Smart Fish Feeder Using Arduino Uno With Fuzzy Logic Controller

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***Abstract*—Smart Fish Feeder is an automatic fish feeder that can be controlled using android smartphone. With this tool, fish owners will easily adjust the feeding schedule according to the recommended feed dose, and provide aquarium cleaning scheduling. In designing a fish feeder, there are some criteria such as temperature and time interval of feeding. The data collection has been done by interviewing ornamental fish traders. The data also has been obtained from literature studies that support problem solving theory. The Laravel framework is used to interpret the system while Firebase as the Database Management System. The Android is as a front end that interacts directly with the user. Automatic fish feeding systems are implemented using arduino micro-controller and prototype feeding devices. This research uses Fuzzy Logic Controller method. With the creation of the prototype smart fish feeder the device functions well in terms of both controller and push data. The results of the calculation of the duration of fish feed using the Fuzzy Sugeno Algorithm have been successfully applied to the smart fish feeder**

Keywords— Smart Fish Feeder, Arduino, Android, Firebase and Fuzzy Logic

I. INTRODUCTION

The advancement in the field of electronics is now dominat-ing in science and technology [1]. With the advances in technology and the improvement of people's living standards, [2] ornamental fish become an integral part of daily life. One of the hobbies that the community of seeks to keep is the fish in the aquarium [3],like a goldfish chef. Goldfish is one of the most popular ornamental fish. This fish has a diverse body shape and has a variety of colors, namely red, yellow, green, black and silvery. This is due to the ease of care, feeding and so forth. Fish feeding is the main ingredient [4]. Fish will eat all the food given. Often the pet fish die because most of the food is eaten [5]. Fish feeding is generally done manually by sprinkling fish feed into the pond and this work is done regularly every day. People who have a hobby of fishing fish are worried about the feed that should be done every day. With the smart fish feeder tool then the owner of the fish can easily adjust the feeding schedule according to t he recommended feed dosage [6]. However, for people who have a fairly busy level of work, certainly feel a little difficulty when going to leave home moreover in a long time. With the least intensity of time at home they have. The usual alternative is to ask for help to others like close relatives or to neighbors. But this can lead to new problems, such as nothing can be asked to help keep the fish in the aquarium.

For the method of supporting the problem in this research, we purpose the optimization of fish feeding by using the fuzzy logic controller. A way to control the provision of fish feeding in this study is determined by the rules of fuzzy logic controller that is using the parameters of temperature and turbidity of water which is an important aspect in fish cultivation [7] [8].

With these problems, there must be a solution to solve existing therefore, in this research entitled "Smart Fish Feeder Using Arduino Uno With Fuzzy Logic C0ntroller", this study aims to predict the depletion of fish feed with a technological tool that is needed to grow at this time, so it can be applied in everyday life . With the smart fish feeder, the fish owner can easily set the feeding schedule according to the recommended dose of feed. Simple but very effective, with this tool is expected to be an alternative solution for people who like to keep goldfish without any feeling of worry when leaving home in a long time. Framework Laravel used to intercept systems with databases using Firebase as Database Management System and Android as front end in-teracting directly with user. Automatic fish feeding systems are implemented using a microcontroller to produce a prototype smart fish feeder to allow fish owners to schedule fish feeding schedules.

II. RELATED WORKS

Often the fish die because most of the food intake [4][5]. People who have a hobby of fishing fish are worried about the feed that should be done every day. With the smart fish feeder tool then the owner of the fish can easily adjust the feeding schedule according to the recommended feed dosage [6]. So a regular diet can help predict the depletion of fish feed every week [9]. Timely feeding and water turbidity parameters are important aspects of fish farming [7]. Temperature parameters are also important to know how much temperature and oxygen content is present in the aquarium [8]. The ideal temperature for fish farming is a stable temperature in the range of 23-30 ° C and there is no significant water temperature difference between day and night (no more than 5 °C). Fish are classified according to cold water habitats (below 20 ° C), and warm water (above 20 °C). The tolerance of warm water fish to turbidity is higher (25 NTU) than cold water habitat fish (10 NTU). In this condition the fish will give a maximum response when feeding. Besides that the fish's immune system also works optimally in these conditions. The innovation engine is deliberately used for fish farming especially for fish farming with the enclosure system[10]. Smart Fish Feeder using a microcontroller like Arduino as Microcontroller serves as the main of the system [11]. The microcontroller is even more than a microprocessor because it consists of ROM

