 mm) using a constant mass of 3 kg feeds and a dispensing period of 10 seconds. The machine dispense feeds based on the aforementioned feed sizes at a distance of 0.248 m, 0.304 m, 0.457 m and a mass flow rate of 0.12 kg/s, 0.15 kg/s, 0.2 kg/s and the weight of feed discharged are 1.02 kg, 1.5 kg, 2.03 kg respectively. The results generated satisfy that the device will perform efficiently and boost growth of fish farming.

Keywords: Aquaculture, Automated control, feed, blower

1.0 INTRODUCTION

Fish aquaculture is a promising venture that often expands quickly. Fish feeding is without doubt one of the most important aspects of fish farming process intensification and expansion (Ojo and Bernard, 2018). Food and feeding are essential for growth and output, while their administration is a difficult aspect of aquaculture development, survival and upkeep. In aquaculture, both overfeeding and underfeeding are frequent. Overfeeding results in wastes and degrades water quality, whereas underfeeding promotes poor growth and, as a result, low output. Aquaculture feed supplied in the correct quality, at the right time and in the right proportion is essential

for good aquaculture production (Malgwi et al, 2020).

The feeding of farm animals is frequently based on proper management, where some factors are critical, such as selecting high-quality feeds and scheduling feeding times, as well as determining adequate feeding frequencies and quantities, as these factors can have an important effect on both the animals' performance and the activity's economic return (Eriegha and Ekokotu 2017).

The fish feeder system is designed as a mechanical and electrical device that gives the fishes the right quantity of food at the right time, according to the farmer's instructions (Ozigbo 2013). A programmed

fish feeder is essentially a component that feeds the fishes an allocated amount of meal at predetermined intervals. A type of programmable device that permits the farmer to vary the frequency and amount of feeding is a fundamental component of programmed feeders (Dada et al, 2018). It is possible that this is a combination of both electrical and mechanical components that releases feed into the fish pond. Electrical clocks are used on some concepts to sequence the release of feed (Osueke et al, 2018).

In recent years, the Arduino microcontroller has primarily been utilized to create prototype device. Arduino, according to Anschau et al, (2020) is a user-friendly device that runs open source software and as a result users from all around the world can contribute their expertise. Furthermore, the Arduino UNO is an ATmega328 that contains 16 digital output pins, 6 analog inputs, and a variety of other functions, according to Akinwole and Adeoye (2020). The Arduino is based on the C++ programming language and developing software is fairly simple. It is also less expensive than the other microcontrollers in the market. Arduino as a microcontroller is extensively utilized in a variety of sectors, including lab kits for beginners, school competitions to foster future researchers and robotic setup.

The aim of this research is to develop an automatic fish feeder which can automatically dispense feeds according to the user's interest. The objectives of the study includes designing, fabricate and test an automated fish feed and To evaluate the performance of the developed system.

Food and fishing are crucial aspects for growth and output in aquaculture, with their management being a significant barrier for aquaculture development, survival, and maintenance (Sakshi et al, 2017). Several people have characterised automatic fish feeders as a way to improve fish culture.

An existing design called a smart fish feeder reported by Sabari et al, 2017 could dispense feed with various grain sizes over a wide range of dispensing volumes, and it did so by utilizing an adjustable counterbalance weight that changes the amount of water required to produce a dispensing action while also adjusting the vibration movement made by the fish feeder to differentiate the quantity of food given out.

Figure 1 shows a design by Dhavale et al, 2019 which utilizes an electromagnet connected to an AC power supply to generate a vibratory motion to dispense feed. It had the limitations of accuracy due to the usage of AC power



Figure 1: Vibratory fish feeder machine (Dhavale et al, 2019)

There are many fish feed sizes of floating or sinking fish feed. Typically, floating feed is shorter and bigger than sinking feeds. These are the different sizes of feed; (1.5, 1.8, 2.0, 3.0, 4.0, 6.0, 8.0, and 10.0) mm.



