MODELING AND CONTROL OF THE FISH FEEDER SYSTEM

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ABSTRACT

Food and feeding was the main growth and production, and both of them become a major challenge in aquaculture development. The way adjustment of food delivery to pond is a important role to get the maximum return or profit to aquaculture entrepreneurs. This project represents an investigation about the fish feeding system. A system device to feed fish at predetermined amounts of food and time. A system that designed which has a computer monitored system which was developed in order to manage and control the system with real time. The aim of the project is to monitor and control the fish feeding system. This project is a simulation and experimental investigation into the development of PID controller using MATLAB/SIMULINK software. The simulation development of the PID controller with the mathematical model of fish feeder system is done using trial and error method. The PID parameter is to be tested with an DC motor in MATLAB/SIMULINK software. For the system, the best value of PID controller is when Kp = 100, Ki = 0.05 and Kd = 25. When Kp = 100 the rise time is a 0.113 second, when Ki = 0.05 the rise time is at 0.151 second and when Kd = 25, the rise time is a 0.143 second.

ABSTRACT

Makanan dan pemakanan adalah pertumbuhan utama dan pengeluaran, dan kedua-dua mereka menjadi cabaran utama dalam pembangunan akuakultur. Pelarasan cara penghantaran makanan ke kolam adalah peranan penting untuk mendapatkan pulangan atau keuntungan yang maksimum kepda akuakultur usahawan. Projek ini merupakan satu penyiasatan tentang sistem pemberi ikan makan. Peranti sistem untuk memberi ikan makan pada jumlah yang telah ditetapkan makanan dan masa. Satu sistem yang direka yang mempunyai sistem komputer dipantau yang telah dibangunkan dalam usaha untuk mengurus dan mengawal sistem dengan masa sebenar. Tujuan projek ini adalah untuk memantau dan mengawal sistem ikan makan. Project in adalah penyelidikan secara simulasi dan eksperimen dalam pembangunan pengawal PID mengunakan perisian MATLAB/SIMULINK. Pembangunan simulasi pengawal PID dengan model matematik bagi sistem pemberi ikan makan menggunakan kaedah cuba dan jaya. Parameter pengawal PID akan diuji mengunakan perisian MATLAB/SIMULINK. Bagi sistem ini, nilai yang terbaik bagi pengawal PID adalah apabila Kp = 100, Ki = 0.05 dan Kd = 25. Apabila Kp = 100 masa naik adalah 0.113 saat, apabila Ki = 0.05 masa naik adalah pada 0.151 saat dan apabila Kd = 25, masa meningkat adalah pada 0.143 saat.

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LIST OF ABBREVIATIONS

DC	-	Direct Current
PWM	-	Pulse Width Modulation
PC	-	Personal Computer
UTHM	-	Universiti Tun Hussein Onn Malaysia
SFC	-	Sequential Function Chart
FBD	-	Function Block Diagram
LD	-	Ladder Diagram
ST	-	Structured Text
IL	-	Instruction List
RLL	-	Relay Ladder Logic
CPU	-	Central Processing Unit
I/O	-	Input/Output
PID	-	Proportional Integral Derivative
PIC	-	Proportional Integral Controller
MATLAB	-	MATrix LABoratory
API	-	Application Program Interface
KE	-	Kinetic Energy
PE	-	Potential Energy
Q	-	Volume per rate
m	-	Mass flow rate
p	-	density
La	-	Inductance
J	-	Inertia
Km	-	Motor Constant
B	-	Load

CHAPTER 1

INTRODUCTION

1.1 Overview

The fisheries and aquaculture sector in Malaysia has proven to be an important supplier of animal protein and has contributed significantly to the country's economy. In addition this sector has provided many communities with employment and socio-economic opportunities. The industry plays a vital role in providing social and economic stability to the industry players and fishermen as a whole. Contribution of this industry can be categorized in three aspects: a source of foreign exchange in trades, source of affordable and reliable animal protein and income generation.

Fish in Malaysia is everyman's food. The per capita consumption of fish and other seafood in the country is estimated to be close to 50 kg. This represents more than two-thirds of the total animal protein consumed per capita locally. By end of the planning period of the Third National Agriculture Policy which is year 2010, it is expected that the total national fish production will be 1.93 million metric tones worth more than RM 9.36 billion. To this end the Fisheries Department of Malaysia has targeted the fisheries sub-sector to grow by at least 5% annually. Aquaculture is one of the fastest growing sectors in the food production sector. Now it accounts for almost 50 percent of the world's food fish (NOAA, 1997).

