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Development of an automatic fish feeder

[1]Ozigbo Emmanuel, [1]Anyadike Chinenye, [2]Gbadebo Forolunsho, [2]Okechukwu Richardson and [2]Kolawole Peter
[1]Department of Agricultural and Bioresources Engineering, University of Nigeria, Nsukka.
[2]Post Harvest Unit, International Institute of Tropical Agriculture, Ibadan, Nigeria.
E-mail: *emmanuel.ozigbo@yahoo.com*

ABSTRACT

An automatic fish feeder was designed, fabricated and tested. It eliminates major problems associated with manual feeding in aquaculture. The machine was powered electrically by one horse power motor. The overall dimension of the machine is 62 × 45 × 45cm. The hopper carrying capacity is 5.5kg/volume of hopper with a variable discharging chute. The timer was designed with a 24hour time step at user's specified discharge duration. Test results at the discharge time of 60 minutes showed that 85.5kg of feeds were evenly distributed across the pond. Less than 3% feed loss was recorded due to breakage and fragile nature of feed. The machine has 86.9% efficiency and adequately manages and preserves feed under harsh conditions.

Keywords: Feeders, FishFeeds, Machine, Aquaculture

Introduction

Nigeria is among the largest fish consumers in the world with over 1.5 millions tons of fish consumed annually. Yet, Nigeria imports over 900,000 metric tons of fish while its domestic catch is estimated at 450,000 metric tons/year (Davies *et al*, 2008). This dependence on imported fish has adverse effect on Nigeria economy. One of the ways to bridge the gap between the reduced fish supply and increased world food fish demand is through aquaculture (Ajana, 2003). However, one of the major challenges in aquaculture is feeding. Overfeeding and underfeeding is common in aquaculture. The former wastes feed and degrade water quality while the later results in poor growth which eventually leads to low productivity. Feed delivery in the correct form, at the right time and appropriate amount is expedient to increase and maintain a successful aquaculture production. Drudgery involved in manual feeding discourages aquaculturists, as it consumes time and human capital.

In view of these problems, an automatic fish feeder was developed with the aim of increasing fish production that will lead to higher economic returns, that will improved timeliness and precision operation, that will reduce labour requirement and minimize losses of feed and drudgery associated with hand feeding.

Methodology

The materials used in construction of this automatic fish feeder were locally sourced from readily available and quite common but adaptable materials. The design and construction was divided into two sections:

1. The mechanical section; and
2. The electronic sections

The following important considerations were made during the design and construction of the automated system; ability of the system to be compatible with the size and form of feed being used; ability of the system to protect the feed from degradation and spoilage due to rain, excessive heat, and moisture; reliability of the system's power source, timer, and drive mechanism under adverse environmental conditions; ability of the system to prevent grinding and crushing of pellets; justification of the expenses on capital and operational costs of the system over hand feeding.

The Mechanical Section

The materials used in the frame work include mild steel angle iron (45 × 45 × 6mm), mild steel sheet (1mm, 1.5mm) and air compressor engine. An air compressor tank (3 gallon), a compressor valves, flat bar (1 inch) and mild steel electrodes with air and fuel hoses were used. Light stainless pipe, metallic blower, electric motor with bolts and nuts were assembled.

The Frame and the Hopper of the feeder

The frame was designed to supports the other components. The overall dimension of the frame is re 65cm x 45cm x 45cm. It was constructed using 45mm x 45mm x 6mm thick angle iron and 2mm mild steel plate. A metallic 5.5kg hopper was designed to hold and protect the feed from degradation and moisture as shown on figure 1 and 2 below.

