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MODELLING AND CONTROL 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.

Keywords: *PID, fish feeder, Matlab, proportional, intergral.*

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PERMODELAN DAN PENGAWALAN SISTEM PEMBERI MAKAN IKAN

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Abstrak

Makanan dan pemakanan adalah pertumbuhan utama dan pengeluaran, dan kedua-duanya menjadi satu cabaran utama dalam pembangunan akuakultur. Pelarasan cara penghantaran makanan ke kolam adalah peranan penting untuk mendapatkan pulangan maksimum atau keuntungan kepada usahawan akuakultur. Projek ini merupakan satu penyiasatan tentang sistem memberi makan ikan. Peranti sistem untuk memberi makan ikan pada jumlah yang telah ditetapkan makanan dan masa. Sistem yang direka yang mempunyai sistem komputer dipantau yang dibangunkan untuk mengurus dan mengawal sistem dengan masa sebenar. Tujuan projek ini adalah untuk memantau dan mengawal sistem memberi makan ikan. Projek ini adalah simulasi dan penyelidikan ujikaji ke dalam pembangunan pengawal PID menggunakan perisian Matlab / Simulink. Pembangunan simulasi pengawal PID dengan model matematik system pemberi makan ikan selesai menggunakan percubaan dan kaedah kesilapan. PID parameter adalah untuk diuji dengan motor DC dalam perisian Matlab / Simulink. Untuk sistem, nilai terbaik pengawal PID adalah apabila Kp = 100, Ki = 0.05 dan Kd = 25. Apabila Kp = 100 masa naik adalah kedua 0.113, apabila Ki = 0.05 masa naik adalah pada 0,151 kedua dan apabila Kd = 25, masa naik adalah kedua 0,143.

Kata Kunci: PID, Pemberi Makan Ikan, Matlab, Berkadar, Asasi.

1.0 INTRODUCTION

An automatic fish feeder system is an electronic gadget that has been designed to dispense the right amount of pellets at a particular time. In addition, such system also demonstrated the capability in repeating the task daily and accurately, hence promising efficiency and productivity in fish farming field in long run. In general, two basic concepts which are fixed and mobile conceived the automatic fish feeder. This device fed fish following the right schedule and amount pre-defined by user, therefore avoiding the issue of overfeeding. Nowadays, many of the fish farmers still stick with the manual feeding system. By utilizing the traditional manual feeding system, it means that more work forces would be needed by owner of fish farm in handling certain jobs, particularly in cleaning the feeder, refilling the pellet and even repair or maintenance procedure. All these process consumed considerably more time and energy compare to the automatic fish feeding system. Moreover, the benefits automatic fish feeding system emerged as the areas of the farm increased. For larger area, the manual feeding system users will certainly face difficulty in managing the entire feeding schedule.

Based on previous research, there were some efforts taken in order to replace the inefficient and unproductive manual feeding system. Some of the product or design has a limited by the ability in order to dispense pellets at a constant speed. And also, has some design that can cause unbalance growth of fish as the dispensed pellets focused at one part only. Discovering the shortcoming of current automatic feeding systems had motivated the research to develop a system which overcome previous systems' flaw, hence giving more advantages and benefits to the owner and workers. As a remedy of dispensing pellets solely at one part, the new system was able to dispense pellets into the desire area based on the rotation speed of the motor, combined with suitable cycle time.

The system resulted in more systematic feeding schedule which certainly, will directly decrease the labor cost. 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.

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 these projects, both parts are integrated after they are completed so that the result can be observed. The paper focuses about the development of an automatic fish feeder system using controller application. 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.

2.0 LITERATURE REVIEW

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.

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. The other method are used the hydroacoustic sensors to detect food pellets at 2.5 m depth in sea cages for feeding control. 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.

Use a PID controller provides many advantages in the system developed can be used in a variety of sizes and number of ponds due to the functions that can be programmable by personal computer. A PID controller has historically been considered to be the best controller. By tuning the three parameters in the PID controller algorithm, the controller can provide control action designed for specific process requirements. The response of the controller can be described in terms of the responsiveness of the controller to an error, the degree to which the controller overshoots the set point, and the degree of system oscillation.

3.0 METHODOLOGY

This chapter explains the working procedures to execute the whole project. Methodology is very important to determine a direction, guideline and method to work in this project. Besides that, this methodology also indicates the illustration step by step that was obtained from the study of this project. Some of the steps are develop the mathematical equation of the system, method to collect the data, analyze the data by using Matlab software, discuss with detail outcome that obtain from the analysis data and lastly make the conclusion base on the result and discussion. All the procedures and method should be listed down to give a guideline on project progress and to make sure the entire project go as planned.

There are several ideas and methods required in order to target the main objective. Figure 1 show the explaining the methodologies of designing and implementing automatic fish feeder using PID controller application which encompassed system design and software development..