(Read-Only Memory), RAM (Read-Write Memory), multiple ports (input) and output [3]. Popularity has been driven by the simplicity of the use of Arduino and a large number of sensors and libraries available to improve the basic capabilities of this controller [12]. Arduino is a platform for physical computing that is open source [13]. The Arduino programming environment facilitates developers to manage, organize, upload, and simulate programs [14]. Arduino is not just a development tool but it is a combination of advanced hardware, programming languages and Integrated Develop-ment Environment (IDE) [15]. This appliance can be used for remote monitoring over the internet [16]. Arduino Uno is a microcontroller board based on ATmega328, This board has 14 digital input/output pins (where 6 pins can be used as PWM output), 6 analog inputs, 16 MHz crystal oscillators, USB connection, reset button. [17] Research predicted the depletion of fish feed using fuzzy logic controller method. The fuzzy logic process is fuzzification (crisp blurred input value), rule evaluation (fuzzy control), and defuzzification (fuzzy output for crisp value). The purpose of the fuzzy control system is to replace a human expert by a fuzzy rule-based system [18]. The FLC can convert the linguistic control based on expert knowledge into an automatic control strategy [19]. The Fuzzy System Center is the knowledge base, formed by IF THEN rules of obscurity [20]. Fuzzy rules based on IF-THEN rules[11].

The knowledge base is comprised of two components [12] namely called fuzzy sets (data base) and fuzzy control rule base. The concepts associated with fuzzy sets are used to characterize fuzzy control rules and fuzzy data manipulation in an FLC. Previous research that discusses the smart fish feeder is different from the current research. This research is different related to research method used, not controlled using a smartphone (android), the parameter used. While this study aims to predict the depletion of fish feed, therefore for the method of supporting problem-solving using fuzzy logic controller method. By using the fuzzy logic controller method it will get the prediction of the end of the fish feed. Parameters used are turbidity of water, temperature and time interval. Framework Laravel used to intercept systems with databases using Firebase as Database Management System (DBMS) and Android as front end interacting directly with user. Automatic fish feeding systems are implemented using a microcontroller to produce a prototype smart fish feeder to allow fish owners to schedule fish feeding schedules

III. METHODS

The principle of smart fish feeders is that all tasks are carried out together in a short time, the feeding time calculated in milliseconds. Measurements are given by sensors that installed in aquariums, using a real time firebase database so that the monitoring or controlling process does not increase on the server. The microcontroller used is Arduino Uno.

The method implemented is FLC, this method is used to develop a controller that will determine optimization of feed-ing given the temperature and turbidity. Fuzzy logic controller is a changing linguistic control strategies derived from expert thinking becomes an automatic control strategy [23] The fuzzy logic controller process can be seen as Figure 1

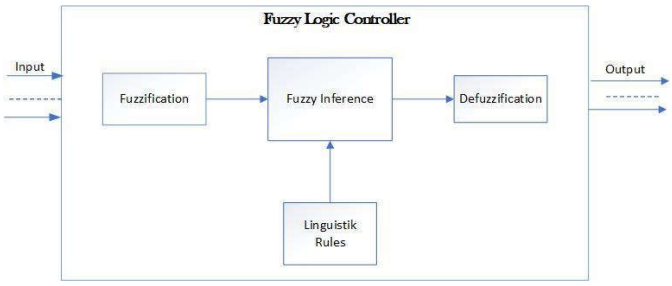

Fig. 1 Fuzzy Logic Controller

In Takagi-Sugeno neuro-fuzzy inference is presented in the form of functional relationships rather than in the form of output membership variables for fuzzy sets. Sugeno type inference system use the output membership function which is linear or constant [24]

The input stages will map sensors, such as switches to membership functions. The fuzification process will transform the input sensor into a fuzzy set. Fuzzy sets will be mapped by the inference process which will be the basis of the decision [25]

Figure 1 shows the basic elements of the FLC, consists of four main components: fuzzification, liguistic rules, fuzzy inference, defuzzification.

1) Fuzzification : A step to converting the parameter value from a set of input or input that is firm to be a fuzzy input by the membership function into a linguistic variable.