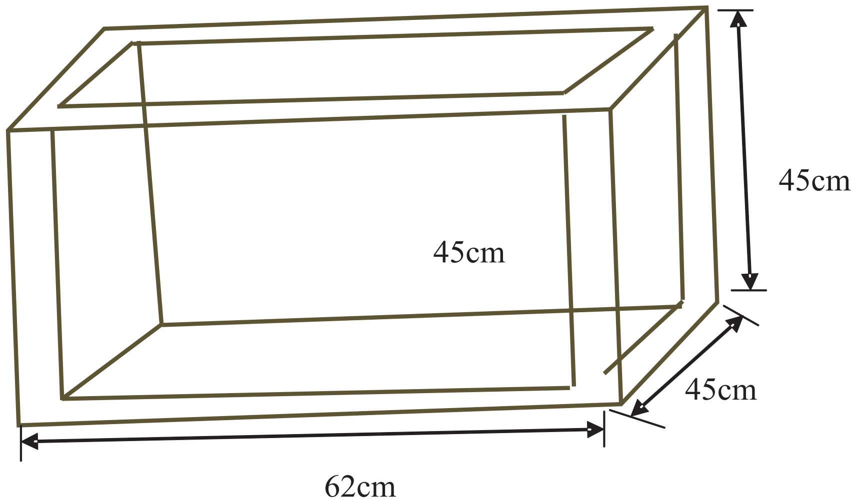

Figure 1: Box

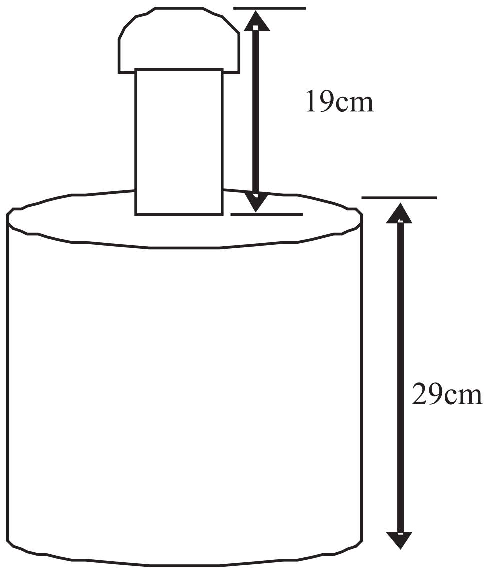

Figure 2: Hopper

The Metallic Blower

An impeller creates actual suction in for the blower. The impeller was placed directly onto the shaft of the electric motor so that it spins at a very high speed. The spinning air moves outward away from the hub by creating a partial vacuum.

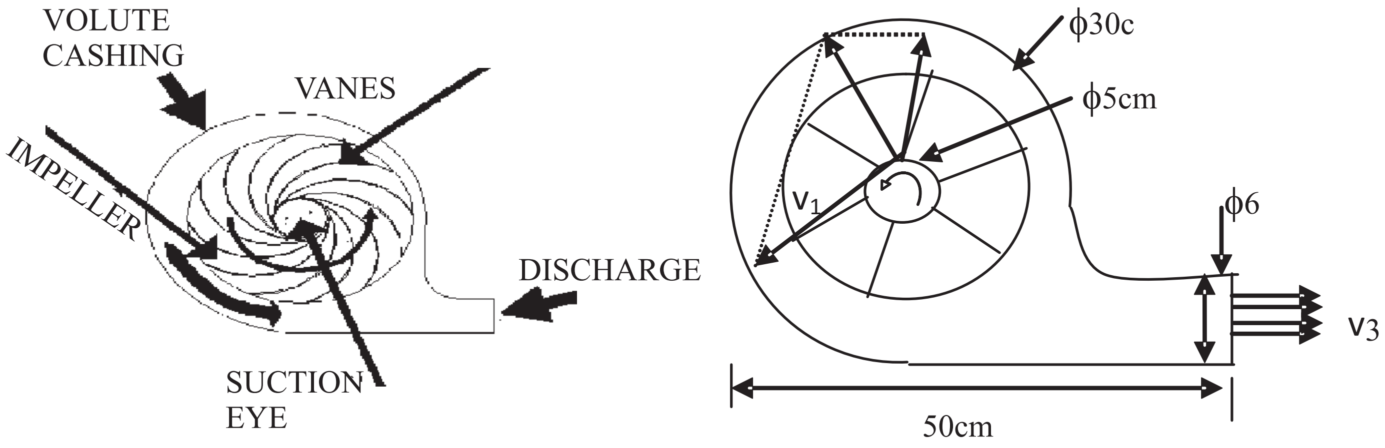

Figure 3: Sectional Drawing of a Blower

The Electronic Components

The component parts of the electronic circuit automatically control the machine. The whole of this section was built on assembly language coded on a microchip (microcontroller) designed to store information. The electronic components include; Microcontroller (PIC 16F 84A); Transformers (9V-0V-9V); 12V Relay (s); Capacitors (1000μF/50V, 4.7μF/25V, 104μF/25V); Resistors (1kΩ × 11and 4kΩ × 10); Transistors (C1815 × 10); Regulators (LM7812, LM 7805); Integrated Circuit (CD 4017); Light Emitting Diodes (LED × 3); Diodes (IN4007 × 6); Crystals (4MHz); Vero board, LCD Display sensors Leads; Connecting Wires and Solenoids; 7 segment display × 8; Plugs Insulating Sleeves; Casing; Push Switches

Microcontroller

The designed circuit diagram is given in fig.4 below.

