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THE CREATION OF AUTO FISH FEEDER POWERED BY SOLENOID

Nival S. Ostan EdD,[1,2,3,4] Mark Mohsen D. Vital,[1,2,3,] Sarah Marie B. Moran,[1,2,3] Ben Noah Ray P. Maragana,[1,2,3] Abduzzahir S. Hadjula,[1,2,3] Gerwyn C. Libay,[1,2,3] Bianca Margarette M. Gasang,[1,2,3]

Philippine School Doha, Doha, Qatar, PO Box 19664,
Quality Assurance and Accreditation Department, PSD, Doha Qatar
Research Capstone Project, PSD, Doha, Qatar

ABSTRACT

Since the rise of aquarium fishkeeping during the COVID-19 pandemic, aquarium fish pet owners have to take into account one of the most crucial aspects of fishkeeping - feeding the fish. To properly care for aquarium fish, one must ensure that the amount and timing of the given fish feed is accurate to avoid overfeeding or underfeeding the fish. The problem of fish feeding then led the researchers to create an Auto Fish Feeder powered by a solenoid. The research study followed a quantitative study method and an experimental research design. The device was then tested for the dispense delay, feed distributed per dispense, and the capacity of the fish feeder. The researchers observed that the Auto Fish Feeder created performed swiftly as the device's opening and closing dispense delay reached an average of 0.732 seconds and 0.252 seconds respectively. Next, the mass of fish feed per dispense observed was 0.7 grams throughout the three trials. Furthermore, the capacity of the fish-feeding device was measured to last around 63 days. To conclude, using a solenoid in creating an Auto Fish Feeder was feasible evidenced by the efficiency and effectiveness of the device to disperse fish food quickly and accurately. The Auto Fish Feeder would benefit communities concerned with aquarium fishes and fish equipment as long as future studies would improve on hygiene issues and energy storage issues.

KEYWORDS: *Aquarium Fish Feeder, Auto Fish Feeder, Fish Feeding Automation, Solenoid*

1. INTRODUCTION

In recent years, notably during the pandemic, there has been an increase in aquarium fishkeeping habits globally. Nations like Japan and the United Kingdom have seen a growth in fishkeeping along with the ownership of cats and dogs (Koochaknejad et. al, 2022; Wood, 2020). Fishkeeping's popularity during the Coronavirus-19 situation may also be related to benefits such as relaxation, stress reduction, and companionship (Clements et al., 2019).

One of the most crucial aspects of the art and science of fishkeeping is feeding. As though there are several elements taken into account, including tank setup and water quality, feeding remains the most crucial element in fishkeeping (Venugopalan, 2015). The primary goal of fish feeding is to meet the protein and energy requirements of the fish. Aquatic creatures require energy and nutrients from feeds for development, reproduction, and overall health. Diet influences fish performance in terms of growth, reproduction, health, and resistance to pathogens and physiological stressors. Excessive or insufficient amounts of fish food may result in illness or stunted growth. Betta fish, for example, can cause a variety of ailments, including swim bladder infection, digestive issues, and even death, if fed in excess (Prabu et. al, 2017).

Underfeeding results in less development, whereas overfeeding results in food waste. With the volume of water in the culture system, little fish require very little nutrition (Abana et. al, 2020). Small fish require practically continuous feeding every hour due to their high energy requirements. If little fish are overfed, dissolved oxygen levels will fall, biological oxygen demand will rise, and bacterial diseases will occur. Fish that also receive less protein than their daily requirement exhibit indications of diminished development, lower production, and anemia at first. These indicators appear first in younger fish, then in the most productive. If starvation becomes more chronic, fish mortality may increase. Weaker fish may be more prone to secondary bacterial infections (Mayer, 2012).