Based on the data taken from Fisheries Department (http://www.fishdept.sabah.gov.my/), whether the fish is come from a lake, pond, river or sea, the increasing numbers of fish makes fish farmers need to look for alternatives in care and feeding on a large number of fish. Feeding is important in the life cycle of fish due to lack of food would be detrimental to fish size. So, food and feeding are the role important factor in the production, and then the management of the feeding is a main challenge in agriculture sector. The quantity of food delivery to match fish appetite plays a main role to improve or to increase the income for aquaculture entrepreneur. In the large area, aquaculture production, the management of fish feeding is control by the survivor of the company involved. A good management of fish feeding is plays a key role whether small aquaculture or highly invested aquaculture project cannot be ignored as this point is related to the income profit (F.Hungtingford *etal*, 2012).

In order to develop the aquaculture system, food and feeding are the keywords of growth and production. The adjustment of food delivery to match fish appetite plays a key role to maximize the income or benefit for aqua industry. Nowadays, technologies in aquaculture become a role model in order to increase the source of protein. Many industrialist need help from other source including their own energy, because it is not involve the high cost, although can make the low productivity of production.

Based on the innovation and follow the technology nowadays, several direct and indirect techniques are developed. In order to make the system of automatic fish feeder become more effective, many ideas are come out. In this project, designs the automatic fish feeder by using the controller system are developed to make the system more intelligent and make useful for many entrepreneur.

1.2 Project Background

In farming fish, there are many several structures such as ponds, tanks, raceway or cages. By using the current technology, today`s ingredients were transformed into pellet form through a local feed mill company. Most entrepreneurs of marine finfish are reared

in floating net cages near shore, and all their nutrition is supplied by formulated feeds. With the advanced technology, the formulated feeds consists good nutrition in fish production systems is essential to economically produce a healthy and high quality product. In fish farming, nutrition is highly critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically n recent years with the development of new, balanced commercial diets that promote optimal fish growth and health (Steven Craig, 2009).

There are several major and minor problems that are being study recently in order to improve feeding system and management. One of these major problems is to reduce cost of feeding and increase the efficiency of this tank at the same time. This is because the future investment will include labor cost that spent by entrepreneur such as taking workers to work at their ponds. This will even require higher spending just to settle out for the workers especially for bigger industries which involve high value and long term investment. They need to hire more people to look after their fish in order to make sure that their earlier investment will not only become a waste, but benefit them later on (B.C.Mohapatra *et al*, 2009).

Feeding rates and frequencies are in part a function of fish growth or size. Feeding fish is labor-intensive and expensive. Feeding frequency is dependent on labor availability, farm size and the fish species and sizes grown. Today`s, many entrepreneur has improve their feeding management by using the current technology such as high tech gadgets or machine for their fish, but instead of this, they sometime need manual survey, which is referring to human job to manage their machine. Machine consists many parts and task to do, and from this there are many job that require manpower to execute the task or job such as cleaning the feeder, refilling the pellets and also need the technician that able to repair or do maintenance job when require. To make clearly, by using the manual machine, there are many costs needed to operate the production system. By this problem, the new technology with low cost manufacture and easy maintenance must develop to overcome this problem. The feeding device should be simple and ease of use, reliable in operation and relatively inexpensive to purchase and operate (Ang *et al*, 2003).

Some methods were developed in such a way that it can replace of human activity. This automatic fish feeder system offered the user control feeding time up to 24 daily feeding cycles depending on the timer employed in the system and the optional reset time on the feeder. Also, the amount of pellets dispensed depended on the length of the feeding cycle adjusted on the feeder itself (Noor, M.Z.H *et al*, 2012). Besides, some methods to detect left over feed in order to stop feeding. This method were estimated food waste by suspending a sheet below the sheet cage during the feeding period, retrieving it after feeding, and counting the left over feed pellets (Shepherd and Bromage, 1998). Other method to overcome this problem are use automatic fish feeder that controlled by a digital timer and it is capable of feeding the fish in accordance with predetermined time schedule without presence of an operator, and at a feeding rate of 250 g/min. The feeder can be adjusted to the desired height and conveniently moved around to be positioned adjacent to the pond (Yeoh, S.J. *et al*, 2010).

The parameter that involve in a feeder is a time management controller that playing a role important of a fish feeding system. Many entrepreneurs face many problems according to the timely operation. By using the traditional feeding method for fish in pond, cage or even small lake is by use of man power. For the worker, they not able to do the feedings at the predetermined time especially during the some expected event such raining. It`s can be a critical problem such as unfed fish. This matter will even grow bigger during raining event and will cost a lot of trouble to the entrepreneur. From this, timing schedule are playing a role important for fish growth and profit of entrepreneur. Feeding rate or time can change by the user when consider many factors such as type of fish, size of pond, quantity of fish and many other aspect.