The program was written in assembly language.

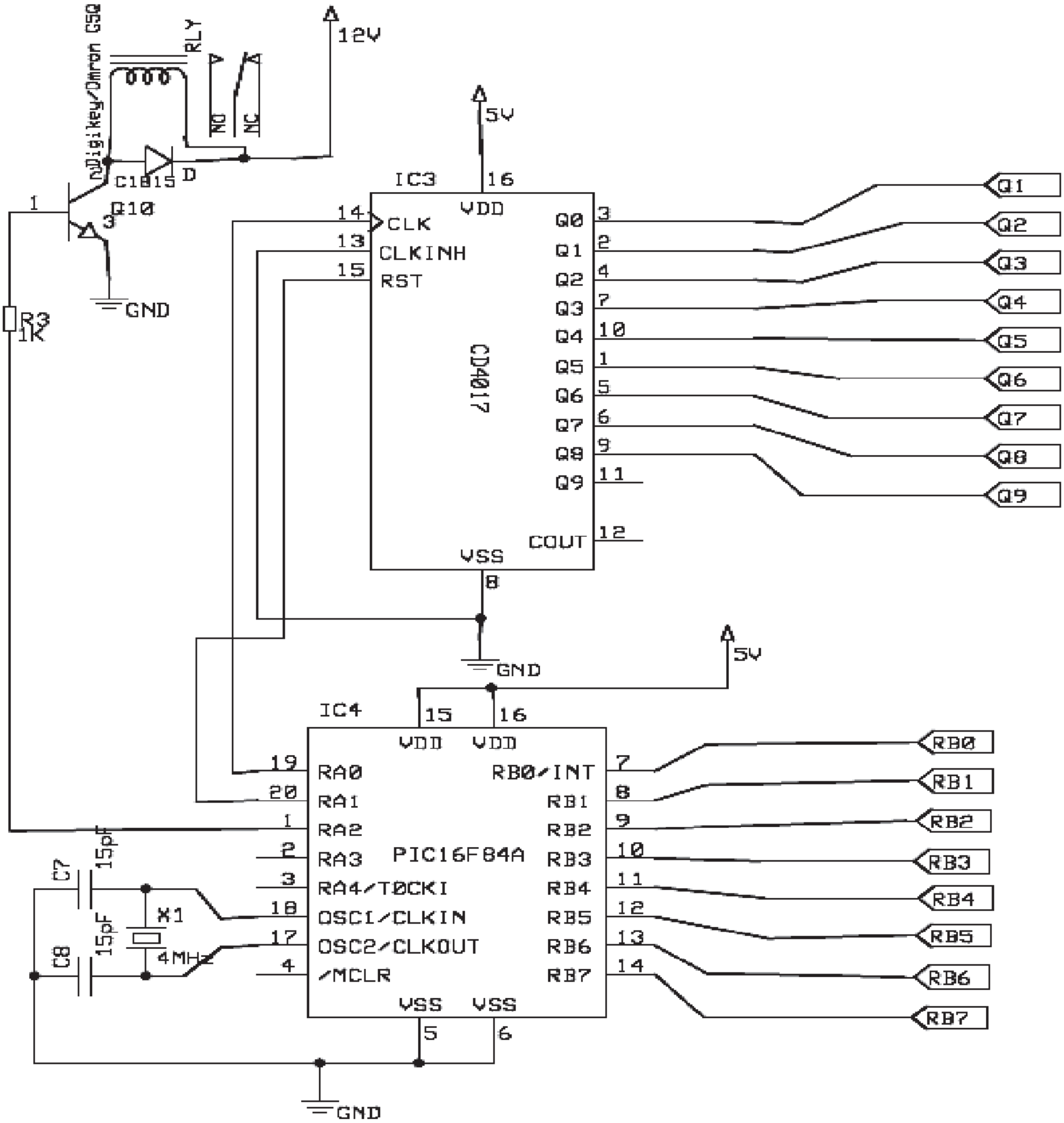

Figure 4: Circuit Diagram of the Microcontroller Power supply unit

A 9V-0V-9V transformer was used to reduce the main voltage from 240V AC to 18V AC. 18V AC was rectified by four (4) diode (IN4007) which were connected as bridge rectifiers. The output of the rectifier was filtered by 1000μF capacitor. This maintains a ripple free DC supply. The DC output was regulated to 12V by 7812 IC and 5V by 7805 IC with 12V relay, the 5V was supplied to the microcontroller. The microcontroller process and controls set of codes loaded in it. Both the mechanical and electronic systems were connected as shown in figures 5 and 6 to electric motor (1 horse power).

