Development of Control Mechanism of Fish Farm Feeding Machine

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ABSTRACT

Fish feeding is very important to ensure the survival of the fish for fish owners, whether as domestic pet or in an aquacultural entreprise. However, the development of aquaculture in Malaysia is impeded due to difficulties in land acquisition, rising production costs, lack of skilled labor and threat of diseases. Therefore, there is a need for the development of a control mechanism for the fish farm feeding machine. In this research, a control mechanism for a semi-automated or automated feeding was developed and the performance analysis on the control mechanism carried out. Arduino microcontroller was used in developing the control mechanism of the fish farm feeding machine. The prototype was developed and served as a platform for the programming and testing. Suitable DC motors were selected based on the results of the control mechanism analysis with the improved solutions. In terms of the performance analysis, the effective dispenser range is found to be between 1 and 2 m. The pellets dispensed count drop is deemed outside the effective dispenser range. Financially, the mechanism required a total of RM925 for its development, which is within the allocated budget of RM1500. From the results, the control mechanism of fish farm feeding machine was successfully developed with a low-cost budget.

Keywords: *Fish farm feeding machine, control mechanism, automation, microcontrollers*

1.0 INTRODUCTION

Fish feeding is very important to ensure the survival of the fish for fish owners [1]. In Asia, the production of aquaculture contributes around 91% of the world's total by volume. Asia has also been the highest seafood consuming region of the world, accounting for two-third of the world's food fish supply [2]. In Malaysia, aquaculture has developed rapidly since 1920 and is now an important way for increasing the local production for food security and increasing export revenues [3]. The fisheries sector in Malaysia has provided a direct employment of 89,453 fishermen and 21,504 fish culturists. The consumption of fish in Malaysia is expected to increase by 14% by 2010 and currently, the country is producing 89% of the fish supply for its own consumption [1]. However, the development of aquaculture in Malaysia is impeded due to difficulties in land acquisition, rising production costs, lack of skilled labour and threat of diseases.

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There are three major freshwater species groups farmed in Malaysia aquaculture which are the tilapias, catfishes and carps. Freshwater aquaculture in Malaysia adopts various culture systems such as ponds, former tin mining pools, cages and tanks or pens. The use of former tin mining pools for freshwater aquaculture is unique to Malaysia due to many abandoned sites that are now filled with water [4].

Two types of fish feeds are commonly practised, namely, the floating and sinking feed. Both types produce satisfactory growth but some of the fish species have preference for the floating or sinking type. For instance, shrimp prefers sinking feed while most of the fish species can be trained to accept a floating feed [5].

Feeding action can be done by manual with hands or automation with dedicated machines. The feeding activity is executed by manually scattering feed over the side of the ponds or cages or with the use of automatic feeders. Manual feeding is labor intensive and inefficient. On the other hand, automated feeding that were produced [1, 6-8] is efficient and reduces manpower prerequisite for fish farm. Automated feeders also can be cost wise by reducing labor requirements and encourage large volumes of feed to be fed efficiently. Automatic fish feeders utilize several mechanisms to dispense fish feed. The size of the fish and the design of the culture system are the factors in determining the choice and complexity of the automated systems required [9]. Each mechanism has its own strengths and weaknesses which affect automatic fish feeders control mechanisms. This system already been used in Thailand, Belgium, United States and Italy but this system still in research and development [10]. Only selected fish farms in Malaysia adopt the automated feeding system while small-scale farmers generally rely on hand feeding [11].

The objective of the project is to build a control mechanism that matches with the fish farm feeding machine functions. Furthermore, it is to control the fish farm feeding machine with digital means by mobile application.

2.0 METHODS AND MATERIALS

The project was started by reverse engineering a previous fish farm feeding machine. Restoration attempt was made on the previous fish farm feeding machine to understand the feeding mechanism and the control mechanism. A site visit was carried out to investigate the fish farm layout and to determine the fish farm feeding machine design. A research background was done to gain a better understanding of aquaculture and potential control mechanisms. The block diagram in Figure 1 shows the fish farm feeding machine operation.