2) Rule-Base (Linguistic Rules): Contains IF-THEN rules that are determined through fuzzy logic.

3) Formation of Fuzzy Set (Inference) : Fuzzy rules are a combination of several events consisting of 3 variables with 3 fuzzy sets of each variable that will produce fuzzy rules called inference.

4) Process of determining crip output (Defuzzyfication) : The determination of output in the form of a strict constant using a weighted average formula.

Figure 2 shows the system block diagram, the input from the system is the value of turbidity sensor and temperature, but the system can also run when getting a trigger from the user. Arduino performs data collection, the output from Arduino will signal the module esp8266. When the signal is received it will activate a servo that will drop fish feed in the aquarium. The values of turbidity and temperature have been set with a fuzzy formula to automatically create a control for dropping fish feed.

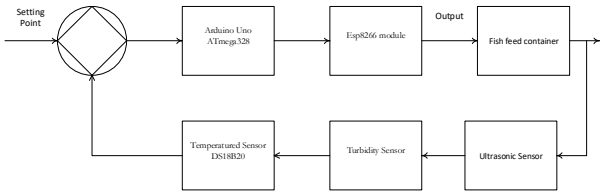

Fig. 2 Block System

Figure 3 shows the hardware block diagram. Arduino Uno microcontroller is used as a data acquisition and data processing unit. The turbidity sensor serves to measure tur-bidity in the water. Temperature sensor serves to measure the temperature in the aquarium. Servo is used to drop fish

feed in the aquarium and the esp8266 module as a connecting microcontroller with the internet. Feeder tanks are places for fish feed in the form of pellets placed. Ultrasonic sensor to measure fish feed residue.

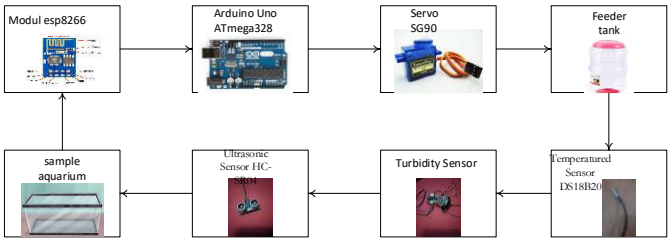

Fig. 3 Hardware Block Diagram

Figure 4 shows the workflow system , the user will select the control menu, the system enters the activity control. Users can choose control, if manually on then the system will give a choice of feed dropping interval. When changing the control menu to off, the fuzzy function will be executed and the interval for dropping fish feed will be calculated based on defuzzification value. The prototype of smart fish feeder shows in Figure 5

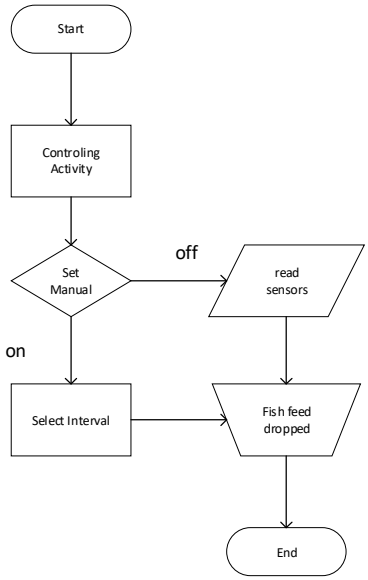

Fig. 4 Flowmap

IV. EXPERIMENT AND RESULT

In this section, we use the controlled of inputs value is 20 °C for temperatur and 26 % for turbidity.

A. Fuzzy Sets Input variables

Table. 1 Fuzzy Sets for Input Variables

No.	Variable	Fuzzy Set	Domain
1	Temperature	Low	0 - 20
		Normal	20 - 30
		High	24 - 35
2	Turbidity	Clear	0 - 25
		Pretty Clear	25 - 50
		Turbid	30 - 80

In Table. 1 we set the input value by the membership function into a linguistic variable.