Hence, creating an Auto Fish Feeder would resolve problems like overfeeding and underfeeding. In creating the Auto Fish Feeder, the independent variable would be a solenoid that will be used as the main component in pushing fish food from the device to the aquarium. A solenoid is part of a mechanism called a solenoid valve that usually controls the flow and motion of industrial works (Tian et al., 2021). Contrary to other auto fish feeder brands like Aoyar, Barkmew, and Fishnosh, which feature commercial fish feeders valued at $24.99, $25.95, and $28.97 correspondingly, the auto fish feeder largely uses scrap materials, making the product more affordable. Additionally, the auto fish feeder would support remote access via a wireless fidelity (Wi-Fi) switch through a mobile application. The feeder can hold approximately 250 milliliters of fish food, which is more than the 200-milliliter capacity of Aoyar, Barkmew, and Fishnosh fish feeders. Finally, the fish feeder developed in the study is powered by Alternating Current (AC), a quality that commercial fish feeders lack because the device operates endlessly.

In conducting the study, the researchers hope that the study would assist the following groups: the fish tank industry, recreational fish owners, future researchers, and the researchers themselves. The study's findings would benefit the fish tank business since developing a more inexpensive and practical auto fish feeder will allow for innovation in comparable items. The study would also help recreational fish owners rationalize food portion sizes. Furthermore, the research would tell present and future researchers that discarded materials can be used to produce more effective solutions to problems such as the auto fish feeder.

2. STATEMENT OF PROBLEM

The objective of this study is to create an Auto Fish Feeder that is powered by a solenoid. Specifically, it answers the following questions:

1. How long is the delay of the Auto Fish Feeder in releasing the fish food;
2. What is the mass of fish food the Auto Fish Feeder produces per dispense; and
3. What is the duration of the feeding cycle until the container of the Auto Fish Feeder becomes empty?

3. PURPOSES OF THE STUDY

The purpose of the study is to create an Auto Fish Feeder powered by a solenoid, utilizing a mobile application-controlled system with a WiFi switch interface. The innovative approach used in the study aims to modernize and make an efficient feeding process in aquariums, enhancing automation in fish care while offering ease of use and efficiency.

4. OBJECTIVES OF THE STUDY

The objective of the study is to create a low-priced Auto Fish Feeder powered by a solenoid built from recyclable materials. The study also evaluates the development system's practicality and ease of use, considering variables such as reliability, energy efficiency, and sustainability of the gadget. As a result, the study highlights the differences in the developed Auto Fish Feeder's capabilities compared to commercially available automatic fish feeders. Furthermore, the Auto Fish Feeder aims to readily automate the fish feeding procedure, providing fish owners with ease and peace of mind.

5. RESEARCH HYPOTHESES

H1: The Auto Fish Feeder powered by a solenoid will dispense fish food.

6. RESEARCH METHODOLOGY

6.1. Research Design

The study employed an experimental research design. The experimental research design is centrally concerned with creating research with strong causal validity. The correctness of claims about cause and effect relationships is called causal validity (Mitchell, 2015). In this study, the solenoid was the independent variable, and the auto fish feeder was the dependent variable. Furthermore, the quantitative method was utilized and included quantifying and analyzing factors to produce results. The method entails the use of numerical data to answer questions like who, how much, what, where, when, how many, and how (Apuke, 2017). This approach must be used since it offers a great degree of control over the factors that show a consequence and helps generate accurate, dependable findings.

6.2 Research Locale

The research study was conducted at Philippine School Doha in Doha, State of Qatar, specifically in the Mesaimeer Area (Zone 56), Al Khulaifat Al Jadeeda Street (St. 1011).

6.3 Data Gathering Procedure

The procedure shows the step-by-step process of creating an Auto Fish Feeder with a solenoid attached and how the device will be tested.

Ensuring the protection and maintaining safety

Wear personal protective equipment such as safety goggles, safety gloves, safety shoes, and a laboratory coat while performing the procedures below to avoid hazardous conditions.

Exterior of the Auto Fish Feeder

1. Mark the center of the lunchbox.
2. Use a soldering iron to create a hole in the center of the lunchbox, 2 cm above the base, with a diameter of 2.5 cm.
3. Create a 5 cm hole in the cap of the water bottle.
4. Make a corresponding 5 cm hole in the lid of the container.
5. Glue the water bottle cap over the container lid, aligning the holes.