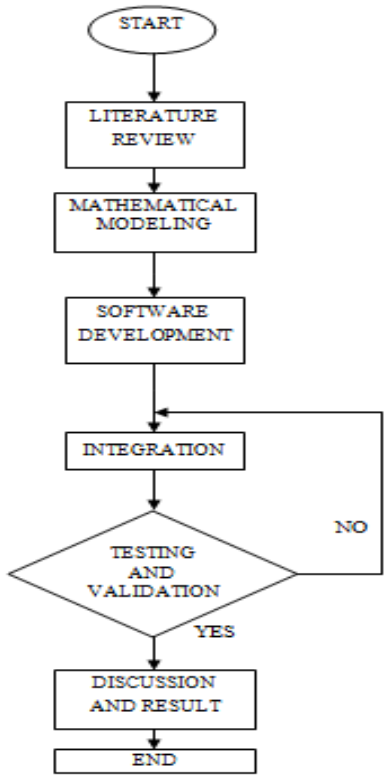

Figure 1: Methodologies of designing Automatic Fish Feeder System.

Figure 1 depicted the flowchart of the procedure conducted. Firstly, the literature review involved studies and collecting information, particularly from previous research. At mathematical modeling, equations that are relevant are use to create the block diagram of the system. Then, reviewed the current issue or development state of automatic feeding system, and made comparison among the researches to identify the flaw of existing systems. Problems or shortcomings were identified and remedies were proposed in software development stage.

In integration stage, all circuit developed will be combined and integrated with the programming code to initiate the system. The data was initialized and processed by PID controller on the program with the user interface. Later, the data processed by PID controller was then sent to device as output of this system. The output for this system would be the speed and the torque, generated by the DC motor and control by the controller. Once the system started or failure occurred, researcher proceeds to testing and validating stage. As a result, data collected form system, especially output voltage drop and the distance of the pellet travelled will be discussed in system discussion stage.

3.1 System Modeling

Block diagram preparation take a several point to develop the overall mathematical modeling system. The design of this Automatic fish feeder block diagram comprised of three main parts namely motor, compressor and system. Layouts of the overall block diagram are shown in Figure 2.

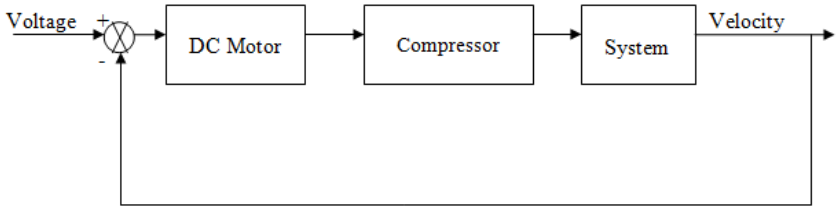

Figure 2: Block diagram of automatic fish feeder system

For transfer function of the DC motor, DC motor as the form in which the motor input supply voltage (ea (t)) and the output is the position of rotary speed (ω).

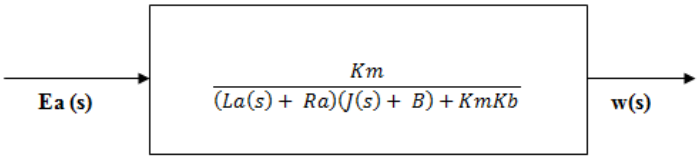

Figure 3: Transfer function of the DC Motor

Where Km is the motor constant, Kb is the constant GGL Opponents, J is the inertia, B is the motor load, La is the inductance and Ra is the detention.

For compressor system, the equation that has been use as follow:

$$\dot{p} = \frac{c_p^2}{V_p}(w - k_t'\sqrt{p - p_a}) \quad (1)$$

$$\dot{w} = \frac{A}{L_c + L_{cd}}(p_c(w, N) - p) \quad (2)$$

For the fish feeding system, the output of the system is a velocity and the input of the system is a pressure. Know that the pressure is equal to force per area. The equations are shows below:

$$p = \frac{m\frac{dv}{dt}}{A} \quad (3)$$

So, output per input in the system is a:

$$\frac{\frac{dv}{dt}}{p} = \frac{m}{A} \quad (4)$$

The transfer function of this model is a:

$$\frac{v}{p} = \frac{A}{m}.\frac{1}{s} \quad (5)$$

3.2 Control strategy for the fish feeding system

In this section a control system of the fish feeding system will be discussed and presented. The control will be based on the proportional plus integral (PI), derivative plus integral (PD) and proportional plus integral plus derivative (PID) techniques. The proportional control mode produces a change in the controller output proportional to the error signal. The integral control mode changes the output of the controller by an amount proportional to the integral of the error signal.

PID controller or proportional–integral–derivative controller is a generic control loop feedback mechanism widely used in industrial control systems. A PID controller attempts to correct the error between a measured process variable and a desired set point by calculating and then outputting a corrective action that can adjust the process accordingly. So by integrating the PID controller to the DC motor were able to correct the error made by the DC motor and control the speed or the position of the motor to the desired point or speed.

The PID controller calculation involves three separate parameters; the Proportional, the Integral and Derivative values. The Proportional value determines the reaction to the current error, the Integral determines the reaction based on the sum of recent errors and the Derivative determines the reaction to the rate at which the error has been changing. The weighted sum of these three actions is used to adjust the process via a control element such as the position of a control valve, the power supply of a heating element or DC motor speed and position.

4.0 SIMULATION AND RESULTS

The PID controller result are get from the simulation of the fish feeding system. The value of Kp that optimize and good for the system is a Kp=100 which is the rise time is a 0.113 second and settling time at 0.614 second. So, assume the overall system use Kp=100 as shown in Figure 4. While the value of Ki that optimize and good for the system is a Ki=0.05 as shown in Figure 5 which is the rise time is a 0.151 second and settling time at 11.5 second is a the best settling time. And then, the value of Kd that optimize and good for the system is a Kd=25 which is the rise time is a 0.143 second and settling time at 0.433 second is a the best settling time as shown in Figure 6.

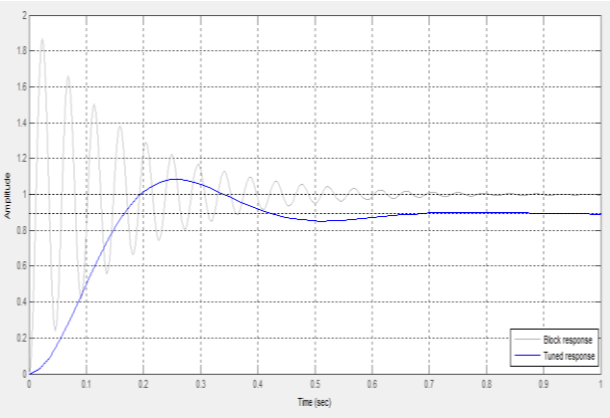

Figure 4: Kp=100, Ki=0, Kd=0

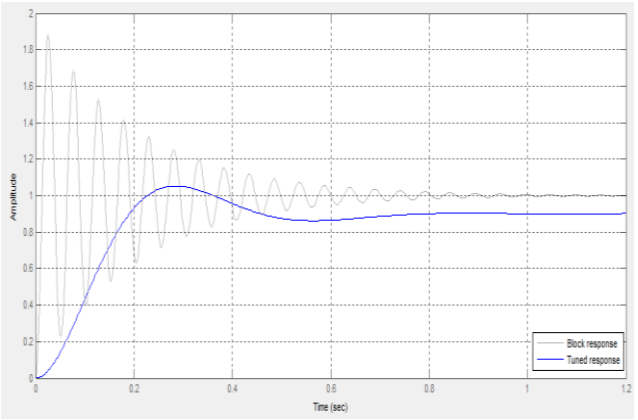

Figure 5: Kp=100, Ki=0.05, Kd=0

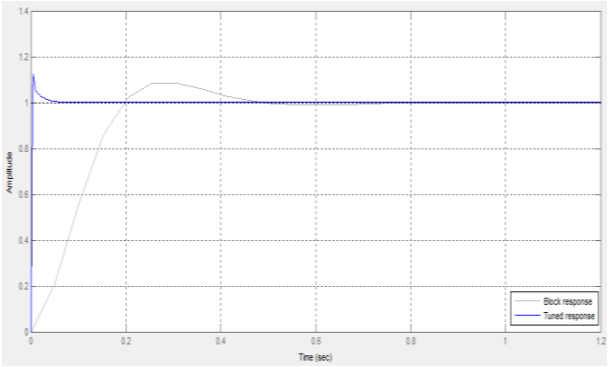

Figure 6: Kp=100, Ki=0.05, Kd=25

5.0 SUMMARY

This research is one of the alternative and easy ways to feed the fish at the right cycle time. Nowadays, the entire fish farmer has to hire more labor cost to handle any kind of work dealing with the feeding fish. So this research can reduce the owner to hire more workers and also reduce the time needed.

BIODATA PENULIS

Hazwan Jamal memperoleh Ijazah Sarjana Kejuruteraan Mekanikal dari Universiti Tun Hussein Onn Malaysia dan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Automotif) dari Universiti Teknikal Malaysia Melaka. Sebelum ini, beliau menjawat jawatan sebagai Dekan Fakulti Sains & Teknologi sebelum dilantik menjadi Pemangku Pengarah Pembangunan di Kolej Universiti Islam Melaka.

Prof Madya Dr Badrul Aisham Bin Md Zain memperoleh Ijazah Doktor Falsafah Kejuruteraan Kawalan dari Universiti Sheffield, Ijazah Sarjana Kejuruteraan Mekanikal dari Universiti Teknologi Malaysia dan Ijazah Sarjana Muda Kejuruteraan Mekanikal dari Universiti Malaya. Kini berkhidmat sebagai Timbalan Dekan, Fakulti Kejuruteraan Mekanikal dan Pembuatan di Universiti Tun Hussein Onn Malaysia.

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