B. Fuzzyfization

Is a curve that shows the value of data input points into its membership degree which has intervals 1- 0. Based on the fuzzy set that is formed then the membership function that will be used to represent data is a triangular membership function, using equations. The following membership function input variables

The membership function of the temperature variable can be seen in Figure 5 and the turbidity variable membership function can be seen in Figure 6

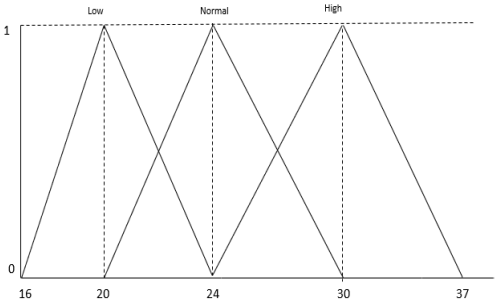

Fig. 5 Temperature Variable Function(X Value)

The water temperature in the tank not only affects food intake, but also feed conversion rates, because they affect the physiology of fish. It is reflected in the growth of fish which has a direct effect on the quality, quantity, and time of harvest in the aquaculture system.

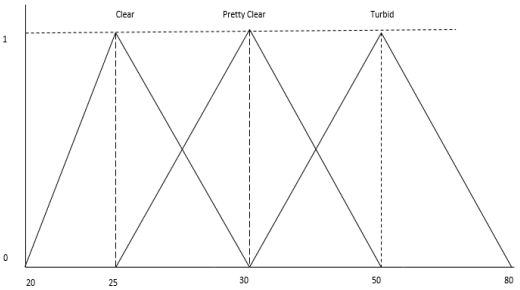

Fig. 6 Turbidity Variable Function (Y Value)

Research [10] shows a decrease in the survival rate of fish egg embryos occurs when an increase in fine particles by 5-10% at spawning.

C. Fuzzy Set

Fuzzy rules are a combination of several events. As has been explained that there are 3 variables with 3 fuzzy sets of each variable which will produce 9 fuzzy rules called inference.

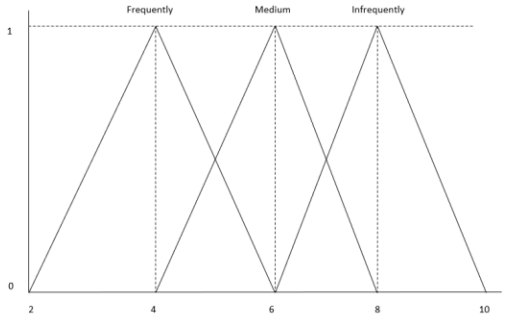

Fig. 7 Output Variable (Z Value)

The fuzzy rules that will be created are 9 rules with the note that each rule that is formed including all variables using equation below is the 9th rule of the fuzzy set:

[R1] = IF LOW Temperature and Turbidity CLEAR THEN Medium feeding duration
[R2] = IF LOW Temperature and Turbidity PRETTY CLEAR THEN Long feeding duration
[R3] = IF LOW Temperature and Turbidity TURBID THEN Long feeding duration
[R4] = IF NORMAL Temperature and Turbidity CLEAR THEN Often feeding duration
[R5] = IF NORMAL Temperature and Turbidity PRETTY CLEAR THEN Medium feeding duration
[R6] = IF NORMAL Temperature and Turbidity TURBID THEN Long feeding duration
[R7] = IF HIGH TEMPERATURE and Turbidity CLEAR THEN Often feeding duration
[R8] = IF HIGH TEMPERATURE and Turbidity PRETTY CLEARITY THEN Often feeding duration
[R9] = IF HIGH TEMPERATURE and Turbidity TURBID THEN Medium feeding duration

the degree of membership value of each variable in each set using the following equation

Input Temperature = 20
μlow [20]=1; μnormal [20]=0; μhigh [20]=0 (1)
Input Turbidity= 26
μClear [26]= 0,8; μPretty Clear [26]=0,25; μturbid [26]=0 (2)

after the value of the α predicate is obtained then look for the z value using the following equation:

[R1] = IF LOW Temperature and Turbidity CLEAR THEN Medium feeding duration
α predikat 1 = μ low (20); μ clear (26)
= 1 ; 0,8
= 0,8

z = 10 – 0,8 (10 – 2) = 3,6

[R2] = IF LOW Temperature and Turbidity PRETTY CLEAR THEN Long feeding duration
α predikat 2 = μ low (20); μ Pretty Clear(26)
= 1 ; 0,25
= 0,25

z = 10 – 0,25 (10 – 2) = 8

[R3] = IF LOW Temperature and Turbidity TURBID THEN Long feeding duration
α predikat 3 = μ low (20); μ turbid (26)
= 0 ; 0
= 0
z = 10 – 0 (10 – 2) = 0