Making the Auto Fish Feeder

1. Cut a metal plate to size using a dremel: 11.5 cm in length and 12 cm in width.
2. Glue the metal plate inside the lunchbox to create a base for the solenoid.
3. Remove the top of a 5 ml syringe and create a 2 cm hole.
4. Trim 2.5 cm off the top of a 3 ml syringe and glue it onto the 5 ml syringe.

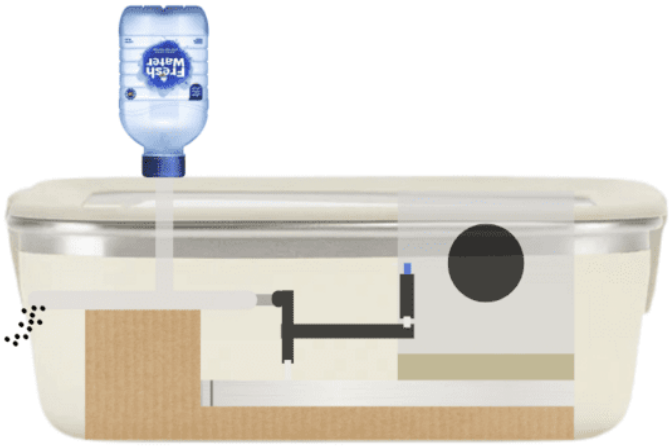
5. Cut a piece of cardboard to 5 cm x 13 cm.
6. Assemble the cardboard to a height of 3 cm and glue it near the solenoid.
7. Attach the 5 ml syringe to the cardboard and the 3 ml injection.
8. Glue the plunger (part of an injection) to the solenoid.
9. Insert the 5 ml syringe into the hole in the lunchbox.

Power supply for the Auto Fish Feeder

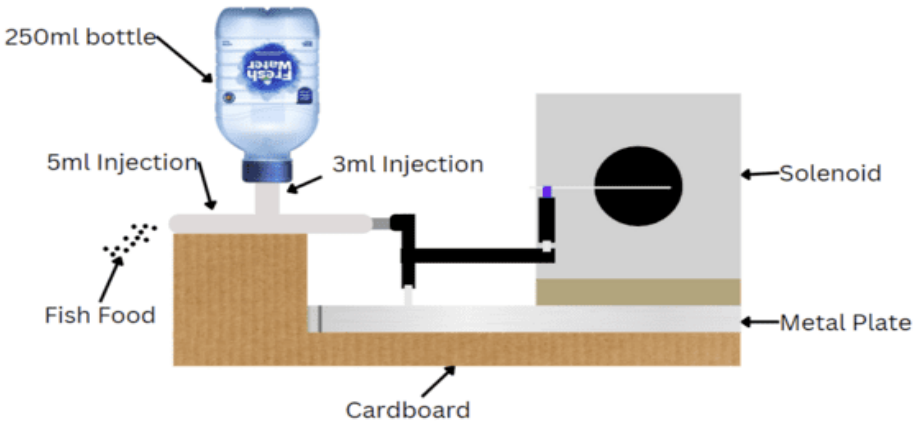
1. Solder the power supply output to the solenoid, ensuring correct polarity.
2. Connect the power supply to the WiFi switch output.
3. Power on the WiFi switch and conduct test runs to determine the correct amount of fish food to dispense.
4. Secure the WiFi switch away from water, using a scrap plastic container if needed.