Apart from that, many current technologies has focus on their feeding type, time operation and just drop out the food with no proper or effective way before they are eaten by the fish. Many consequences can occur from this issue such as water pollution as the food dispersed at the bottom at the water source. The most important consideration is the development of an efficient water treatment system (Krause, J. *et al*, 2006). After a period time, the worker then need to do some extra job that is to clean the pond and changing the water. It`s become a frequent task for them if this matter still on

the problem list. The feeder must use door mechanism to manage the opening and closing the gate where the food moves before spread onto the water surface.

There are many cases whereas the pellets were jammed at the outlet of the machine or along the tunnel of the device. This problem occurs mainly because of two reasons. Firstly the properties of the pellet itself that cannot be exposed to moisture as it absorb the water molecule quite fast as today's pellet are made into dry food type. Secondly, the size and shape of pellet usually a short cylinder which separated from a long cylinder shape. As a result, the flow of this type of food as a smooth flow such as the smooth fluid flow properties. Thus, this restriction may cause them to stick along the outlet tunnel or at the end of the outlet with additional of the moisture effect to the fish food.

1.3 Problem Statement

In today`s competitive world where a good technology is fundamental to success, many entrepreneur believe that the technology are invented to ease human`s life. Government also provided many changes and opportunities for entrepreneur to increase or improve the productivity of production such as agriculture areas.

To date, many of the fish farmers still use the old system for example manual feeding system. By utilizing the manual feeding system, it means that many work would needed by the fish farmer in order to cover the many jobs such as cleaning the feeder, refilling the pellet and also repair or maintenance operation. All these activities are required more energy and time compare to the automatic fish feeder. However, for large area of agriculture, the traditional manual feeding system users will certainly face difficulty in managing the entire feeding schedule.

Based on the previous research, there were some ideas or some exertions are taken in order to improve the manual feeding systems that have a low efficient and unproductive. For instance, the simple Automatic Fish Feeder which employed the timer

in dispensing the pellets. However, this system was limited by the ability of dispensing pellets at a constant speed.

Finding the solution of automatic fish feeder system had motivated the research to develop a system that replaces the previous systems, hence giving the many advantages to the entrepreneur, owner and workers. As a solution, the new system was able to dispense pellets into the desire area based on the speed of the motor. The system resulted in more systematic feeding schedule which certainly, will decrease the labor cost. This automatic system was also designed in such a way that it can replace of human activity and offered the user control feeding time up to 24 daily feeding cycles depending on the timer employed in the system following the time stated by the entrepreneur.

1.4 Project Objective

The aim of the objective is to monitor and control the Automatic Fish Feeder system through the personal computer (PC). The objectives of this project are explained based on project problem statement and the project scope.

1. To investigate an automatic fish feeder in industrial application.
2. To model mathematical modeling of an automatic fish feeder system.
3. Analyze the data to produce results.

1.5 Project Scope

Since this project concentrating on the system and controller that invlolved in the feeding system, there are some limitation still on this project that need further attention in order to improve the capabilities of this system. This project is divided into two parts which are the developing mathematical modeling equation and model an automatic fish

feeder system by using PID controller. In this projects, both parts are integrated after they are completed so that the result can be observed.

The report focuses about the development of an automatic fish feeder system using controller application. The scope of this project is to analyze existing processes in fish feeding system. In addition, for a given quantity of a food can be set to avoid waste in the pond. In aquaculture, automatic fish feeder has been widely used by all fish farmers and according to research from previous products; each product shall have the functions and certain weaknesses. For example certain products can only be used for small and medium-sized ponds and cannot be used in large quantities pond.

The overall system are developed by using mathematical modeling to get the equation of this system and then are designed an automatic fish feeder by using engineering software which is Matlab. This processes are to make analysis the efficiency of the mechanism used on the automatic fish feeder**.** In this project, the fish feeder system is identifying the characteristics of feedback control system action. Then, analyze and compare the results of the simulation via control techniques applied in this study.

1.6 Summary

This project has brought many benefits to society, particularly in the aquaculture sector. This project helps to reduce the cost of aquaculture farmers. This is because by using the system, they can reduce costs such as labor costs and also the cost of time. In addition, labor costs are reduced because of the use of this machine system and aquaculture farmers have the option to hire workers just to keep their farms only. This is because the systems and machines that are specially designed to feed the fish at the time set by the farmer according to the habits and fish species.

Time plays a very important role in any type of business in this world especially aquaculture sector. Time spent each day by the farmers and their workers solely to feed the fish can be reduced by using this invention. So, farmers do not have to worry about their fish because the machine works automatically feed the fishes at some point. Therefore, the farmers can spend their time on other activities.

This project will help lead to increased technology in the aquaculture sector. System and designed this machine is an improvement over some of the older designs. This course will give the agricultural sector a new look and also a step forward in the world of science and technology. This invention will also help reduce costs and increase productivity directly increase farmers' income sources. In addition, it will provide a revolution in the public's perspective on aquaculture. This is because aquaculture is considered as the more traditional areas compared to other sectors such as manufacturing. Furthermore, the aquaculture sector has been lagging behind compared to other sectors in the current technology is booming. With this invention, farmers can change the negative perceptions, and thus be able to attract the attention and interest of the younger generation, especially in aquaculture.

By using the system, aquaculture farmers can increase their productivity. This is based on a proper feeding schedule will help increase the growth rates of fish. This will then ensure that the preservation of fish larger in size and therefore have a better market price. In addition, the proper feeding schedule will avoid any mishap that may occur

such as malnutrition and other matters that may occur due to the lack of food or feeding instability.

This invention would help change the negative perceptions that people are more likely to agriculture. This will encourage the growth of aquaculture and more specifically the field of aquaculture. This is because the public will have a better view of the field of aquaculture and also realized the potential marketability for this field. In addition, the present invention also will open up new markets and also increase the productivity of the aquaculture sector. Thus, the money earned may be reinvested in aquaculture to bring more new technological improvements in the field of aquaculture. This will be helping the agricultural sector in aquaculture grow and become one of the leading suppliers of income in the country.

Since independence, the aquaculture sector has always been one of the main income providers to the country's economic progress. With this invention, farmers can stimulate economic growth and lead to economic revolution beloved country. Then it will be able to increase productivity and can indirectly increase their own income. In comprehensive, this will stimulate economic growth in the country and may indirectly contribute to economic growth in the country (Yeoh, S.J. *et al*, 2009).

CHAPTER 2

LITERATURE REVIEW

In this chapter are the reviews of previous discovery of fish feeder in many journals from various references. Previous inventions are dividing to aquaculture and system of an automatic feeder. This chapter is provided detail description of literature done regarding the project title and the development of automatic fish feeder system using PID controller.

2.1 Aquaculture

Aquaculture usually refer to the fish farming and it is often determining as art, science and business of cultivating aquatic animals and plants in fresh or marine waters (NOAA Fishes, 2010). Aquaculture often done in water and because it is a farming activities, involves the considerations of property or the farmer who owns the products and activity or work is done in order to raise the animals or plants. Usually, these activities have been done in certain water source types such as river, ponds, lake and tanks (Ang *et al*, 2003).

In recent years, aquaculture production increase highly and in Asia, aquaculture contributing around 91% of the world`s total by volume and 82% by value. Thailand for example, has been the top ten in the world as the aquaculture production and also the region that has a highest variety of cultured species. Asia has also become the highest

seafood-consuming region of the world where accounting for two-third of the world`s food fish supply, the increase of which mainly came from aquaculture in recent years. In Malaysia, the fisheries sector has provided direct employment to 89,453 fisherman and 21,507 fish culturists (A.Victor Suresh, 2007).

Aquaculture plays a very important economic role in the food production industry because of the high protein content found in fish meal as a food for human (NDP3, 2009). The continuous supply of fish for consumption to the ever-increasing population can only be achieved through vertical and horizontal expansion of existing aquaculture practices in the country. The importance of aquaculture in the overall fish supply is growing. In the future, aquaculture production is expected to overtake capture production of food supply. Food fish supply prospects will depend to a large extent on the effectiveness of fisheries management and the responsible development of aquaculture, both of which will be tested in facing the sustainability challenge. An essential requirement for ensuring sustainable fisheries and aquaculture through good policies and management will be the provision of objective information on the state of fisheries and aquaculture (Richard Gringer, 2010).

The industry is a key factor for increasing the economic income in developing countries, most notably in the rural areas while providing new employment opportunities to improve the economic situation for the people in these regions. In this situation, fish must get the enough supplies of feeding to make sure the fish growth properly. Worldwide, automatic fish feeders have been implemented in aquaculture system to convenience to fish culturists.

2.2 Fish Feeder System

Fish feeder system is a device or an electronic gadget that has been developed or designed to dispense the exact or right amount of pellets at an exact time. However, this particular system also showed the capability or their function in repeating the task daily and accurately, hence promising efficiency and productivity in fish farming field long

run. This device fed fish following the right schedule and amount pre-defined by user, therefore avoiding the issue of overfeeding.

Visit the livestock aquaculture in Sri Lalang, Ayer Hitam, Batu Pahat, revealed that the entrepreneur hire employee to feed fish in ponds. Through the interviews, most entrepreneur think that feeding fishes by using automatic fish feeding system is more easier, useful and more effective, although it is need a high cost to develop at initial stages. Besides that, many entrepreneur or fish culturists did not know about the existence of the system or machine of fish feeding.

Nowadays, many aquaculture livestock entrepreneur overseas had already used this system or machine while running the aquaculture production since 1990s. Among the countries that had been already used this system such as Belgium, United States, Italy and also Thailand. But in this country, these system or machine still become a new development or under the research and some entrepreneur use this system at large area (Lucas.J.S., *et al*, 2012).

Some method are developed over the past year and some method estimated food waste by suspending a sheet below the sea cage during the feeding period, retrieving it after feeding, and counting the left over feed pellets (Shepredand Bromage, 1988). The other method are used the hydroacoustic sensors to detect food pellets at 2.5 m depth in sea cages for feeding control (Juell 1993). Foster *et al*. (1995) used an underwater camera and image analysis tool to detect and count left over pellets. Some other methods is used the accuracy of a new machine-vision system for the identification of a feed-wastage event and the response times are reported (Kevin and Royann, 2003).

2.3 Previous Product

Some methods were developed or designed to detect left over feed in order to stop feeding. In previous years, some methods that used in feeding system has an own advantages and capability to feeding the pellets. Even some methods has their function, the point of the system are use to overtake the overfeeding. Nowadays, many

entrepreneurs have implemented this feeding system to their production and their feedback from this system is better and more efficiency from the traditional method. Below are the latest technologies that people out there use for their feeding system or machine.

2.3.1 Automatic Fish Feeder System Using PIC Microcontroller

This device developed combines mechanical and electrical system in controlling fish feeding activity as shown in Figure 2.1. The pellets controlled by DC motor which located under the pellet storage. A control system was then attached to this device allowing the fish to be fed at the right cycle time as required or predefined by user or entrepreneur. Timer was employed in this device to control the motor rotation attached to sphere former, which dispense the pellets into the water. The pellets dispensed into the marking area of the pond based solely on the rotation speed of the motor itself. The controller came with a keypad giving user more option in determining the suitable speed for the motor depends on their cattle. (Noor, M.Z.H. *et al*, 2012)

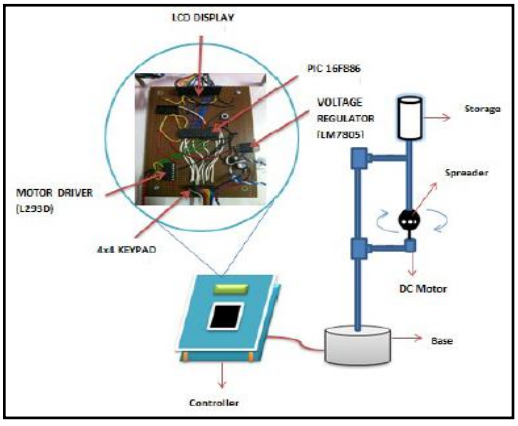

Figure 2.1: Automatic Fish Feeder System Using PIC Microcontroller (Noor, M.Z.H. *et al*, 2012)

The design of this system comprised four main part namely main controller, pellet storage, stand and spreader. The controller of this system, a 4x4 Keypad functional as input device which provided the user abilities to set timer and motor speed to spread the pellet into the water. Apart from that, LCG display played an important role in illustrating the data entered by the user before DC motor start to operate. PIC 16F886 controller was employed as main controller output of DC motor. L293D motor driver which work with PWM (Pulse Width Modulation) technique are to control the speed rotation of DC motor. All appropriate components used in hardware design stage were assembled to set up the feeding device. This system was simple in construction and operation, also relatively inexpensive. The advantages of this device are it is effective because easy to feed the fish at the right cycle time. These devices also reduce the owner to hire more workers and also reduce the time needed.

2.3.2 Automatic Fish Feeder Using an Intelligent Feeding Controller

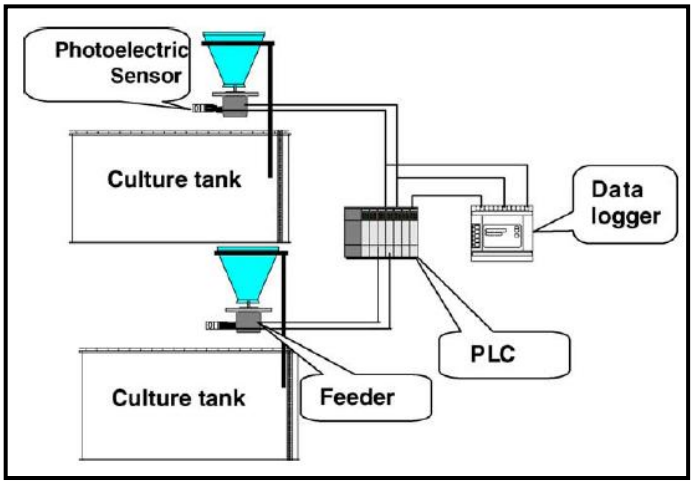

Figure 2.2 : Schematic diagram of the Automatic Fish Feeder Using an Intelligent Feeding Controller (C.M.Chang *et al*, 2005).

A modified feeding system was developed based on the preliminary results. (Fang and Chang, 1999). An infrared generating and detecting photoelectric sensor (E3JM-

DS70M4-G, OMRON, Japan) was added to each feeder. A 'PC-based PLC' controller (OMC1 FAMA, Mirle, Taiwan) was used to replace the timer to control feeding time and duration as shown in Figure. 2.2. The 'PC-based PLC' stands for PLC with CPU module according to the manufacturer. Control strategy was built into the PLC using Paradmy-31, (Intellution, USA, or Mirle, Taiwan), software, which allows the user to create a ladder diagram easily. A control strategy with six governing parameters was developed and coded into the PLC. The result is a new, intelligent feeder (C.M.Chang *et al*, 2005).

The advantages of this feeding system are it is an intelligent control system that function effective and efficiency because can pretend water from polluted during feeding operation. This feature makes this control system unique compared to other feeding control systems. This feature plays an important role in successful feed management especially for the night-time with no night-shift workers available.

2.3.3 Arvo-Tec T Drum 2000 Feeder

Figure 2.3 : Arvo-Tec T Drum 2000 (Arvotec, 2010).

The Arvotec Feeding Robot was developed in order to meet the customer requirement as shown in Figure 2.3. The Arvotec Feeding Robot improves feed efficiency and saves labor time. One feeding robot supplies many tanks, eliminating the need for a feeder at each tank. A high feed turnover rate through the hopper eliminated rancidity or other

storage problems. The Arvo-Tec T Drum feeder has a very high accuracy, whilst remaining at a competitive price. The feeder is multifunctional and is suitable for start feeding in hatcheries to on-growing on tanks, ponds and cages (Arvotec, 2010).

The Arvotec-control system is a fully integrated feeding, measurement and alarm system. Feed amounts are automatically calculated separately to each tank according to automatically updated biomass data, incoming water temperature and oxygen content. The system is easy to use with a menu driven display in control unit or an optional MS Windows based PC connection. The feeding program is controlled by a microprocessor mounted on the robot, which can be connected to a PC for monitoring and control by a centrally managed Network Control System.

This robot uses battery power supply 24 volt direct current and speed 16 minutes per meters. The advantages of this robot are it is effective because only use one robot to doing feeding process where this robot can move dispense the feed across the tank. The disadvantages on this robot are it high cost of manufacturing and difficult to operate (Arvotec, 2010).

2.3.4 Centralized Feeding System

Figure 2.4 : Centralized Feeding System (Dirfeeders, 2005)

The standard feeding system utilizes one or more feed storage silos, a regenerative or positive displacement blower, one or more frequency controlled dosing augers, rotary air lock (sluice) hopper, feed injector and a rotary selector valve and diverter valves as shown in Figure 2.4. A Siemens Programmable Logic Controller (PLC) is used to control the operation of the system. The operator interfaces and programs the feeding system with a standard Personal Computer (PC) programmed with our Auto Feeder Software (Dirfeeders, 2005).

In basic operation feed from the storage silo empties into a feed dosing auger. The auger moves this feed into a sluice-hopper-injector system. The injector introduces the feed into the main transport pipe. The feed is then picked up by air from the blower and moved into the distribution valve where it is directed into the individual feed pipes travelling to the specific tanks, raceways or net-pens on the site. All aspects of the feeding operation such as feed rates, meal times, feed types, etc. are controlled with the New Auto Feeder Software. The operator, with either the PC or a wireless remote control can monitor, interface, reprogram or override the automatic operation of the system (Dirfeeders, 2005).

In short, a properly sized feeding system can be configured to economically and efficiently feed virtually any type of fish in any type of application.

2.4 Structure Used For Aquaculture

Fish can be commercialized in some kind of aquaculture ponds. Aquaculture pond has its own advantages and disadvantages depending on the type of culture and environment factor. There are differences in the structures used, the intensities of culture, the degree of water exchange and the factors to be considered in selecting suitable species and farm sites for aquaculture. (John.S etal, 2012). To a considerable extent they are inter-related as shown in Figure 2.5. Here are some types of aquaculture ponds are often seen in the countries of the developing world.

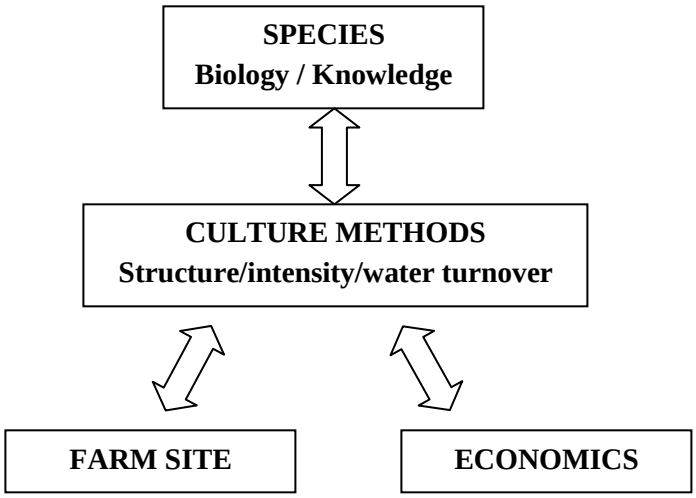

Figure 2.5: The inter-relationships between cultured species, culture methods, farm site, and economics in an aquaculture venture.

2.4.1 Ponds

Ponds are broadly defined as earthen impoundments for holding aquatic species. Ponds are the oldest aquaculture structure because of the simplicity of basic pond culture in freshwater. Pond culture can be undertaken with nothing more than convenient natural ponds. Purely harvesting from natural ponds is not aquaculture, it lacks the component

of enhancing production; but enhancing production may involve nothing more than adding crude organic fertilizers or removing predators or competitors of the cultured species (Kadri, S. *et al*, 2012).

A pond may be a simple hole in the ground or an enclosed waterway in a valley or stream bed where only one or two walls are constructed, or it may be above ground. Ponds are most commonly used for culture of fish and crustaceans. Cheap simple ponds are the most widely used freshwater and brackish water aquaculture systems.

Ponds in general are cheaper to construct per unit area than tanks and cages, may be inexpensive to run, depending on pumping costs. Ponds tend to have the lowest stocking densities of the culture structures; however, density varies according to whether the system is extensive, semi-intensive or intensive. Figure 2.6 shows the ponds farming fish.

Figure 2.6: Ponds (Verreth, J.A.J. *et al*, 2007)

2.4.2 Cage

Originally, the cages used for aquaculture consisted of poles or stakes driven into the sediment of shallow lakes or bays with netting stretched around them. These are still in use and are referred to as net pens or hapas. Modern cages are floating structures with a net suspended below. They may be square, rectangular or round. Floating cages may be small and of limited strength or they may be many thousands of cubic meters in volume and designed for use in open ocean. (John.S *et al*, 2012). Cages are used for fish culture in their grow-out phase that is the month or years up to their market size.

Today cage culture received greater attention by researchers and commercial fish producers. Factor to the growing needs of fish, wild fish stocks decline and economic constraints of the farm has expressed strong interest in the production of fish in cages. Cage also offers opportunities for fish farmers to make use of existing water resources. Example farming cage as shown in Figure 2.7.

Figure 2.7: Cage farming fish (The Columbia Electronic Encyclopedia, 2001-2005).

2.4.3 Tanks

Tanks are second to ponds as the most commonly used structures for aquaculture. Tanks are generally situated above ground on a solid base and may be used indoors or outdoors. Tanks have the advantage of allowing the use of land normally unsuitable for aquaculture, as the water is contained within the structures with no contact to the surrounding soils. There is a wide range of dimensions and size of tanks, corresponding to their wide range of uses stages of fish and invertebrates. They range in size from tens of litres to hundreds of cubic metres (Lucas, J.S. *et al*, 2012).

Tanks are most commonly used for culturing the early development stages of fish, bivalves and crustaceans, and for culturing high-value fish species. As with ponds, there is a variety of tank systems is simply a confinement for the animals, to recirculating tank systems, in which the water is used, treated and re-used while maintaining a high density of animals. Figure 2.8 show the tank system of farming fish.

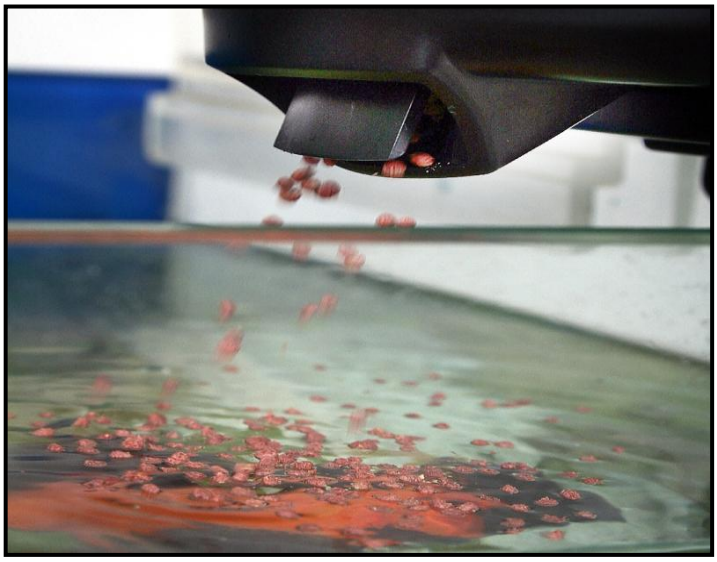

Figure 2.8: Tank (Beau, 2011)