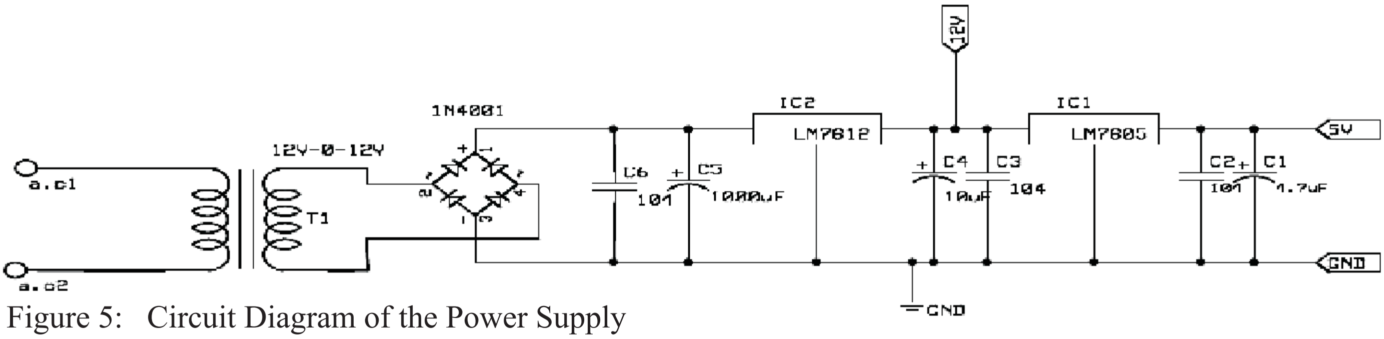

Figure 5: Circuit Diagram of the Power Supply

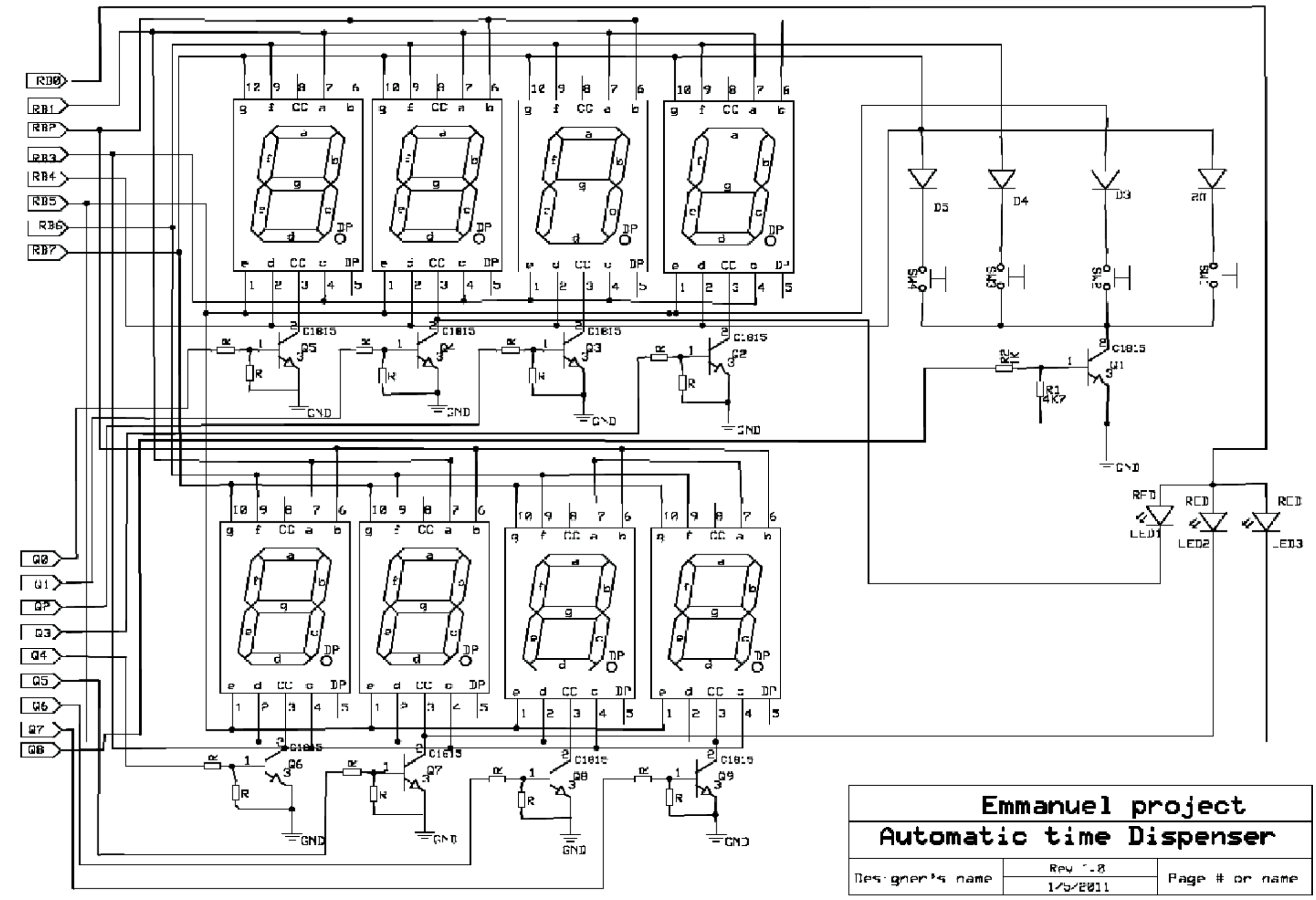

Figure 6: Circuit Diagram of the 7-Segment Display

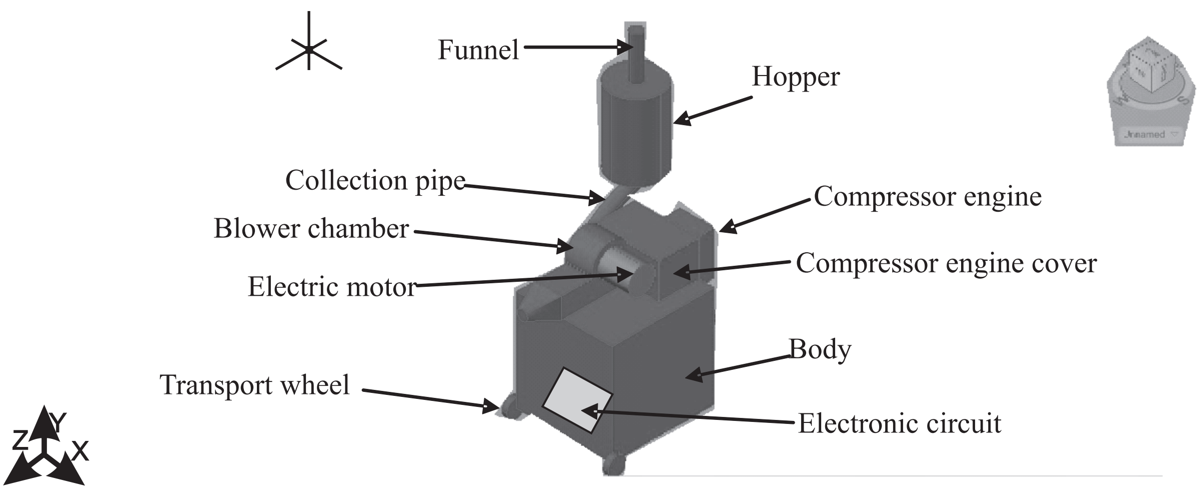

Figure 7: The 3-Dimensional Angle Front View in AutoCAD

Performance evaluation

The machine's hopper, (approximately 5.5kg) capacity was filled to the brim and allowed to discharge till the tank was empty (No specific interval of time). 4.78kg of the feed was delivered.