Programming the commands of the Auto Fish Feeder

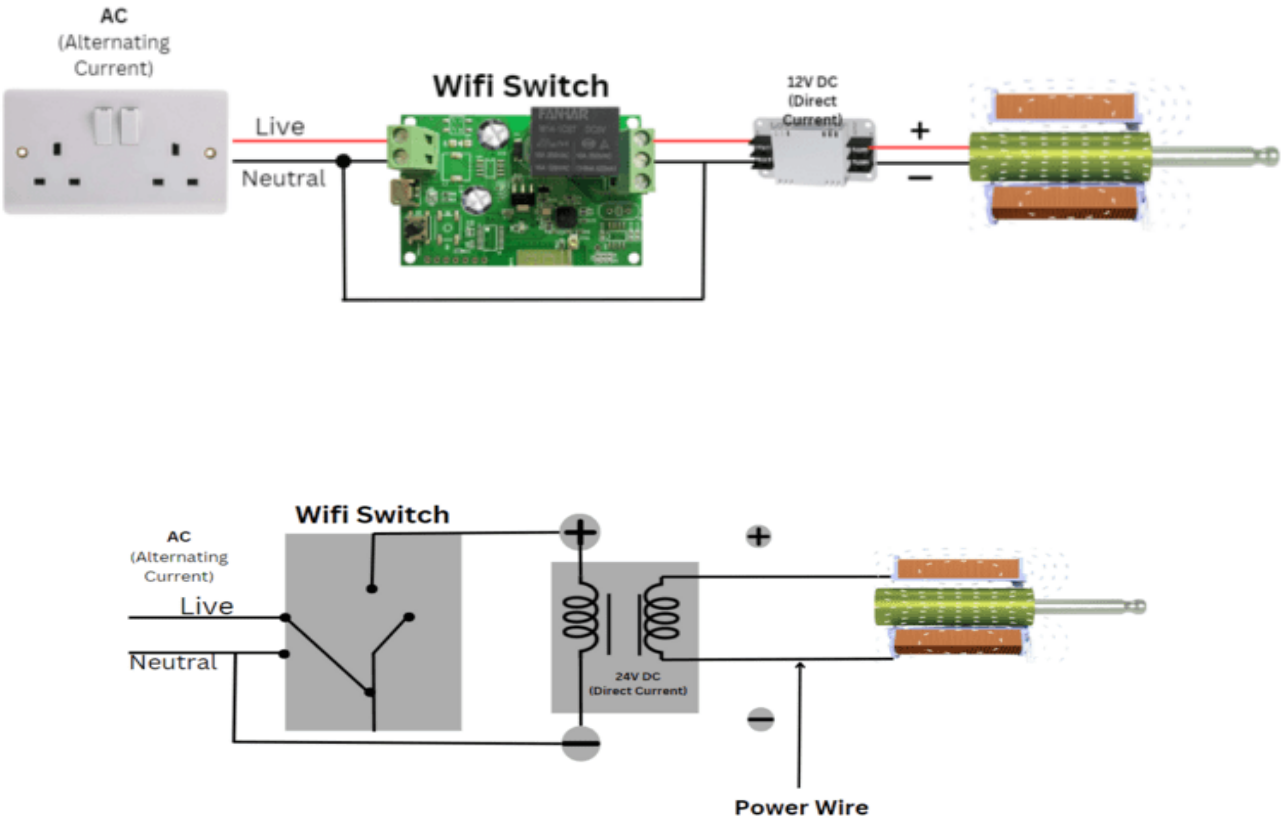
1. Open the application “E-control”.
2. Add the Wi-Fi switch as a device.
3. Pair the WiFi switch with your phone.
4. Set the desired feeding times in the app.