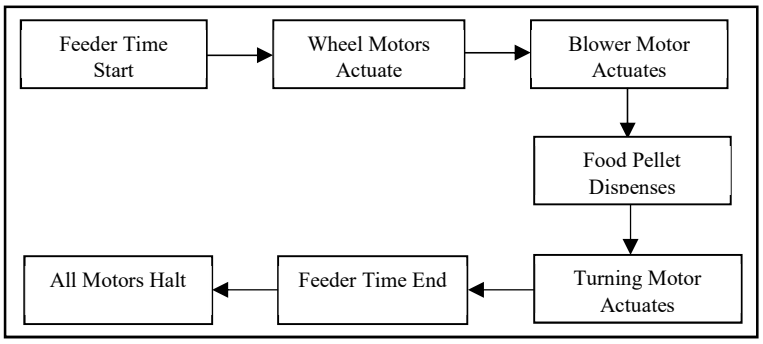

Figure 1: The block diagram for the fish farm feeding machine operation

When the feeder time starts, the fish farm feeding machine moves to the designated point. A total of 2 kg feed pellets that were put into the storage were later fed into the barrel via the tube connected to the storage. The feed pellets were then blown by the blower, exiting the barrel to dispense. The turning motor turns the upper body clockwise and counter clockwise alternately while dispensing the feed pellets. When the feeder time ends,

the fish farm feeding machine moves back to its initial point. Table 1 summarizes the components selection for the control mechanism of the fish farming machine. The battery supplies power to the fish farm feeding machine to drive the DC motors and the microcontrollers.

Table 1: The components for the fish farm feeding machine control mechanism

Element	Component/Equipment
Power supply	Battery
Motors	DC motors
Electronic board	Microcontroller
User interface	Touch Screen
Connectivity	Wi-Fi

The DC motors were used to actuate the fish farming machine, blow for dispensing feeds and rotate the feed blower housing. The microcontroller was fitted with a touch screen for manual control and Wi-Fi feature for the wireless control.

The control mechanism analysis was carried out to choose the most suitable DC motor to actuate the fish farm feeding machine. The feeding range and capacity were analyzed to determine the fish farm feeding machine capability. The wheel analysis was performed based on two situations, which are moving on a normal plane and climbing an inclined plane because the input torque required by the wheel motors are different due to terrain conditions.

3.0 RESULTS AND DISCUSSION

Microcontrollers based on *Arduino* boards were selected to control the fish farm feeding machine. Microcontrollers have high versatility, high customization and are widely available in markets. The microcontrollers in the fish farm feeding machine drive seven DC motors with widgets in the smart phone application. Microcontrollers provide wireless connectivity to the machine and are controlled via Internet. Moreover, microcontrollers provide automation to the machine with a time input. The machine can be run automatically on the specified schedule for convenience and reducing labour requirements.

Due to the fish farm feeding machine casing/chassis is still under development, a prototype to the fish farming machine was created and the microcontrollers were mounted onto it for programming and testing. The errors in the program can be observed and corrected (troubleshoot) before the microcontrollers were installed into the fish farm feeding machine chassis. The double joysticks manual control in Figure 2 was designed to ensure the manual control is ergonomic to users. Necessary changes were made to accommodate the fish farm feeding machine new casing design as shown in Figure 3.

