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Design of Fish Feeder Robot based on Arduino-Android with Fuzzy Logic Controller

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***Abstract*— *Fish Feeder Robot is a robot shaped device and has the task of feeding fish to ponds, this robot has an intelligent system that can estimate the feed size based on the type and age of the fish and can be controlled by using an application installed on an android smartphone. Arduino Mega 2560 is the main microcontroller module as the controller of the entire system on the robot. The Arduino Mega 2560 module functions as an intermediary link between the smartphone and the main microcontroller, the smartphone is connected to the HC-05 bluetooth module and the Arduino mega 2560 is connected with the HC12 radio frequency module. Waterproof DC motor is a motion actuator that functions to push the robot, the direction of drive is regulated by a servo motor. The application on an Android smartphone features an automatic feed dose system based on the age of the fish and the database, the database serves to store feed history data. This study useds to develop fish feeders in aquaculture ponds, the control of Robot Fish Feeder using applications installed on android smartphones, so that it is easy for fish farmers to feed and to measure feed accuracy. The heading angle of the robot is detected using a gyroscope sensor then processing using Kalman Filter. Fuzzy Logic Controller is used for robot motion control to achieve the setpoint heading angle and minimize steady state error.*

Keywords*— *Fish Feeder Robot; Arduino; Android; Gyroscope, Kalman Filter, Fuzzy Logic Controller.

I. INTRODUCTION

Aquaculture production activities has become the livelihood of most people in Indonesia. Aquaculture production in Indonesia in 2012-2017 has a positive development. The production grown 12.84 percent per year. In 2017, aquaculture production reached 17.2 million tons. This number increased by 3.26 percent compared to 2016 which is 16.6 million tons [1] [2]. The increment in aquaculture production has also occurred in Madiun Regency, East Java. recorded by the local Agriculture and Livestock Services in 2011, fish production reached 1,795 tons per year and in 2016 reached 3,892 tons. There are many factors that affect the production of aquaculture, one of them is feeding.

Feeding management is an attempt to maximize the use of fish food for growth. But most of the production costs in aquaculture are feed costs. The optimal feeding will feed efficiently and reduce the environmental degradation. In general, the process of fish feeding is still done manually by spreading the feed into the pond. However, this method is inefficient, because the distribution of feed being spread manually is not evenly distributed.

Based on these problems, a Fish Feeder Robot is designed to be used to feed fish in aquaculture ponds. The robot is chosen because the robot can be controlled remotely. This robot uses the Arduino Mega 2560 as a data processor, as well as the HC 12 and HC 05 modules as a communicator between the robot and Android smartphone via the Radio Frequency network. Android smartphones are used to control the motion of the robot and monitor the availability of fish feed in the robot's feed container. This robot uses a waterproof DC motor with a propeller to drive the robot which is located at the bottom of the robot and a servo motor to control the direction of the propeller movement. This research is expected to be useful for aquaculture farmer to help feeding the fish.

II. METHODOLOGY

2.1 System Diagram

The system diagram of "Designing Robot Fish Feeder Based on Arduino-Android" is shown in figure 1.

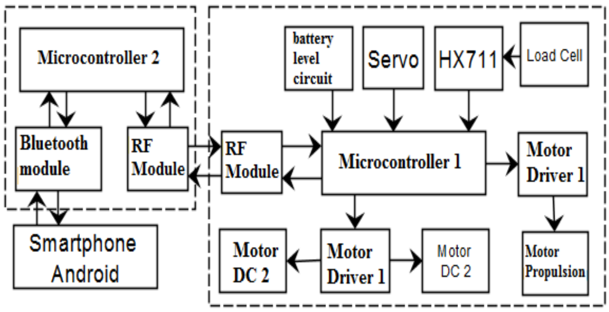

Figure 1. Fish Feeder robot design system diagram

1. Microcontroller 1 is used as a data processor obtained from Android smartphones and load cell sensors. The data that has been processed then distributed to the actuator for execution.
2. Load cells are used to detect the availability of feed in the container by weighing the feed in the container.
3. The HX711 module is used as a conditioner from the load cell sensor into data. The data generated by the load cell sensor is then forwarded to the microcontroller 1.
4. The battery level circuit is used to detect the voltage in the battery. the circuit used is a voltage divider circuit, the output of the voltage divider circuit is forwarded to the microcontroller analog pin.
5. Motor Driver 1 is an IBT-2 BTS7960 motor driver, which is used to adjust the speed of the waterproof dc motor. The motor driver receives a PWM signal from the microcontroller which is used to adjust the waterproof dc motor voltage.
6. Motor Driver 2 is an L298N motor driver which is used to regulate the speed of 2 12V DC motors. The 12V dc motor

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is used to rotate the mechanical dispensing on the feed and rotate the anguler on the fish feed container.