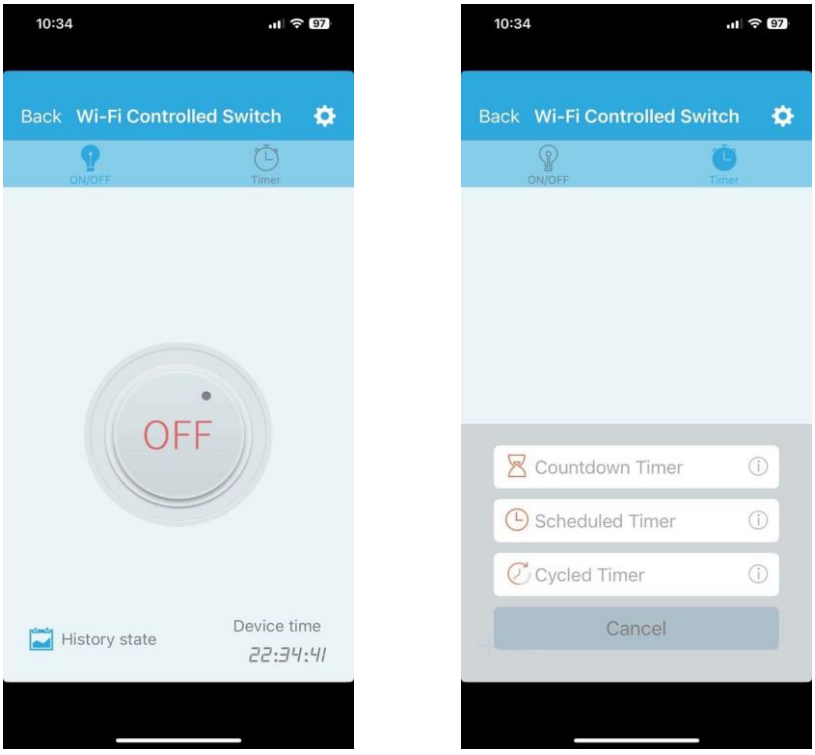
1.1 Exterior



1.2 Interior



1.3 Power Source



1.4 Application for Auto Fish Feeder Controls (End)

Figure 1: The Complete Overview of the Auto Fish Feeder

7. FINDINGS

This section presents the collected data and its results and interpretations based on the given research questions. The Auto Fish Feeder device was tested for the dispense delay, dispense amount, and device longevity, as written in the research questions of the study. Afterward, the collected data was then processed by getting the average unit per trial.

7.1. The delay of the Auto Fish Feeder in releasing the fish food

Table 1: Delay of the Solenoid's Time of Fish Food Dispense in terms of seconds

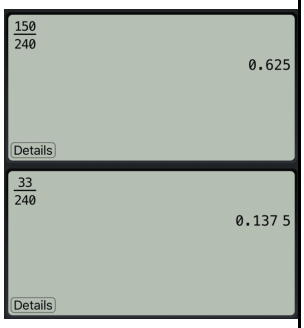
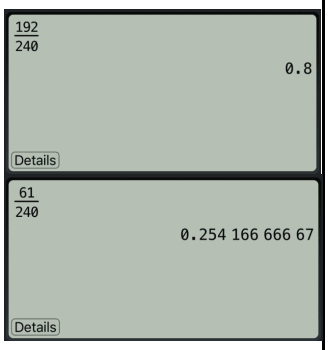
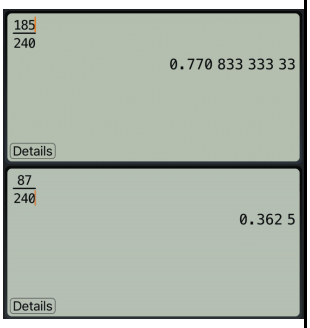
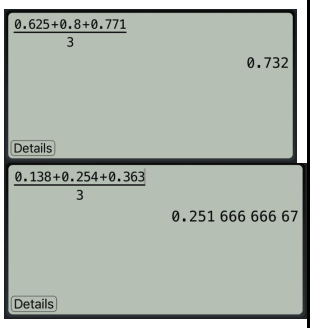
Trial	1	2	3	Average
Photos OPEN: CLOSE:				
Time	Open: 0.625s Close: 0.138s	Open: 0.800s Close: 0.254s	Open: 0.771s Close: 0.363s	Open: 0.732s Close: 0.252s