2.5 Fish Feeding System

In general, there are three methods of fish feeding which the manual feeding, semi automatic feeding and automatic feeding as shown in Figure 2.9. However the latter has been seriously put into conversation by many aqua culturists and researchers as it applies technological approaches in a multi scale manner. the classification of automatic feeders which was based on the type of the applied energy to dispense the feed such as pneumatic energy, hydraulic energy and electric energy. The classification also could be determined based on feed delivering method whereby the automatic feeder could be in static condition or works as a mobile unit. Labor is required to deliver feed to the static or fixed feeders except the high pressure pipe feeder. Punctual feeding schedule could be achieved by using the timer (Shaari, M.F., *et al*, 2011).

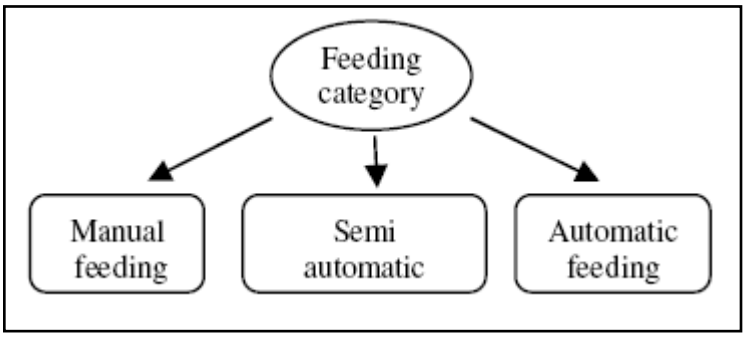

Figure 2.9: Fish Feeding Category (Shaari, M.F., *et al*, 2011).

Contrary to the fixed feeder, autonomous mobile feeder does not need labor to deliver the feed. It acquires the feed from the main storage and delivers the feed independently to the pond for dispensing process. Shaari, M.F., *et al* (2011) said intelligent control system with algorithm is necessary to make decision in determining path planning, obstacle avoidance and dispensing feed as scheduled. Assistance from technological devices such as vision camera, sensors and transducers is essential to provide real time and accurate feedback to the controller to form an effective and efficient system (Steven Craig, 2009).

Alternatively, in order to reduce control system complexity and increasing the robustness of the system, fixed track could be utilized for the mobile feeder. In common practice, the fixed track would be the train track where the mobile feeder is mounted on the track or top hung rails where the mobile feeder is hung to the rail. Fixed track feeding system has relatively higher capital cost as well as maintenance cost compared to the independent track mobile feeder. Metal based structure that constructs the track would easily corroded by the salinity of the pond water and so on with high humidity environment such as in tropical countries. As the conclusion, design selection of the automatic fish feeder must concern with many aspects such as feeding frequency, pond layout, feed form, culture system, environmental factors, water quality and type or size of fish.

2.6 Introduction of Control

In the recent years, control system has assumed an increasingly important role in the development and advancement of modern civilization and technology. Practically every aspect of our day-to-day activities is affected by some type of control systems. Automatic control system are found in abundance in all sectors of industry, such as quality control of manufactured products, automatic assembly line, machine-tool control, space technology and weapon system, computer control, transportation systems, power systems, robotics and many others. It is essential in such industrial operations as controlling pressure, temperature, humidity, and flow in the process industries.

Recent application of modern control theory includes such non-engineering systems as biological, biomedical, control of inventory, economic and socioeconomic systems. The basic ingredients of a control system can be described by:

- Objectives of control.
- Control system components.
- Results or output.

2.6.1 Automatic Controllers

An automatic controller is used to compare the actual value of plant result with reference command, determines the difference, and produces a control signal that will reduce this difference to a negligible value. The manner in which the automatic controller produces such a control signal is called the control action.

An industrial control system comprises of an automatic controller, an actuator, a plant, and a sensor (measuring element). The controller detects the actuating error command, which is usually at a very low power level, and amplifies it to a very high level. The output of the automatic controller is fed to an actuator, such as a hydraulic motor, an electric motor or a pneumatic motor or valve (or any other sources of energy). The actuator is a power device that produces input to the plant according to the control signal so that the output signal will point to the reference input signal.

The sensor or the measuring element is a device that converts the output variable into another optimum variable, such as a displacement, pressure or voltage, that can be used to compare the output to the reference input command. This element is in a feedback path of the closed loop system. The set point controller must be converted to reference input with the same unit as the feedback signal from the sensor element.

Classification of Industrial controllers:-

Industrial controllers may be classified according to their control action as:

- Two-position or on-off controllers
- Proportional controllers
- Integral controllers
- Proportional-plus-integral controllers

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