Figure 2: Different fish feed sizes (Ojo and Bernard 2018)

The bigger the fishes, the bigger the feed size the fish can pick. The following are different sizes of fishes

- i. Fingerlings (3 to 4) g needs up to 1.5 mm feed size
- ii. Post fingerlings (4 to 6) g needs up to 1.8 mm feed size
- iii. Juvenile (6 to 10) g needs up to 2 mm feed size.

2.0 METHODOLOGY

In the selection of materials the most important thing to consider was the availability of the material amongst other factors such as; quality, suitability, strength and rigidity and resistance to corrosion. The fish feeder consists of the mechanical and electrical parts.

The design technique follow a modular approach of both hardware and software phases. The electronics and mechanical component frames up the hardware where the programming makes up the software. The materials required are fairly basic, with the device being mostly mild steel. Mild steel was chosen because of its strength and weld-ability.

2.1 Systems development concept

i. Mechanical features

The following materials were used for the fabrication of the automated fish feeding machine such as: low mild steel sheet of thickness 5 mm because it has very high strength, hardness, moderate ductility and good weld-ability. Square pipes metals of 20 mm thickness were also used for the standing frames.

ii. Electrical Materials

- a. Arduino Uno is the most crucial element required for the feeding automation operations. It is a programmable hardware that, in accordance with a written program, switches on the blower automatically at predetermined intervals.

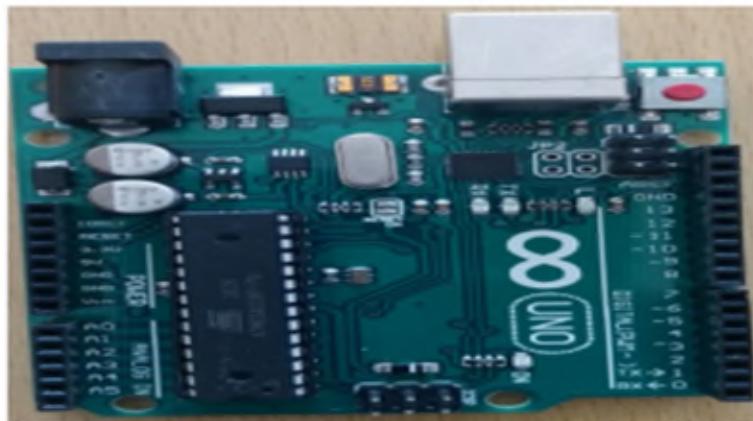


Figure 3: An Arduino Uno board

```
digitalWrite(BlowerPin, HIGH); // Turn on Blower for
10 secs delay(10000); // wait for a 10 second
digitalWrite(BlowerPin, LOW); // Turn off the Blower
for 10 secs delay(10000); // wait for a 10 second
if ( BlowerPin== HIGH)
{for (StopperPos = 0; StopperPos<= 180; StopperPos += 5){ // goes from 0degrees
to180 degreesmyservo.write(StopperPos); // tell servo to go to position in variable 'pos'
delay(15); // waits 15 ms for the servo to reach the position}
else{for (StopperPos = 180; StopperPos>= 0; StopperPos -= 1) { // goes from
180 degreesto 0 degrees }
```

- b. Battery is used to power the blower and it is a 20V DC Lithium-Ion rechargeable battery. It has the ratings of 2.0 Ah and

20 V. The time duration to be fully charged is 1-2 hours and can last up to 8 hours when fully charged.



Figure 4: 20V Lithium-Ion rechargeable battery and charger

- c. Blowers are commonly used for turbo machines which deliver air at a desired high velocity, static pressure and mass flow rate. Figure 5 shows the machine been powered by a blower containing

775 large motor, which provide a large air volume. It has specifications of no load speed of 10000/12500/17000 per min and max air volume of 0 - 1.5 / 0 - 2.0 / 0 - 2.7 m³/min.