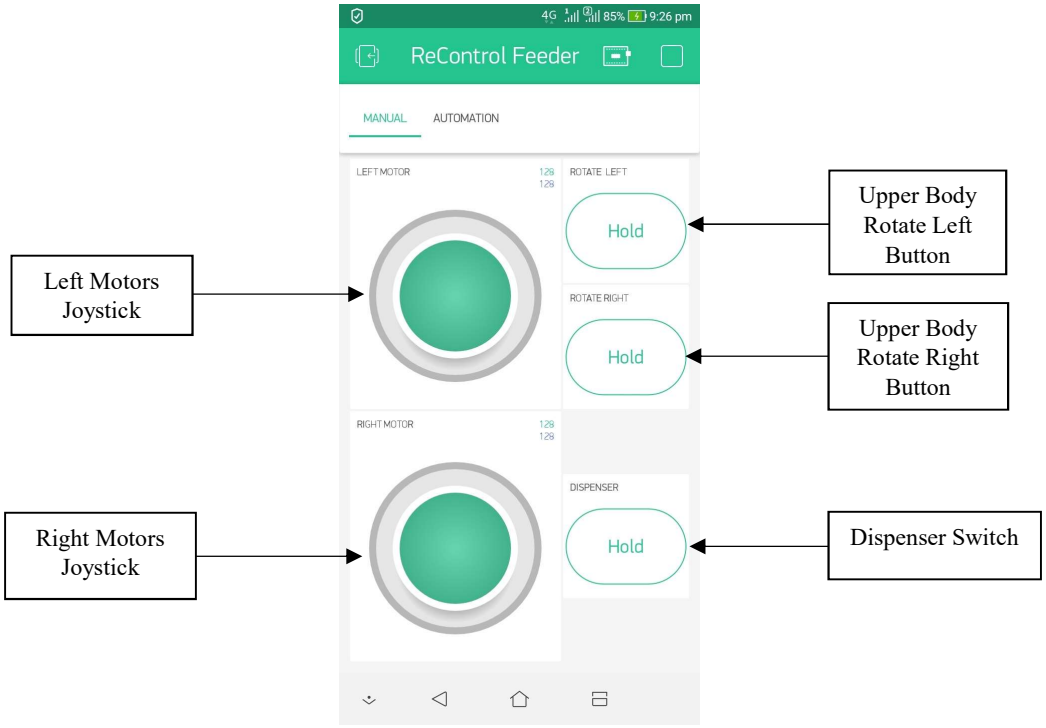

Figure 2: The double joysticks manual control

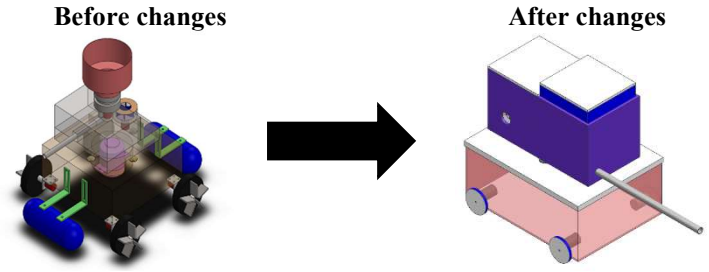

Figure 3: The initial and the new fish farm feeding machine casing design

The initial *Arduino* main board which is *CT-UNO* was upgraded to *Arduino Mega 2560* to accommodate the increased number of the digital pins required by the motor drivers and touch screen shield. The *Arduino* boards were then rewired and remounted on top of the prototype as shown in Figure 4.