The efficiency was calculated using the formula below:

$$\text{Eff.} = \frac{\text{Quantity of the discharge}}{\text{Quantity of the feed input into the feeder}} \times 100$$

$$\text{Eff} = \frac{4.78 \text{ kg} \times 100}{5.5 \text{ kg}} = 86.9\%$$

Note: The remaining 0.72kg not undelivered were hanging in the bottom of the flat hopper and blower chamber. This experiment was repeated five consecutive times and the average mark was taken.

Further test on the feeder: 4kg of (4mm local fish feed) was weighed and poured into the hopper, the automatic feeder was powered with automatic panel bearing push switch, the segment display emits diode light turned on immediately with the clock mode. This was set followed by on time (when the feeder would start running) and off time (when the feeder would stop running respectively). The results obtained were listed on the table 1 and 2 below both for the develop feeder and purchased foreign feeder at different time intervals.

RESULTS

Table 1. Quantity of feed discharge and time interval for (4mm local vital) feeder

Test number	Time interval (sec)	Quantity of feed discharge (kg)
1	120	1.8
2	90	1.3
3	60	0.95
4	30	0.72
5	15	0.51

Table 2. Quantity of feed discharge and time interval for (4mm foreign vital) feeder

Test number	Time interval (sec)	Quantity of feed discharge (kg)
1	120	2.85
2	90	2.1
3	60	1.55
4	30	1.0
5	15	0.75

Discussion

The feeding efficiency was found to have improved significantly when compared with other feeders as presented in tables 1 and 2. The machine delivers both fingerlings and adult fish feed of about 6-10mm. The price is affordable and operation is simple, it can be operated by any gender. The moisture control mechanism is adequate unlike some local fish feeders because of the incorporated air compressor that introduces air into the feeding trough which keeps the feed away from moisture. Its feeding time is flexible.

Conclusion

This prototype machine was designed, constructed and tested. It is a very simple machine with low maintenance cost. It has high delivery capacity and adaptable automatic device for fish feeding. Based on the result of the performance evaluation carried out some modifications might be considered. The hopper size could be increased to accommodate larger quantity of feeds when considered for mass/commercial production. Inverter circuit should be incorporated into the electronic system to keep the machine functional in the absence of electricity.

References

Ajana, A.M. (2003). Economic Development of the Niger Delta: The Role of Fisheries. A paper presented at the 1st Niger Delta Stakeholder Agricultural Forum, organized by NDDC, in Port Harcourt.

Davies, R.M., Davies, O.A., M.B. Inko-Tariah and D.O. Bekibele (2008). The Mechanization of Fish Farms in Rivers State, Nigeria. World Applied Sciences Journal 3 (6): 926-929.

Ezenwa, B. And P. E Anyawu, (2003). Water Reciculatary System Technology as a Major Tool for increased Fish Production by Private Fish Farmers. Processing of the 18th Annual conference of the Fisheries Society of Nigeria (FISON) Owerri.

FAO (2009). Fish farming is the way forward. "(Big Picture)(Food and Agriculture Administration's State of Fisheries and Aquaculture' report)". The Ecologist 39.4 (2009): 8-9. Gale Expanded Academic ASAP.

Green, Bartholomew W. (2008)"Aquaculture." Microsoft® Encarta® 2009.

Kühlmann, K.-J., Jintasataporn O., Lückstädt, C. (2011). Dietary potassium diformate improves performance of while shrimp production under controlled conditions. Aquaculture Asia Pacific, 7(2):22-24.

Lückstädt, C., Kühlmann, K-J. (2011). The use of diformates in tilapia – ways to improve performance sustainability. Infofish International (2):22-25.

Mohd Nizam, Mohd Nor (2008). Development and prototyping an automatic fish feeder. EngD thesis, Faculty of Mechanical Engineering, Universiti Malaysia Pahang.

Yeoh S. J., Taip F. S, Endan J., Talib R. A and Mazlina Siti M. K (2010). Development of Automatic Feeding Machine for Aquaculture Industry. Department of Process and Food Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia.