Proposed Design of an Automatic Feeder and Aerator Systems for Shrimps Farming

Rizki Dian Rahayani and Arif Gunawan

***Abstract*—Vannamei shrimp farming in Indonesia is currently being encouraged. The nature of shrimp vannamei which is considered more resistant to disease than tiger shrimp is the reason. Moreover, Indonesia's geographical condition is on the equator with a constant rainy season and drought, causing vannamei shrimp production to be carried out throughout the year. Appropriate feed management and cultivation environment management are the determinants of sustainability of vannamei shrimp production. Proper feeding, water quality management and monitoring both temperature and dissolved oxygen levels in ponds Proper feeding, water quality management and monitoring of temperature and dissolved oxygen levels in ponds should be done continuously, so that shrimp farming results can be maximized. The limitation of labor-related management of feed and environment becomes a problem. So we propose a compact design of feeding devices, aerators , dual axis solar tracker panel , automatic pond monitoring to overcome these problems.**

***Index Terms*—Automatic feeder, aerator, shrimp, vannamei.**

I. Introduction

The vanname shrimp (Litopenaeus vannamei) is an introduced shrimp that can live in brackish water and fresh water. Vannamei shrimp cultivation is an alternative shrimp cultivation that is being encouraged in Indonesia to replace the prawn cultivation that is susceptible to disease. One of the objectives of introducing this type of shrimp is to boost national shrimp production which for several years has decreased since 1996 due to disease attack and environmental degradation [1].

The development of shrimp farming vannamei is due to the advantages of vannamei shrimp compared to tiger shrimp, among others: a) faster growth and shorter maintenance period to obtain market size (size 60-80), b) generally obtainable harvest size more uniform, c) artificial feed for vannamei shrimp enlargement is relatively cheaper with lower feed conversion ratio, d) productivity per unit of higher land area, as it lives throughout the water column, so its density can be increased to more than one hundred heads / m^2 and e) of vannamei shrimp coming into Indonesia from Specific Pathogen Free (SPF) populations, especially against Taura Syndrome Virus (TSV) infection and more resistant to WSSV infection [1]. In addition, Indonesia's geographical conditions in the sub-tropical areas, making vannamei shrimp farming can be implemented throughout the year.

Vannamei shrimp farming is in line with the strategic plan issued by the Ministry of Marine Affairs and Fisheries (KKP) for the period 2009-2014, with the vision of the future is to realize Indonesia as the largest producer of marine and fishery products starting in 2015.

The success of shrimp farming vannamei is influenced by feed management and environmental management. Effective feeding is appropriate and not excessive in accordance with shrimp life is an important factor. As well as the temperature and dissolved oxygen levels, it must also be maintained within the optimal range. Due to the increase of both factors, it will affect salinity, water pH, and CO2 content dissolved in water [2], [3]. There are many ways to lower the water temperature and increase dissolved oxygen levels, one of them is aerator [4].

Referring to the above problem, we propose the design of a compact system consisting of an automatic feeder according to shrimp age, an automatic aerator that works when the pond conditions beyond the optimal limit, and the monitoring system of pond conditions. Dual axis PV solar panels are used as a standalone power supply system

This proposed system is expected to overcome the problems faced by shrimp farmers associated with the limited resources in the process of monitoring and maintenance of shrimp farming.

II. Feed Management and Environmental Management

The success rate of shrimp farming vannamei depend on by many things, such as feed management and environmental management of shrimp habitats [5]. An adequate and appropriate amount of feeding determines vannamei shrimp growth, as excessive feeding will lead to deterioration in air quality and oxygen [6], [7]. Management of shrimp feeding according to shrimp age shown in Table I.

TABLE I: Shrimp Feed Management [4]

No	Age of shrimp (days)	Weight of shrimp (gr)	Feed of shrimp	Dose of feed (%)	Freq. Of Feeding /day
1	1-15	PL 10-0,1	Crumble	75-25	3
2	16-30	1,1-2,5	Crumble	25-15	4
3	31-45	2,6-5	Pellet	15-10	5
4	46-60	5,1-8	Pellet	10-7	5
5	61-75	8,1-14	Pellet	7-5	5
6	76-90	14,1-18	Pellet	5-3	5
7	91-105	18,1-20	Pellet	5-3	5
8	106-120	20,1-22,5	Pellet	4-2	5

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In the environmental management of shrimp habitats, especially in water quality management, there are several parameters that become the reference. The parameters of water quality management are shown in Table II.

TABLE II: SHRIMP HABITAT MANAGEMENT PARAMETER [4]

No	Parameter	Optimum Value	Tolerance
1	Temperature	28 – 32 ° C	26 – 35 ° C
2	Salinity	15- 25 ppt	0 – 35 < 35 ppt
3	Water clarity	25-40 cm	
4	DO	>4 ppm	>3 ppm
5	pH	7,5 – 8	7 – 8,5
6	Alkalinity	100 – 150 mg/l	>100 ppm
7	CO_2	< 25 mg/l	
8	Amonia	< 0,01 mg/l	
9	Nitrit (NO_2)	0,01 mg/l	

The main habitats of vannamei shrimp are freshwater and brackish water, with certain salinity levels. According this conditions, pond water quality should be monitored periodically for maximum shrimp growth.

In this time, water quality monitoring have been done automatically but the anticipation action is still done manually.

The main parameters to be monitored are the temperature and dissolved oxygen levels due to the increase of these two factors, will affect the salinity, the pH of the water, and the dissolved CO_2 content in water [2], [3].

So in shrimp farming, temperature and oxygen levels dissolved in water should always be maintained within the optimal range. There are many ways to maintained the range. For example to lower the water temperature and to increase dissolved oxygen levels, we use waterwheel [4], [5].

In shrimp farming, waterwheels usually work continuously for 24 hours and are fully controlled by humans.

III. SHRIMP FARMING TECHNOLOGY

The development of fishery technology, encouraging research and manufacture of products to support the success of shrimp farming. One of them is automatic feeding machines that can be adjusted according to the level of shrimp feed requirements that have been developed previously [7]-[10].

Another example of the development of fisheries technology is the water quality monitoring system automatically via wireless [11]. Although the pond water monitoring system has been automatically, but the action of anticipation when water conditions outside the optimal limit is still done manually. For example the use of waterwheels used to maintain oxygen levels and pond water temperatures, waterwheels are still rotated using manual control when dissolved oxygen levels in water decreases.

Automatic aerator and feeder research reviews are shown in the Table III.

TABLE III: PREVIOUS RESEARCH COMPARISION

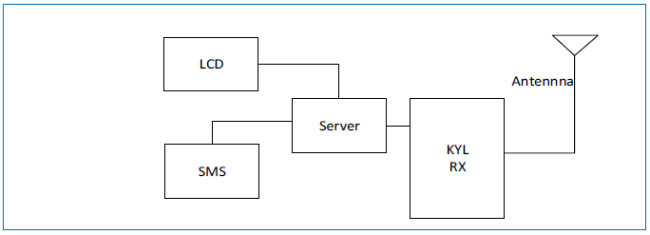
No	Title and Author	Finding
1	Development of Automatic Feeding Machine for Aquaculture Industry [8]	The automatic fish feeder is controlled by a digital timer and it is capable of feeding the fish in accordance with a pre-determined time schedule without the presence of an operator, and at a feeding rate of 250g/min.
2	Development and Performance Evaluation of an Automatic Fish Feeder [10]	Using hopper (stainless steel), bi-directional motor, feed platform and electrical control box.
3	Modeling And Control Of The Fish Feeder System [12]	This project is a simulation and experimental investigation into the development of PID controller using MATLAB/SIMULINK software.
4	Development of an automatic fish feeder [13]	Using hopper blower to distribute the food.
5	An Automatic Feeder with Two Different Control Systems for Intensive Mirror Carp Production [14]	Using Two ways control food provisions. An opened control system based on the ATM89c51 microcontroller controlled the exact dosing based on the tank rquirements according to the carp cycle and the other closed loop control system was determined by the conditions of water temperature, fish age, body weight and the amount of oxygen consumed
6	A Novel Design of Feeder System for Aqua Culture Suitable for Shrimp Farmingc[15]	Using timer, spreading motor and 2 type of feed dispenser depend on type of feed

IV. PROPOSED DESIGN

Based on several literature studies on previous chapter, we propose a compact system for shrimp farming that works based on the results of feed sensors and pond conditions, which consists of:

a) An Automatic Feeder
b) An automatic aerator
c) The monitoring system of pond condition
d) Dual axis solar tracker for the power

Block diagram of the system shown in the Fig. 1.