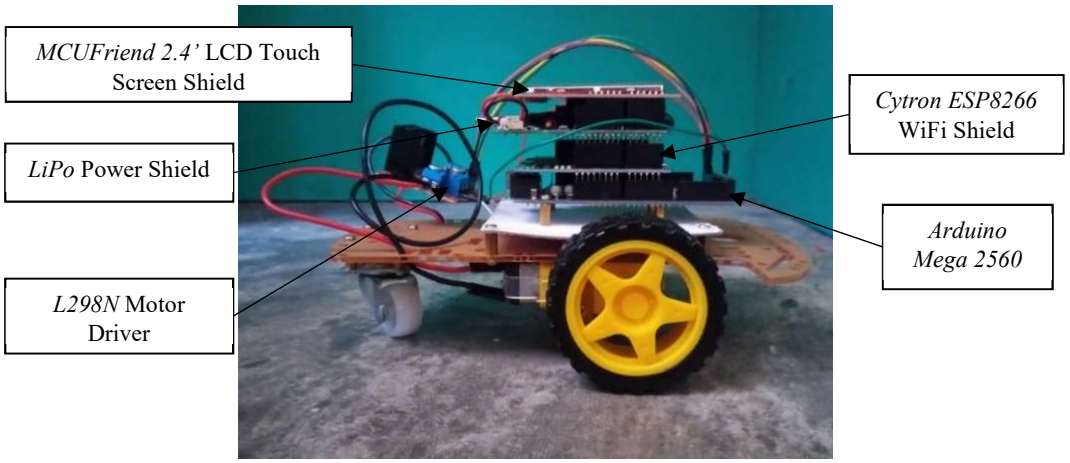

Figure 4: The final assembly of the *Arduino* boards on the prototype

The program was also modified to support and run the final *Arduino* boards. The automation control was designed with a scheduler as shown in Figure 5. The time input allows the *Arduino* boards to synchronize with the real time clock. When the specified time in the time input is the same with the real time clock, the control mechanism was started in the automatic mode. The button in the automatic control allows users to start the control mechanism in the automatic mode right away should the need arises. After the program was successfully written and tested, the *Arduino* boards were move out from the prototyping phase and assembled into the fish farming machine.

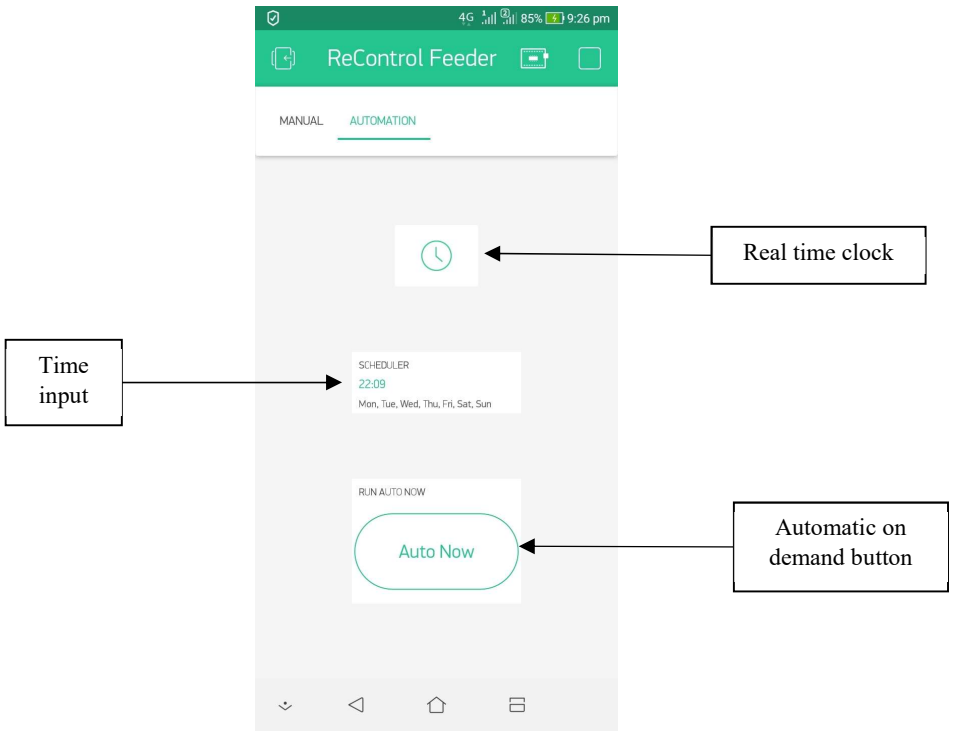

Figure 5: The scheduler automatic control

Based on the summary of the control mechanism calculation results in Table 2, DC motors were selected to give appropriate feed range and capacity and to overcome the input torques required to perform the tasks. Only the input torque required for the wheels on the inclined plane was taken into the consideration for the DC motors selection as it has higher input torque required to overcome.

Table 2: The control mechanism analysis

Upper Body Analysis	
Total pellet mass in storage	2.493 kg
Input torque required for turning	1.643 Nm
Wheel Analysis	
Input torque required for normal plane	0.691 Nm
Input torque required for inclined plane	0.944 Nm
Blower Analysis	
Range	2.117 m

The *Arduino* boards schematic diagram in Figure 6 is drawn to represent the whole *Arduino* boards connections in the fish farm feeding machine. The legends in Table 3 shows the *Arduino* board names and their functions. All four *L298N* motor drivers were connected

to the breadboard in parallel to ensure a constant voltage is supplied to all four *L298N* motor drivers so that they can execute the program properly and all the DC motors perform at their optimal capacities.

