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Design and Prototyping The Automatic Fish Feeder Machine for Low Energy

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***Abstract*— The focus of this paper is to propose the design of energy-efficient automatic feed machines with reasonable accuracy. This paper also presents the results of measurements of electrical energy consumption. Observations carried out include the consumption of electrical energy in each unit with feed weights of 2 mm and 4 mm. Each feed sample was measured based on electrical energy consumption, optimizing machine work processes for feed weight, and identification of optimization in the ejection system. The results of this study have succeeded in making the design of an automatic feeder machine have been proposed with the performance characteristics being that the total electrical energy consumption and the duration of the process for each feed size are 2 mm and 4 mm. Feed size 2 mm with a weight of 2 kg requires a total consumption of electrical energy amounting to 0.085Wh. A feed with a 4 mm size requires electrical energy consumption of 0.0907Wh. The duration of the process for 2 mm feed size with a weight of 2 kg is 1 minute and feed size 4 mm with a weight of 2 kg requires a process duration of 1.2 minutes.**

Keywords—feeder, energy, fish, automatic, machine.

I. INTRODUCTION

The fish livestock industry has become one of the sources of regional income in Indonesia. Therefore, this industry has received more attention from policyholders. One problem in the terrestrial fish farming industry, exceptionally for large scale industries is the lack of quality livestock production due to lack of attention in providing fish feed. The use of human labor in feeding requires high costs; also, the accuracy and consistency of feeding time are less than optimal. Some entrepreneurs use robots or fish-feeding machines so that the consumption of fish feed can be organized with the appropriate quantity. The use of a feed machine can guarantee the weight of fish as needed [1], [2].

Researchers have developed several models of fish feeding machines [2], [3], [4]. Then a fish feeding machine design with automated technology in [2], [2]–[6], [7] has also been developed. Fish feeder machine with Arduino based was proposed by M.Endebu in 2016 for small scale [4]. Feed throwing techniques into ponds using DC motors with turbines have not been proposed in previous studies. Several models and products that have been offered do not provide fish feed throwing facilities to the pond. Therefore, this paper proposed to design and manufacture an automatic fish feeding machine with a throwing system. The feed machine is designed so that the working procedure of the machine can be programmed. In this paper, a control system is proposed using an AT-Mega type of Arduino-Uno microprocessor.

Machine performance is measured only on the consumption of electrical energy, the accuracy, and consistency of each machine unit during work and based on the size and weight of the feed processed to the machine. Machine control technique using AT-Mega microprocessor is one of the solutions in the control industry. The advantage of the control system with a microcontroller is that it is easy to program, is inexpensive, and has excellent working accuracy [8], [9]. Additionally, AT-Mega allows machines to communicate wirelessly [10].

II. METHOD

A. Work Flow Procedure

Fig.1 shows the flowchart of the automatic fish feeder machine design. The work procedure of the machine starts with the scheduling system of the control board module. On the control board, the user can enter two parameters, namely the quantity of feed and the unit of kg and time of feeding. Then at the specified time on the control board, the machine starts to open. Hence, gate A will open, and the load sensor weighs the feed. The load sensor will stop if the feed weight has been validated and as desired through the program control board, then gate B closes. Spiral conveyors deliver feed to the ejection system, and feed is ejected until the feed in the ejection system is exhausted. Then gate B is closed again for the machine to repeat the work procedure.

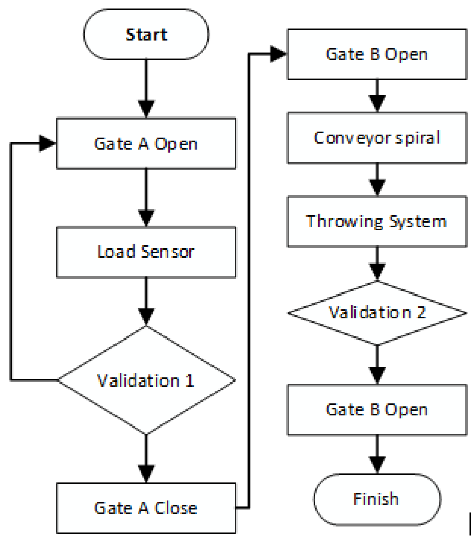

Fig.1. Flow chart system.