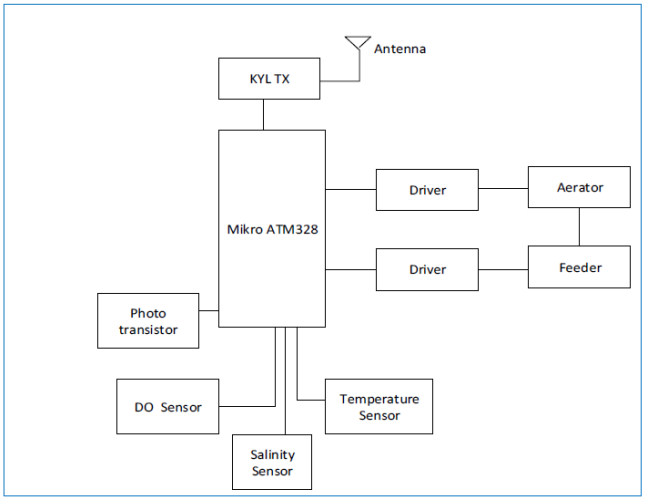
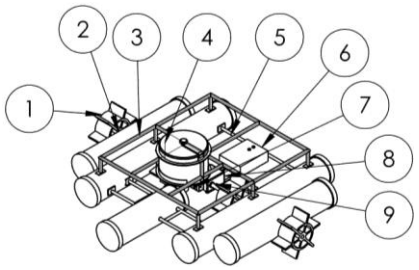


Fig. 1. Block diagram of the proposed system.

System hardware of the automatic feeder and aerator proposed design shown in Fig. 2.



No	Part
1	Wheel aerator
2	Motor AC aerator
3	Float
4	Feeder bowl
5	0.5HP AC Motor
6	Sensor panel
7	Feeder Servo
8	Feeder sensor
9	Timer

Fig. 2. System hardware of the proposed design.

A. Automatic Feeder

An automatic feeder is an automated feeding system where by digital control, shrimp farmer can set time and quantity of feed. This device has controlled by microcontroller installed in the machine.

In shrimp farming, feeding system works both during day and time. Different feeding rate at different times of the day and night can be pre-set. It helps in excluding usage of labor at night-time. It also comprises of a control panel which can be installed indoor for convenience.

How this system works is a servo motor will move the feed bowl cover to open or close in accordance with the time setting and quantity setting to adjust the amount of feed given to the shrimp. The feed bowl is also equipped by the sensor, if the stock feed height is left a quarter of the height of the bowl, then microcontroller will send information via sms about the availability of feed to the user.

The conceptual framework of the feeder is shown in Fig. 3.

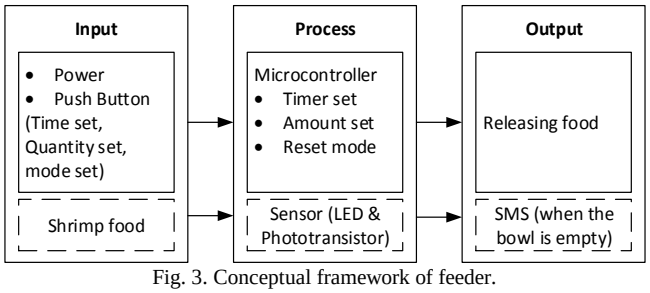


Fig. 3. Conceptual framework of feeder.

B. Automatic Aerator and Monitoring System

At the aerator, the temperature, salinity and oxygen levels in the pond will be monitored and displayed on LCDs located outside the pond. DO sensor is installed underneath the device to measure the oxygen level in the water. DO sensor connected to the microcontroller. When DO state approach the tolerance limit, the sensor will send a signal to the microcontroller to power on the aerator.

Temperature sensor is also installed underneath the device to measure the water temperature. When the temperature out of optimium level, the aerator will power on automatically. The aerator will stop automatically when the optimum condition of the measured port of the sensor. The motor used in the aerator is an ½ HP AC motor.

The sensor measurement, including salinity level also delivered to the pond guard by SMS and LCD where installed out of the pond.

The conceptual aerator frame work shown in Fig. 4.