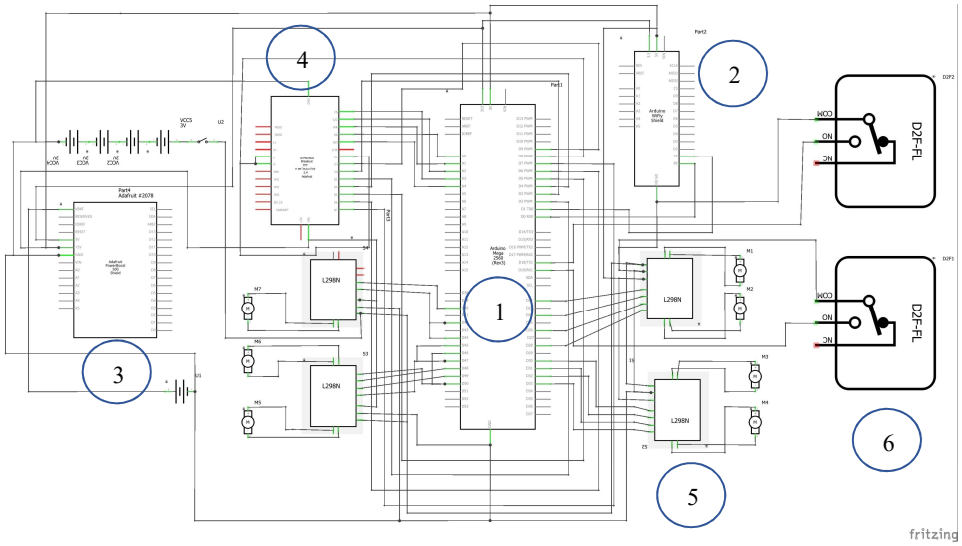

Figure 6: The *Arduino* boards schematic diagram

Table 3: The notations in the *Arduino* boards schematic diagram

Balloon	Item	Function
1	*Arduino Mega 2560*	To process and execute the program
2	*Cytron ESP8266* WiFi shield	To provide wireless connectivity
3	*LiPo* power shield	To supply power to the whole *Arduino* boards
4	*MCUFriend 2.4'* LCD touch screen shield	To provide user display interface
5	*L298N* motor driver	To drive the DC motors
6	Limit switch	To change the turning motor rotation direction upon contact

Apart from that, the control mechanism performance analysis was carried out on a 3 × 3 block at the test site to determine the fish farm feeding machine strengths and weaknesses by determining the frequency of the feed pellets dispensed by the fish farm feeding machine in an area. The effective range of the feed pellets dispensed by the fish farm feeding machine is between 1 and 2 m. Outside the effective range, the fish farm feeding machine performance drastically drops as the feed pellets dispensed count drops. The fish farm feeding machine can only run continuously for about 1 hour before the blower motor comes to an abrupt stop. Financially, the itemized cost of the fish farm feeding machine parts is shown in Table 4 to determine the final cost of the fish farming machine. The budget of the fish farm feeding machine development is RM1500. Since the fish farm feeding machine final cost is about RM925, its development is within the budget.

Table 4: Summary of the costs of the fish farm feeding machine

Item	Total cost (RM)
Fish farm feeding machine body	119.50
Arduino boards	228.94
Hardware	575.73
Final cost	924.17

4.0 CONCLUSION

The objective of developing and building a control mechanism to match with the fish farm feeding machine functions was successfully achieved. The mobile application was developed and built to control the fish farm feeding machine via Wi-Fi. There are a number of recommendations for future works based on the results and discussion of the project, amongst them:

i. The fish farm feeding machine can be fitted with interchangeable outputs to increase its functionalities to serve other industrial needs.
ii. Incorporate long range sensors into the fish farming machine to expand the capability of the control mechanism.

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