7. The servo is used to control the direction from the waterproof dc motor by moving the fin. The servo motor receives commands from the microcontroller which are then executed by changing the angle of the control fins.
8. Microcontroller 2 is an Arduino Mega 2560 which is used to connect the RF module with the Bluetooth module.
9. The RF module is a HC12 module that connects the microcontroller with the microcontroller 2, through radio frequency signals.
10. The Bluetooth module is a HC05 module that connects the microcontroller 2 with an Android Smartphone via Bluetooth.

2.2 Software Design

This section will explain about the robot software design. Which is a program on the Arduino IDE as well as a discussion of flowcharts.

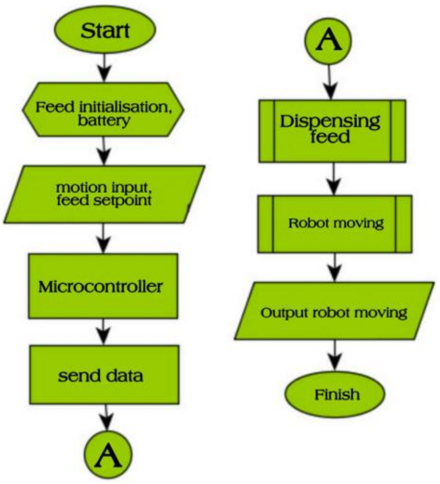

Figure 2. Software system flowchart

Figure 3 is a flowchart of the software system on the Fish Feeder Robot, the robot input obtained from an Android smartphone is in the form of motion code data and the setpoint of the feed to be issued. The data sent from the robot to the Android smartphone includes feed availability and battery level. Program on microcontroller 1 (on robot).

2.3 Fish Feeder Robot System

The feed container has a maximum capacity of 10 kg, the valve for dispensing the feed use 12V DC motor, and another 12V DC motor for spreading the feed. To avoid the feed getting stuck in the valve, augers (helical screw blade) are used to push the feed out of the feed container, the auger is driven by a 12V DC motor. In the feed dispensing system, the L298n motor driver device is used to control 2 12v DC motors, motor 1 is used to spread feed and motor 2 is used to rotate the auger in the feed container. Mechanical illustration of the feed dispensing system is shown in figure3.

Load cell is used as a sensor for weighing the available feed in the feed container. The implementation of this robot shown in figure 4.

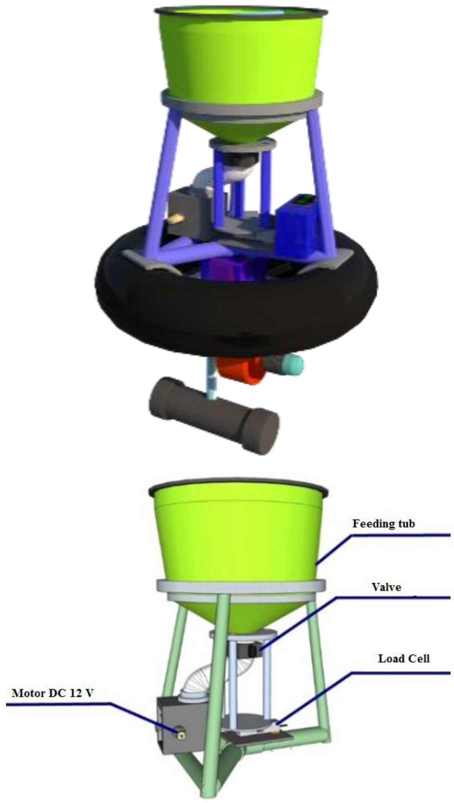

Figure 3. Feed dispensing mechanism design

Figure 4. Implementation of fish feeder robot

2.4 Kalman Filter

Gyroscopes is device that mounted to a frame and can sensing velocity of angular if it's frame is rotate [5]. The output of the gyroscope sensor is processed with a Kalman filter to become the robot's heading angle.

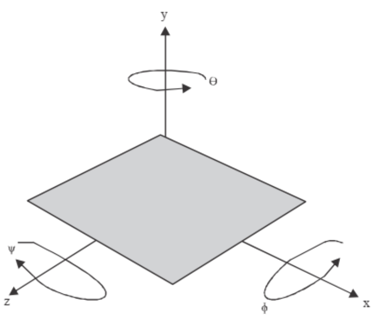

Figure 5. Illustration of the basic principle of a gyroscope and how the rotations (Φ, θ, Ψ) occur around respective axes [6]

Kalman filters rely on the state representation of a system. They are specialized Bayesian estimators for linear systems with discrete time and Gaussian noises, where **V***k* and **W***k* are state and measurement noise vectors [3].

$$X_{k+1} = [A] \cdot X_k + [B] \cdot U_k + V_k \quad (1)$$

$$Y_k = [C] \cdot X_k + [D] \cdot U_k + W_k \quad (2)$$

The Kalman filter is a recursive filter (i.e., it uses the output of its previous corrected estimation to process the next one). This process can be represented by figure 6, with each step detailed by table 1.