[R4] = IF NORMAL Temperature and Turbidity CLEAR THEN Often feeding duration
α predikat 4 = μ normal (20); μ clear (26)
= 0 ; 0,8
= 0
z = 10 – 0 (10 – 2) = 0

[R5] = IF NORMAL Temperature and Turbidity PRETTY CLEAR THEN Medium feeding duration
α predikat 5 = μ normal (20); μ Pretty Clear (26)
= 0 ; 0
= 0
z = 10 – 0 (10 – 2) = 0

[R6] = IF NORMAL Temperature and Turbidity TURBID THEN Long feeding duration
α predikat 6 = μ normal (20); μ turbid (26)
= 0 ; 0
= 0
z = 10 – 0 (10 – 2) = 0

[R7] = IF HIGH TEMPERATURE and Turbidity CLEAR THEN Often feeding duration
α predikat 7 = μ high (20); μ clear (26)
= 0 ; 0,8
= 0
z = 10 – 0 (10 – 2) = 0

[R8] = IF HIGH TEMPERATURE and Turbidity PRETTY CLEARITY THEN Often feeding duration
α predikat 8 = μ high (20); μ Pretty Clear(26)
= 0 ; 0,25
= 0
z = 10 – 0 (10 – 2) = 0

[R9] = IF HIGH TEMPERATURE and Turbidity TURBID THEN Medium feeding duration
α predikat 9 = μ high (20); μ turbid (26)(115);
= 0 ; 0
= 0
z = 10 – 0 (10 – 2) = 0

D. Defuzzyfication

The values that have been obtained are used to determine the output, which is defuzzyfication. The crip output obtained is the final score calculated. Because α a non-zero

predicate is only found in the rules: [R1] and [R2], then it is calculated only [R1] and [R2]. To determine defuzzification are as follows:

$$Z = (\alpha \text{ predikat}_8 * Z_8)/(\alpha \text{ predikat}_8)$$
$$Z = ((0{,}8x3{,}6)+(0{,}25x8))/(0{,}8+0{,}25)$$
$$= (2{,}88+2)/1{,}05$$
$$= 3{,}25$$

The defuzzification result of the duration of fish feeding was 3.25

E. Result

Then the results of the calculation of the duration of fish feeding using the Fuzzy Sugeno Algorithm from the input above, the calculation results with a score of 3.25 with the output being the Medium Duration.

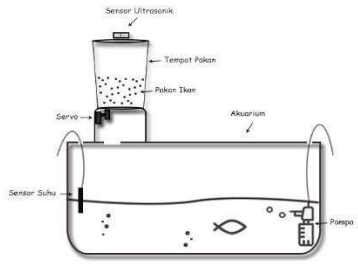

Fig. 8 Smart Fish Feeder

In this study the experiment was carried out by experimenting on / off status on the controlling menu on Android and then seeing how the response of the tool and push the data carried out by the microcontroller to the server.

Table. 2 Experiment Result

Fuzzy Response					
No	Weeks	Temperature (C)	Turdibity (NTU)	Fuzzy	
				Hour	Second
1	First Week	20	20	4	14400
2	Second Week	20	25	4	14400
3	Third Week	20	35	5.3	19200
4	Fourth Week	20	40	8	28800
5	Fifth Week	20	45	16	57600
6	Sixth Week	21	20	4.5	16200
7	Seven Week	22	20	5	18000
8	Eighth Week	23	20	5.5	19800
9	Nine Week	24	20	6	21600
10	Tenth Week	25	20	7.6	27360

V. CONSLUSION

From the results of designing and testing this feed optimization tool, there are several things that can be concluded. There are limitation such as too long a delay in the controller due to RAM limitations. Arduino UNO is not compatible with smart fish feeders because it is associated with limited memory. An unstable internet connection affects the response time of the device. The method used in this research is the fuzzy logic controller method. The application of the Fuzzy Logic Controller method on the smart fish feeder prototype can serve to optimize fish feed based on temperature and turbidity.

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