Table 1 illustrates the speed of the solenoid based on its delay time in seconds. The delay of the solenoid was recorded in a slow-motion camera and was calculated by dividing the number of frames before the solenoid moved to the FPS (frames per second) of the video. For consistency, three trials were conducted and the average was computed by adding the results of each trial and dividing it by three. In trial 1, the solenoid took 0.625 seconds to open and 0.138 seconds to close. In trial 2, the solenoid took 0.800 seconds to open and took 0.254 seconds to close. In trial 3, the solenoid took 0.771 seconds to open and 0.363 seconds to close. Evaluating the results of the trials, the average open delay time of the solenoid was 0.732 seconds and had a close delay time of 0.252 seconds. The results prove that the solenoid had a minimal delay because a certain length of time is required for the coil to overcome the coil inductance. Moreover, findings from a similar study showed that their automated fish feeder that uses a gear system has a significantly slower opening and closing time compared to the results of the automatic fish feeder powered by a solenoid (Banker et al., 2018). Compared with the gear system of a similar fish feeder study, the solenoid uses a push-and-pull mechanism which allows for rapid function of the device with less delay and faster dispense time. Furthermore, the valve opening response time is the time that passes between turning on the solenoid and attaining 90% of the stable outlet pressure. The amount of time it takes to de-energize the solenoid and wait for the pressure to drop to 10% of the test pressure is known as the response time for closing the valve (Pustjens, 2016).

7.2. The mass of fish food the Auto Fish Feeder produces per dispense

Table 2: Mass of Fish Food of the Auto Fish Feeder per Dispense

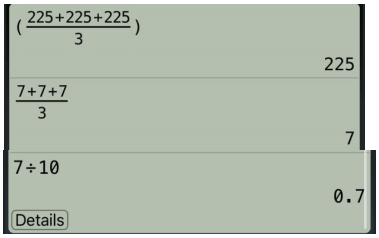
Trial	1	2	3	Average
Photo				
Weight	With bowl: 225g W/O Bowl: 7g	With bowl: 225g W/O Bowl: 7g	With bowl: 225g W/O Bowl: 7g	With bowl: 225g W/O Bowl: 7g 1 Dispense: 0.7g

Table 2 shows the total weight of the fish food each dispense was displayed in grams. Utilizing a weighing scale that uses grams as the unit of measurement to weigh the bowl weighing the fish food distributed by the auto fish feeder. Each trial included the execution of ten dispensing events to improve precision. In trial 1, the weight of the bowl with fish food is 225g. In trial 2, the weight of the bowl with fish food is 225g. In trial 3, the weight of the bowl with fish food is 225g. The total weight of the bowl with the fish food dispensed was deducted from the initial weight of the empty bowl to determine the average weight of the fish food per dispense. That would be 225 grams, the combined bowl and fish feed weight, subtracted by 216 grams, the bowl weight, then divide the difference by 10, the number of dispenses conducted.

Analyzing the results, it took an average of 0.7g per dispense. The results clearly show that the dispensing process was highly accurate in all three trials, consistently delivering an average of 0.7 grams per dispense. Additionally, a similar study showcased a lack of consistency in their dispensing. The findings showed a consistent 0.7g per dispense throughout the three trials, whereas a similar study showed three different results, across their three trials, the dispensing weights varied with values of 91.74mg, 97.08mg, and 95.23mg. (Ali et al., 2020).

7.3. The duration of the feeding cycle until the container of the Auto Fish Feeder becomes empty

Table 3: Duration of feeding cycle until the Auto Fish Feeder is empty

Trial	Time	Photo	Remarks
1	64 days		In the first trial, the auto fish feeder was able to dispense for up to 64 days.
2	63 days		During the second trial, however, the auto fish feeder was able to dispense up to 63 days
3	64 days		Lastly, the auto fish feeder was able to dispense for up to 64 days, similar to the results of the first trial.

Table 3 presents the duration of the Auto Fish Feeder's feeding cycle required for the complete depletion of the container. The results were measured using a digital balance to weigh the amount of fish feed, in grams, inside the container. The device was activated, and all the fish food was dispensed until the fish feeder's container was empty. Utilizing a constant variable of 100g as the weight of a single fish and a feeding session of 2.1 grams from the previous trials, the duration of the Auto Fish Feeder's time was taken.

Upon further examination of the results from three trials, it was observed that the first and third trials both achieved a dispensing duration of 64 days, while the second trial exhibited a dispensing duration of 63 days. Obtaining the average of these results, the auto fish feeder consistently dispensed 135 grams of fish, with an estimated overall duration of approximately 63.66 days until the container was empty. In comparison to a similar study conducted by Saahri (2015), the automatic fish feeder designed in the present study exhibits a longer capacity than the 2015 version, which proposed a 17-day capacity for every 3 grams of fish feed dispensed.