TABLE 1. Kalman filter processing steps.

Step	Kalman Filter	Real System
Evolution	$\tilde{X}_{k+1} = [A]\hat{X}_k + [B]U_k$ $[\tilde{P}_{k+1}] = [A][\hat{P}_k][A]^T + [Q]$	$X_{k+1} = [A]X_k + [B]U_k + V_k$
Prediction/measurement	$\tilde{Y}_k = [C]\tilde{X}_k + [D]U_k$	$Y_k = [C]X_k + [D]U_k + W_k$
Correction	$E_k = Y_k - \tilde{Y}_k$ $[K_k] = [\tilde{P}_k][C]^T([C][\tilde{P}_k][C]^T + [R])^{-1}$ $\hat{X}_k = \tilde{X}_k + [K_k]E_k$ $[\hat{P}_k] = (I - [K_k][C])[\tilde{P}_k]$	

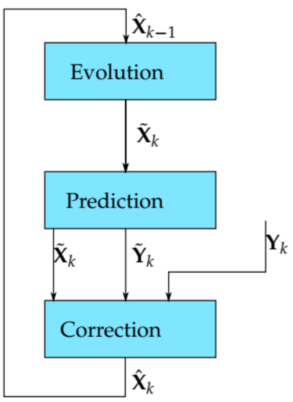

Figure 6. The Kalman filter recursive process.

This filter tends to reduce the quadratic error of **X**ˆ *k*. Once the model is fixed, the fitting of the filter is done by adjusting the values of covariance matrices of **V***k* and **W***k*, [**Q**] and [**R**] respectively, and the initial estimated covariance of **X**, [**P**0].

2.5 Fuzzy Logic Controller

A Fuzzy Logic controller is used to control the motion of the robot in order to achieve the setpoint heading angle input from the Android Smartphone. The Fuzzy Logic Controller (FLC) output is forwarded to the PI controller to adjust the output control signal values which produce a PWM signal to control the angle of the DC servo motor. The block diagram of the Fuzzy Logic Controller can be seen in figure 6.

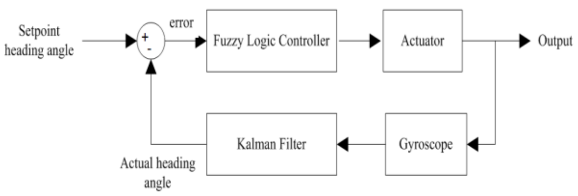

Figure 6. Design of Fuzzy Logic Controller

The membership function input error can be seen in figure 7. Each of them is divided into five, namely Negative Big (NB), Negative Small (NS), Zero (Z), Positive Small (PS) and Positive Big (PB) as shown in figure 7.

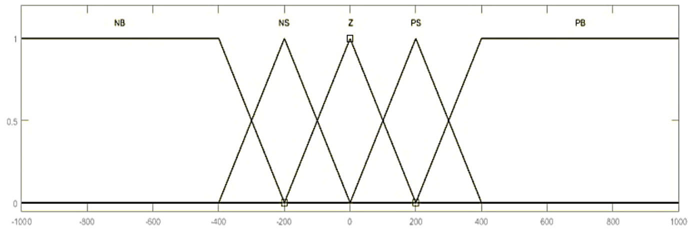

Figure 7. Membership function input *error*

The input delta error is divided into 7, namely Negative Big1 (NB1), Negative Big (NB), Negative Small (NS), Zero (Z), Positive Small (PS), Positive Big (PB), Positive Big1 (PB1) as shown in figure 8.

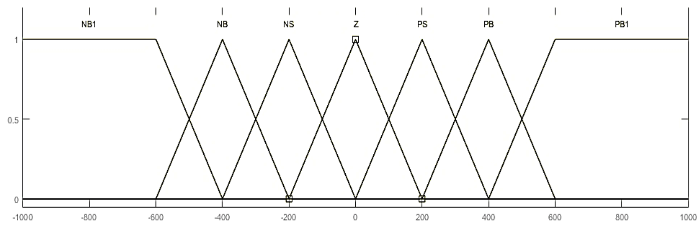

Figure 8. Membership function input *delta error*

Membership output control is divided into 5, namely Negative Big (NB), Negative Small (NS), Zero (Z), Positive Small (PS), Positive Big (PB) as shown in figure 9. The output control is the duty cycle of the PWM signal for control of a servo DC motor as shown on figure 9.