B. Machine Layout Design

Fig.2 is the proposed machine layout. The machine consists of six main parts, namely container, Gate A, load sensor, gate B, spiral conveyor, ejection system. Gate A is a valve to move feed from the container to the feed weight

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system. The feed weighing system consists of Gate B and load sensors. The working principle of the feed weighing system is to weigh the feed. After the feed in the weighing system is validated according to the program, feeding the sensor will provide a trigger to the control board to close gate A and open gate B. The spiral conveyor functions to direct the feed to the thrower system after weighing. Throwing system serves to catapult feed into the pond at a certain distance so that the feed is given indirectly to the middle of the pond or the place according to the target.

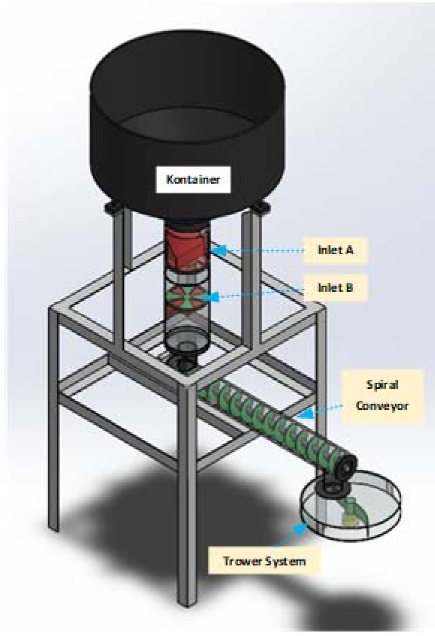

Fig.2. Machine layout design.

C. Board Diagram System

Fig.3 shows the overall system block diagram. Block diagrams consist of Arduino-Uno, displays, relay modules, power supply, load sensors, gate A, gate B, spiral conveyor, thrower system. Arduino-Uno acts as the central board controller system which controls the drive system on the load sensor unit (load cell), gate A, gate B, spiral conveyor, thrower system, besides that, Arduino gets a signal from the load sensor as a trigger. The LCDs the time feed data on the control board.

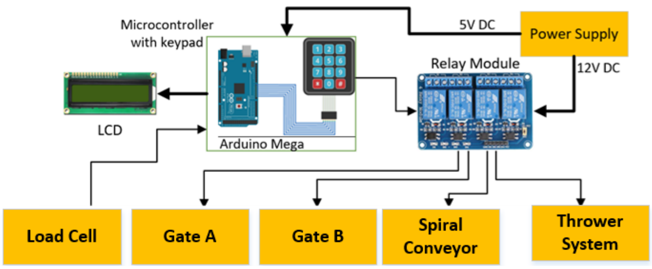

Fig.3. System board diagram.

D. The layout of the Controller Board

Fig.4 shows the layout of the controller board. The control board consists of three task inputs, each of which contains a schedule for feeding, feed weight, and the task record button. LCD to display time and weight information to be stored in Arduino memory. The control board design shows the position of the feeding time setting button placed next to the feed weight adjustment button, which will be provided for each service by the machine. The enter button is also placed adjacent to the other buttons. This is dedicated to being easily used by users who have high anxiety about technology.

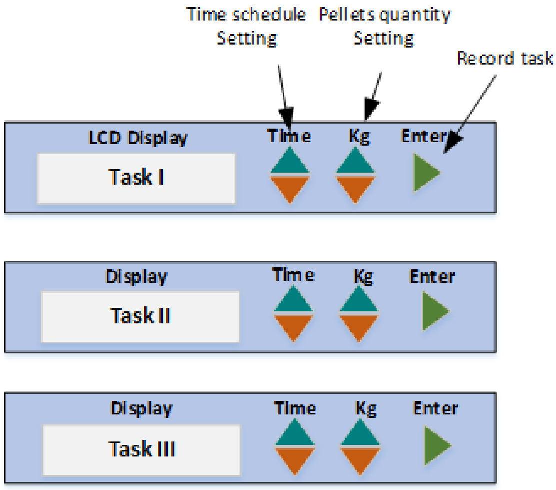

Fig.4. Front end controller board layout.