Figure 5: Automated fish feeding machine powered by a blower

2.1.1 Design of the machine

- i. The blower speed was determined in m/s using the provided specification of the blower of speed 17000 rev/min using equation 1

$$\begin{aligned} \text{Convert to radian per second } (\omega) &= \frac{2\pi N}{60} \\ &= \frac{2 \times \pi \times 17000}{60} = \mathbf{1779.3 \text{ rad/sec}} \end{aligned} \quad (1)$$

Converting rad/s to m/s was done using equation 2

$$\omega \times r = v \quad (2)$$

Where ω = angular velocity, v = linear velocity

r = radius of the blower

$$\omega \times r = 1779.3 \times 0.003 \text{ m} = \mathbf{5.337 \text{ m/s}}$$

- ii. The hopper was constructed to be a frustum pyramid in shape and has the following dimensions that were chosen based on proportionality and aesthetics. The lower base of the hopper has a dimension of 300 mm × 300 mm while the upper base of the hopper has a dimension of 50 mm × 50 mm and then a height of 220 mm. The volumetric capacity of the hopper is calculated using equation 3.

$$V_h = \frac{1}{3}(h)(A_L + \sqrt{A_L A_U} + A_U) \quad (3)$$

Where: h = height of hopper, A_L = lower base of hopper
 A_U = upper base of the hopper, $V_h = 0.0696 \text{ m}^3$.

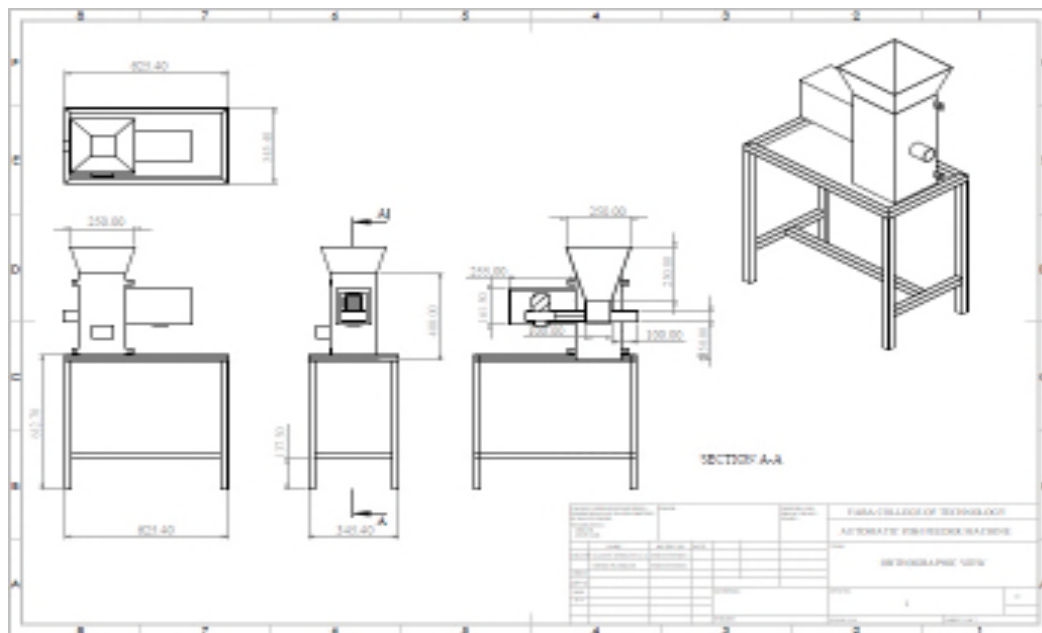


Figure 6: Orthographic view of the automated fish feeder



Figure 7: Developed automated fish feeding machine

Table 1: Part list nomenclature

S/N	Material Description	Material Specification	Quantity
1	Metal plate	Mild steel (2 mm)	1/2 sheet
2	Electrode	Mild steel (low carbon)	Half pack
3	Angle iron	Mild steel	2
4	DC Blower		1
5	Paint		1
6	Bolt and Nut		5
7	Arduino		1
8	Relay		1
9	Wires		

3.0 RESULTS AND DISCUSSION

After fabrication, the Arduino was programmed using an arduino IDE in C language. The circuit was connected to the mechanical part of the feeder and then tested at a pre-set time of 10 seconds for dispensing feeds. As soon as, the machine is turned on, feeds of different sizes (3 mm, 4 mm and 6 mm) of regular mass of 3 kg respectively were poured into the hopper at different periods of the day to ascertain the performance of the machine. The quantity of feed released for various periods of time was

weighed and noted of which would be useful for the farmers. Thereafter, the following results were obtained.

Table 2 shows the result obtained using the three different sizes of fish feed of same weight. Also, the time of discharge and speed of the machine were constant for all three samples which was 10 seconds and 5.34 m/s respectively. The distance travelled by the feed, the amount of feed dispensed and the mass flow rate of the feed were obtained

Table 2: Result obtained from the tests performed

Samples	Weight of feed (kg)	Size of Feed (mm)	Fixed Time to Dispense (Sec)	Distance traveled by feed (m)	Amount of feed discharged (kg)	Mass flow rate (kg/s)
1	3	6	10	0.2483	1.02	0.12
2	3	4	10	0.3048	1.50	0.15
3	3	3	10	0.4572	2.03	0.20

Figure 8 shows the intersection point between the sizes of feeds (mm) and the distance traveled by feeds (m). The pre-set time of 10 seconds was uniformly used to determine the distance travelled by feeds. The feeds of sizes 6 mm travelled a distance of 0.2483 m while feed of size 4 mm covers a distance of 0.3048 m and while the smallest

feed sizes of 3 mm moved a distance of 0.4572 m into the pond. The results showed that the feeds with smallest size because of its weight travelled farther compared to the other two feeds sizes. This would be very useful for ponds that are large and housing smaller fishes.

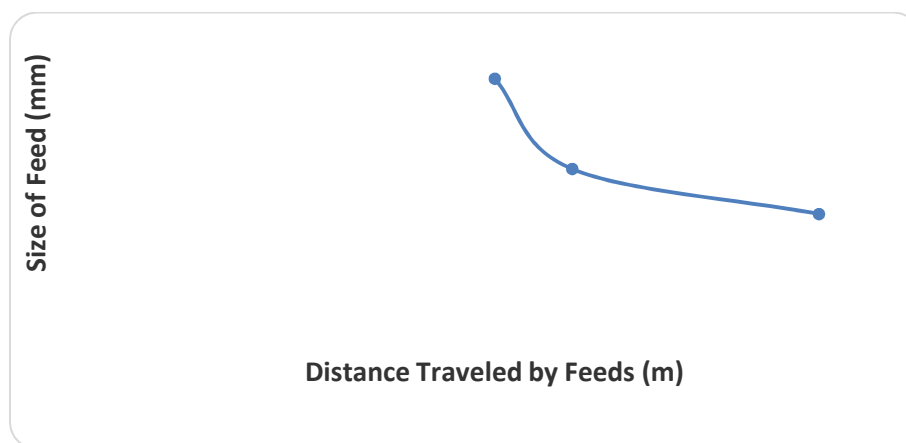


Figure 8: Graph of Feeds sizes plotted against distance travelled

Figure 9 shows the amount of feed that was discharged when tested with the three sizes of feeds one after other at a fixed operation time of 10s. The weight of 6 mm, 4 mm, 3 mm feeds sizes dispensed were 1.02 kg, 1.50 kg and 2.03 kg of feeds respectively. The results

again indicate that the 3 mm feed size because of its lower density moves more and faster from the blower chamber. Therefore the feeds with smaller sizes needs a bigger chamber for housing feeds in order to dispenses at least thrice daily.