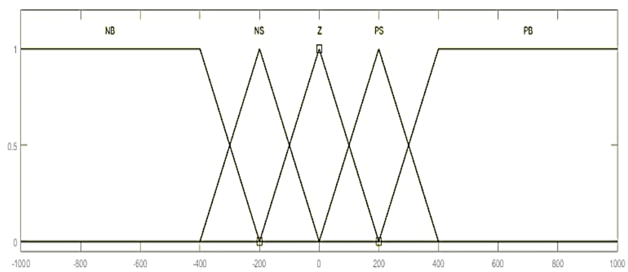

Figure 9. Membership function output *control*

The base fuzzy rules are compiled by considering the input error and delta error until the best response is obtained. There are 35 rule bases for output control output as shown in table 2.

TABLE 2. Rule base Fuzzy output control

d_ERROR \ ERROR	NB	NS	Z	PS	PB
NB1	NB	NB	NS	Z	Z
NB	NB	NB	NS	Z	Z
NS	NB	NS	Z	Z	PS
Z	NB	NS	Z	PS	PB
PS	Z	Z	PS	PS	PB
PB	NS	NS	Z	PS	PB
PB1	NS	NS	Z	PS	PB

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III. Result

The test was carried out by giving a setpoint of the heading angle of 50 degrees and then at 0.2 ms a disturbance was given. observations were made on the robot with Fuzzy Logic Controller, PI controller and without controller. The angular response of the servo motor can be seen in figure 10.

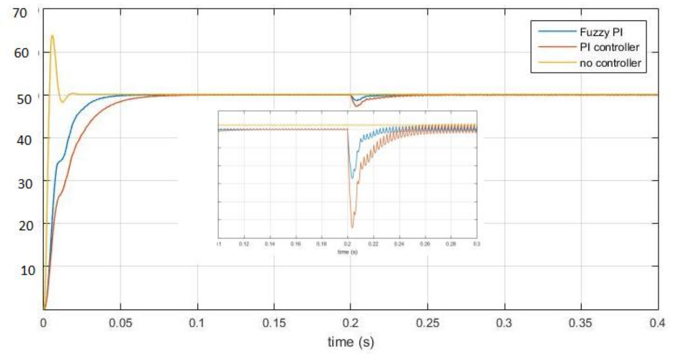

Figure 10. Servo motor heading angle response

Controller test results as shown on table 3.

TABLE 3. Controller test results

No	Type	Overshoot (degree)	Rise Time (ms)	Settling Time (ms)	RMSE (degree)
1	No controller	13	0.002	0.024	7.8
2	PI controller	-	0.034	0.052	4.6
3	Fuzzy Logic	-	0.018	0.034	2.4

IV. Conclusion

Based on the results of the design, testing and analysis carried out on the "Robot Fish Feeder Based on Arduino-Android with Fuzzy Logic Controller", it can be concluded:

1. The design of the Robot Fish Feeder as a tool to spread fish feed evenly in aquaculture ponds can be realized and can be tested in aquaculture fish ponds with satisfying results.
2. Based on the simulation results, it can be concluded that the heading angle control of servo DC motor with Fuzzy PI controller has better performance, can reach the setpoint without overshoot with a rise time of 0.018 ms, settling time of 0.034 ms and RMSE of 2.4 degree.

References

[1] Haryanto, Eri. Design and Implementation of the AT89S52 Microcontroller-Based Automatic Fish Feeder, p. 10, 2015.Helda Yenni, B. 2016. Automatic Feeding Device, Volume 11, p. 11.

[2] Romaria Saragih, Astriyani. Design of Automatic Fish Feeding Equipment in Arduino-Based Fish Hatchery Design of Automatic Fish Feeding Equipment in Arduino Based Fish Hatchery, p 12, 2016.

[3] Aurélien Valade, Pascal Acco, Pierre Grabolosa and Jean-Yves Fourniols, A Study about Kalman Filters Applied to Embedded Sensors, MDPI journal, 2017

[4] Shengzhi Zhang, Shuai Yu, Chaojun Liu , Xuebing Yuan and Sheng Liu, A Dual-Linear Kalman Filter for Real-Time Orientation Determination System Using Low-Cost MEMS Sensors, MDPI Journal 2016

[5] Ilham Arun Faisal, Tito Waluyo Purboyo and Anton Siswo Raharjo Ansori, A Review of Accelerometer Sensor and Gyroscope Sensor in IMU Sensors on Motion Capture, Journal of Engineering and Applied Sciences 15 (3): 826-829, 2020

[6] Grahn, E., 2017. Evaluation of MEMS accelerometer and gyroscope for orientation tracking nutrunner functionality. KTH, School of Technology and Health, Huddinge, Sweden

Wahyu Pribadi, Yuli Prasetyo, and Dirvi Eko Juliando, "Design of Fish Feeder Robot based on Arduino-Android," *International Research Journal of Advanced Engineering and Science*, Volume 5, Issue 4, pp. 47-50, 2020.