Fig.5 shows the arrangement of the modules inside the control board of the feeding machine. The laying is arranged in such a way so that the wiring module becomes neat and competent in using space. The modules in the control board consist of seven modules, namely power supply, Arduino-Uno as MCU, DC motor speed control, RTC, load sensor interface, IO module, relay module.

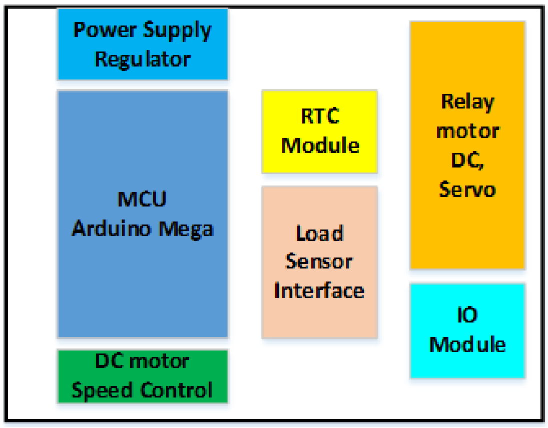

Fig.5. Back end controller board layout.

E. Testing Method

Machine testing techniques are carried out on variations in different feed sizes, namely the size of 2 mm and 4 mm. The order was applied to machines for various weights, from 0.5 kg to 5 kg with multiples of 0.5 kg for each system trial. This feed size is a measure commonly used in the large-scale fish farming industry. There is a process for each type of feed size, then measured the voltage and current values for each unit (module), measured changes in speed. Measurement of the duration of each process cycle of the machine is measured using a stopwatch, while energy consumption, voltage, and electric current are measured using a Kyoritsu Kew 6315 measuring instrument, the speed of rotation in each module is measured using a digital tachometer.

III. Result and Discussion

The feed machine assembly, as shown in Fig.6. Sequentially from the top position are the feed container, gate A, gate B, load sensor, spiral conveyor, thrower system. The results of testing the energy consumption of one time the working cycle of the machine for a sample size of 2 mm feed with a weight of 1kg obtained that the consumption of electrical energy is 0.0048Wh with 3 seconds duration of work. The results of testing the energy consumption of a single work cycle of the machine for a sample size of 4 mm feed with a weight of 1kg obtained that the consumption of electrical energy is 0.007Wh with a working duration of 3.5 seconds.

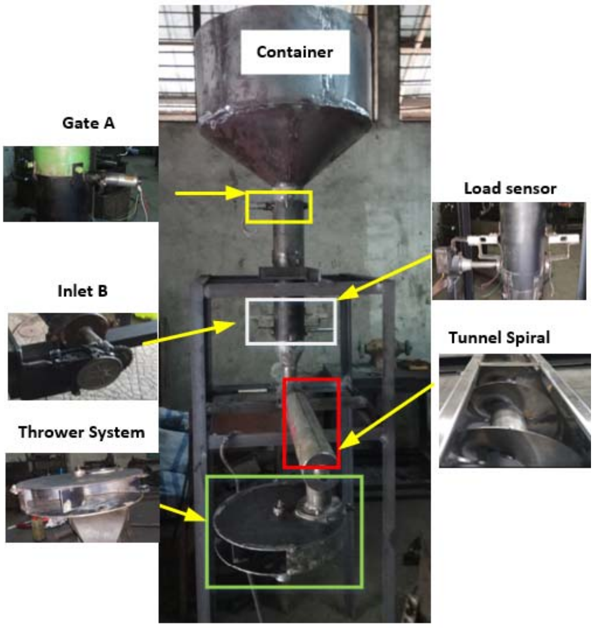

Fig.6. Assembling of feeder machine.

In tests with feed weights above 2 kg, energy requirements increase significantly, while the duration of the work cycle for feed weights above 2 kg does not experience significant changes. Nevertheless, the electrical current needed by the system is increasing, so that electrical energy increases significantly, from Fig.7, it can be concluded that the proposed feed machine can work optimally in one work cycle with a maximum feed weight of 2 kgs.

Fig.7 shows the results of feed rate testing on the main inlet conveyor (inlet A). At 2 mm feed size with feed loads ranging from 0.5 kg to 5 kg, a change in the rate of feed is obtained with time. The highest value of feed transfer rate is obtained at 2 kg load, and this applies to the 2 mm and 4 mm feed sizes. Thus, it can be concluded that the optimal feed rate is at 2 kg of feed weight.