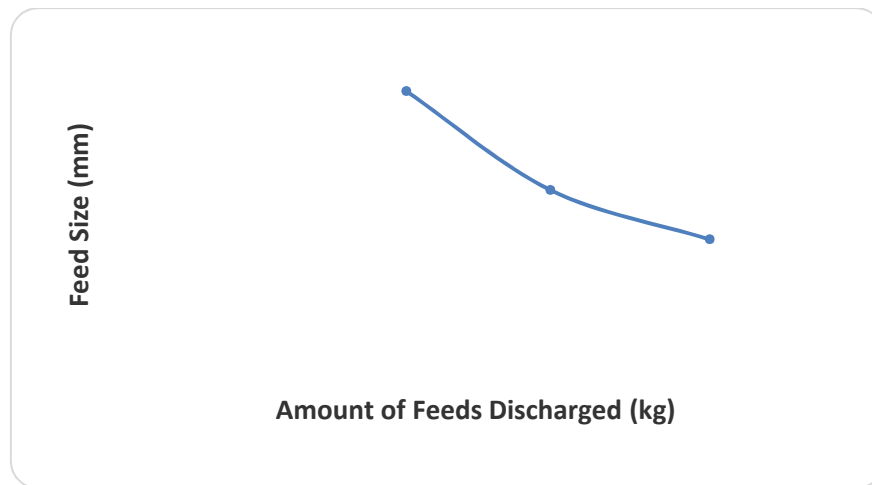


Figure 9: Graph of Feed sizes plotted against feeds discharged

Figure 10 shows the mass flow rate of the feeds against the size of feed. As the feed sizes increases the mass flow rate decreases because it is dependent on the density. These

results validate the fact that the higher the mass flow rate the smaller the weight as realised in the first and second test carried out.

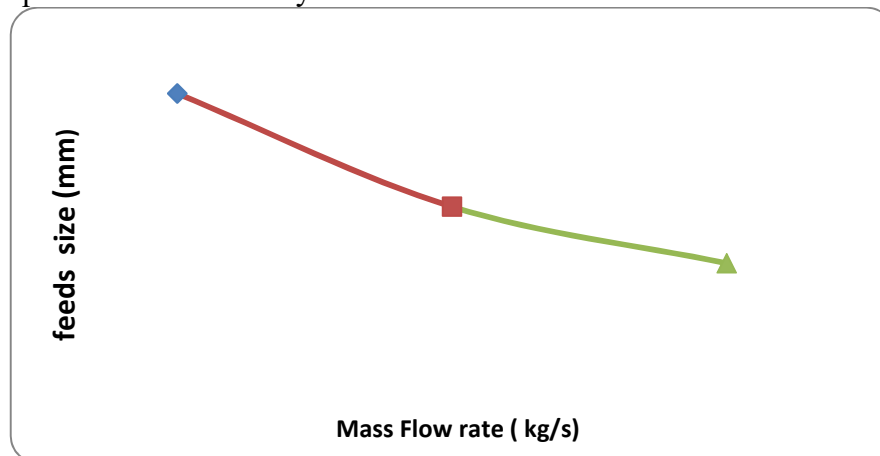


Figure 10: Graph of Feed sizes plotted against Mass flow rate

4.0 CONCLUSION AND RECOMMENDATION

An automated fish feeding machine was developed basically for fish pond farming. In this instance, the farmers are relieved and can relax knowing fully well that the fish would be fed at the appropriate time most especially when far away from the farm. It is controlled by a microcontroller (Arduino Uno) which in turn operates the blower. It has the ability of feeding the fish in line with the pre-set time programmed regardless of the presence of an operator. The timing can also be re-

programmed in order to ensure consistency in the feeding pattern. After testing using different sizes of feeds (6 mm, 4 mm and 3 mm), it was realised that at constant speed and time of 17000 rad/min and 10 seconds respectively the quantity of feeds discharged and the distance travelled by the feed into the pond is a function of the size of the feed. The device would be a supplement for all grades of farmers to increase the growth of fish farming.

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