The obtained statistics indicate that the Auto Fish Feeder showed a consistent and efficient dispensing mechanism. The feeder's dispensing length of 63.33 indicates that it can consistently dispense a predetermined amount of fish feed over an extended period. Furthermore, the extended life span compared to the 2015 version, functions more proficiently and results in a more reliable and efficient automatic fish feeder.

8. DISCUSSIONS

Based on the results, the average open delay time of the solenoid was 0.732 seconds and had a close delay of 0.252 seconds in comparison to an automated fish feeder that uses a gear system with a slower opening and closing time. Additionally, the dispensing process was highly accurate in all three trials, consistently delivering an average of 0.7 grams per dispense. Furthermore, the feeding cycle of the fish feeder lasted for approximately 63 to 64 days for every 2.1 grams fed per session until the container became empty. The fast response time is critical for ensuring that the fish food is distributed precisely and without delay, which is necessary for maintaining a consistent feeding schedule. The consistency of the amount of fish food distributed across the three trials suggests that the Auto Fish Feeder is precise in its Distribution. This precision is essential for ensuring that the fish receive the correct amount of fish feed to prevent overfeeding or underfeeding. The fish feed container lasts for an estimated 64 days, which implies that it has long-lasting capacity and can provide consistent periods without frequent refilling.

9. CONCLUSIONS

To conclude, the developed Auto Fish Feeder performed the intended task quickly and lasted for a substantial amount of time. The study concluded that the duration of the auto fish feeder's opening and closing is instantaneous as the device has been estimated to have less than one-second duration. Next, it is concluded that the amount of fish food per dispense of the device was consistent throughout the three trials, implying that the auto fish feeder was precise in distributing fish feed. Lastly, it is concluded that the duration of the auto fish feeder's container is enduring as the Auto Fish Feeder can last for an estimated 63 days which is roughly two months.

10. RECOMMENDATIONS

Auto fish feeders are devices designed to automate the distribution of fish food in aquarium tanks. The device is useful for pet owners who keep aquarium fish in their homes. The device is also beneficial, particularly for pet fish owners who are preoccupied with working to feed aquarium fish. The Auto Fish Feeder is also helpful for business owners especially ones that handle fish tanks as the device is profitable due to the recycled materials used and the efficiency the Auto Fish Feeder displays.

The study benefits the community in complying with the school's mission of being pro-environment. Furthermore, the researchers advise individuals to utilize superior-quality materials to enhance the durability and the response time of the auto fish feeder, Pet fish owners and fish pet stores are encouraged to purchase and use a cost-effective Auto Fish Feeder with almost all of the capabilities of a high-end Auto Fish Feeder, a product that is compact and all-purpose and never needed to spend a high amount of money, the researchers advise the pet owners and pet stores to change to this solenoid powered auto fish feeder as its cheap and effective. With improper feeding leading to the deaths of many fishes and expensive devices that provide minimal functions and services, an auto fish feeder that is not only affordable but also provides a plethora of functions is a must to lessen one's errors in feeding and help pet stores save money.

Furthermore, it is important to note a significant limitation of this study: the feeder is based on a goldfish that weighs 100 grams. While this number serves as a basis, it poses challenges for compatibility with a diverse range of fish species, each with varying sizes and feeding habits. Consequently, the amount of food dispensed must be adaptable to accommodate different fish types and their dietary requirements. Additionally, the potential for uneaten food accumulation presents a hygiene concern, uneaten foods left for a long time may result in tank contamination and bacteria buildup. Future researchers may utilize this study as a source of knowledge from the researcher's accomplishments in the development of the Auto Fish Feeder, including the weaknesses and strengths in constructing an automatic fish feeder. This study will serve as the foundation for their research to scrutinize the complications that may appear along the way and produce excellent results. Furthermore, the researchers of the study would also benefit from the study as it would provide additional information.

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