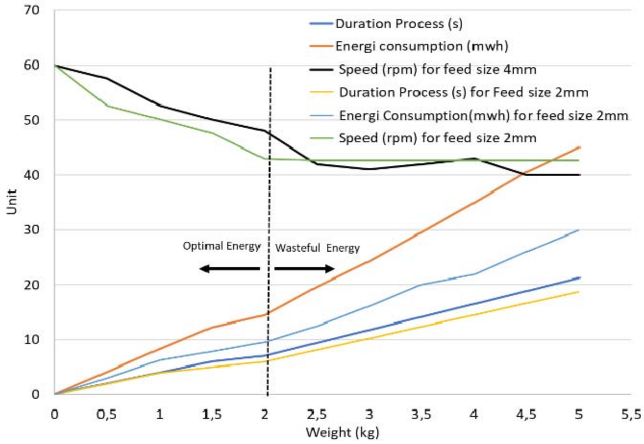

Fig.7. The results of the measurement of the duration of the process and feed displacement energy at 2 mm feed size.

Fig.8 shows the relationship between feed size and electrical energy consumption in a spiral conveyor. Measurement data shows that the larger the feed size, the higher the energy consumption needed. The 2 mm feed size and 1 kg weight require 32s duration of the process and requires 0.0381Wh. Feed size 4 mm and weighs 1 kg requires a duration of the process of 42s and requires the energy of 0.0497Wh. Rotation of spiral conveyor for feed weight of 1 kg is 90 rpm. This condition is still acceptable, given that the minimum rotation of a spiral conveyor with a DC motor drive is 40 rpm.

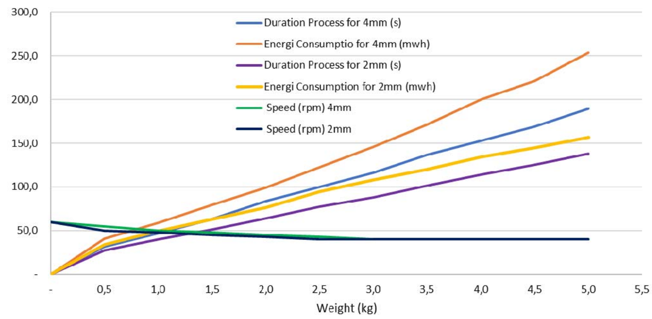

Fig.1. The results of the measurement of the duration of the process and feed displacement energy at 2 mm and 4 mm feed sizes in the spiral tunnel.

Fig.9 shows the results of the feed rate testing on a spiral tunnel (spiral tunnel). At 2 mm feed size with feed loads ranging from 0.5 kg to 5 kg, a change in the rate of feed is obtained with time. The higher the feed load, the greater the feed flow rate in grams per second. Nevertheless, the feed flow rate tends to be stable at a feed load above 3.5 kg, the feed rate occurs at 25 grams / s for feed sizes 4 mm and while at feed loads above 4.5 kg, the feed rate at 36 grams / s occurs for 2 mm feed size.

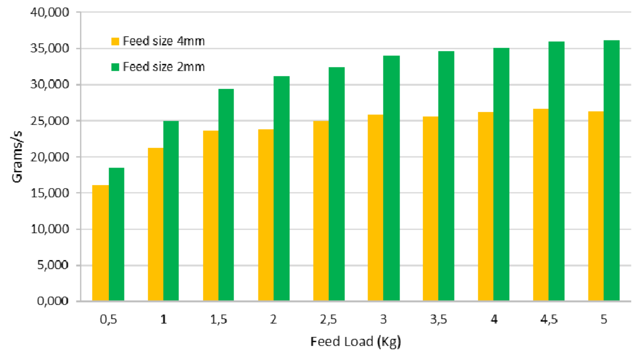

Fig.2. Feed Speed Transfer Rate in Spiral Tunnel with a feed size of 2 mm and 4 mm.

Fig.10, shows the changes in energy consumption, process duration, and rotational speed of the given feed load. At a maximum feed weight of 2 kgs with a 2 mm feed size, electricity consumption reached 74.8mWh, and the process duration was 64 seconds, while at 4 mm feed size, electrical energy consumption reached 98.2mWh and the process duration was 84 seconds.