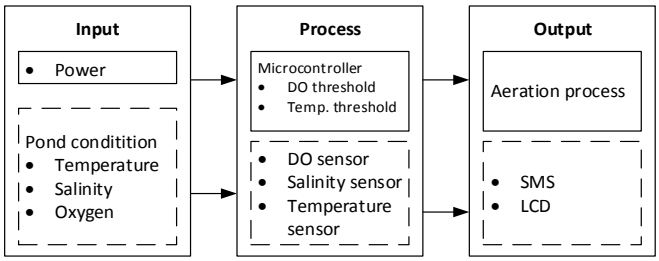


Fig. 4. Conceptual framework of aerator and monitoring system.

C. Dual Axis Solar Tracker Panel

In this system, we use renewable energy from solar cell to provides the power to all component of the system. The power is supplied by 450 WP dual axis solar tracker panel [16].

The solar panel consists of a actuator, solar sensor, photovoltaic (PV) panel, charging system, voltage and current sensor. Actuator in this system is consist of DC electric motors and a motor control system using microcontroller to command the PV panel movement.

Conceptual diagram of dual axis solar tracker panel shown in Fig. 5.

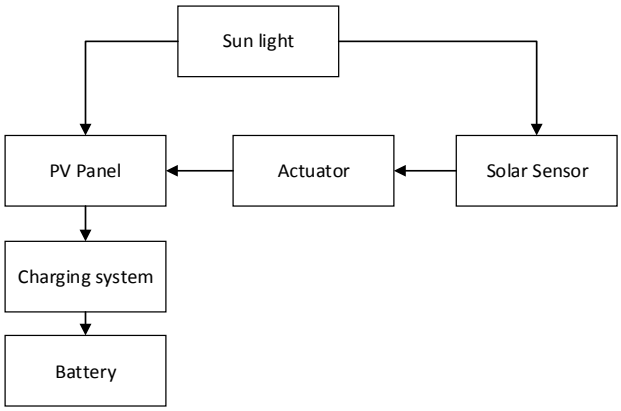


Fig. 5. Conceptual diagram of dual axis solar tracker panel.

Solar sensor voltage became an input to the actuator. Here we use 4 mini PV as solar sensor mounted on PV panel. When solar Voltage from its sensor is low than reference, it will initiate actuator to move the PV panel in 2 axis to tracking the sun position to get an optimal Voltage.

Then, under optimal conditions, the panel would capture sunlight, convert it into a Voltage that will be stored in batteries by charging system. Voltage and current sensors are added to the actuator and the charging system, to control the Voltage and current that goes into it.

Solar charger controller added in the panel to regulate the current flowing the battery, avoiding overcharging and overvoltage, and can control the load to be used, so the use of the battery can be used in the long term [17].

The design of solar panel shown in Fig. 6.

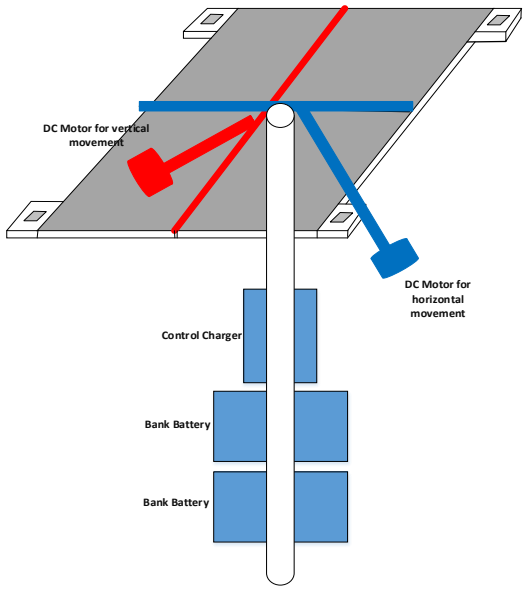


Fig. 6. The design of dual axis solar tracker panel.

V. Conclusion

In further research, will be discussed the dimension and material of an automatic feeder and aerator and its impact to device movement in the pond. Then , the improvement condition after auto feeder installation also will be discussed. Including the success of the distribution of feed according to shrimp age, the improvement water quality and feeding continuity rate.

Unlike manual feeding, automatic feeding helps not only manage feeding more efficiently reducing left over feed but also saves labor costs.

Of the aerator installation, will be discussed the process of sensor readings success, the process of auto aerator to achieve optimal value, the improvement of water quality and the monitoring system of pond condition.

So from the results of further research can be proved that the proposed system can help farmers to minimized feed and labor costs and thus maximizing profits for farms.

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