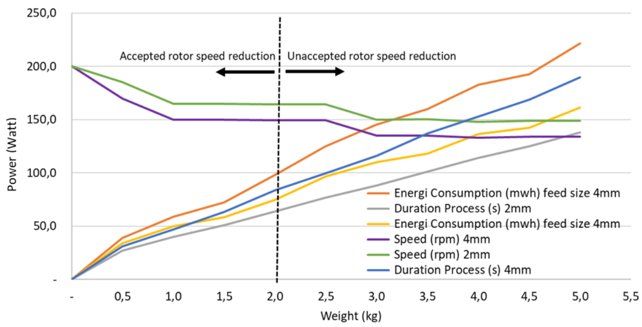

Fig.3. The results of measuring the duration of the process and energy consumption in the thrower system for feed sizes of 2 mm and 4 mm.

The performance of the ejection system is shown in Fig.11, where a feed of 2 mm in size requires 1645 rpm to be used to feed the fish to the center of the pond. In the 4 mm feed, the rpm decreases to 1297rpm. It is tested on 2 mm feed sizes with weight variations ranging from 0.5 kg to 5 kg. The result is that the feed rate in the ejection system will continuously be started at 3.5 kg of feed weight, but the driving motor on the spiral conveyor gets hotter. Therefore, the working conditions of a safe spiral conveyor for 2 mm feed size are 2 kg in weight, while for 4 mm feed size it can be done at 1 kg.

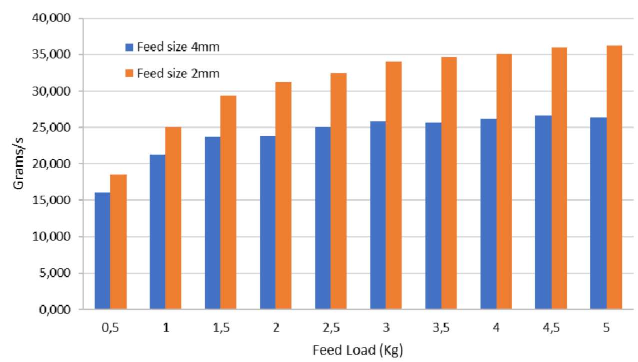

Fig.4. Feed Speed Transfer Rate in Thrower System with a feed size of 2 mm and 4 mm.

Fig.12, is the total electrical energy consumption and process duration for each feed size are 2 mm and 4 mm. The 2 mm feed size with a weight of 2 kg requires a total electrical energy consumption of 0.085Wh. A feed with a 4 mm feed size requires electrical energy consumption of 0.0907Wh. The duration of the process for 2 mm feed size with a weight of 2 kg is 1 minute and feed size 4 mm with a weight of 2 kg requires a process duration of 1.2 minutes.

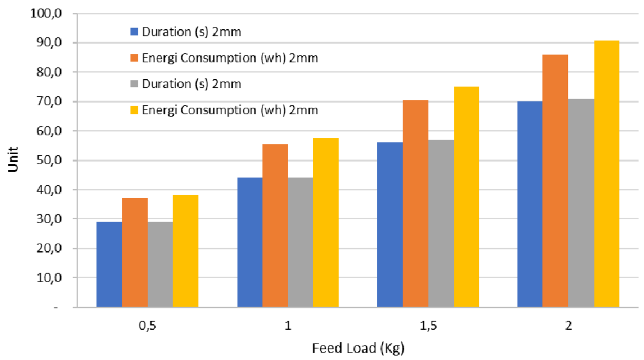

Fig.12. Total electricity consumption, process duration for feed sizes of 2 mm and 4 mm.

IV. Conclusions

The design of an automatic feeding machine has been proposed with the performance characteristics that the total electrical energy consumption and the duration of the process for each feed size are 2 mm and 4 mm. 2 mm feed size with a weight of 2 kg requires a total electrical energy consumption of 0.085Wh. Feed with a 4 mm feed size requires electrical energy consumption of 0.0907Wh. The duration of the process for 2 mm feed size with a weight of 2 kgs in 1 minute and feed size 4 mm with a weight of 2 kgs requires a process duration of 1.2 minutes.

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