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Application of the Fuzzy Logic Method in Determining the Volume of Water Discharge to the Number of Humans Based on a Microcontroller

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ABSTRACT

This research discusses the implementation of fuzzy logic in the design of an automatic water valve system. Fuzzy logic is used to calculate input values to avoid inappropriate power due to excessive sensor input variations. The system performance assessed is the success of the system in regulating the number of people at the capacity of water volume availability. The sensor system detects the number of people entering to determine the capacity according to the given input. The system is designed using an ATmega328 microcontroller. Ultrasonic & PIR sensors are used to predict the number of people passing by the door. To evaluate the performance of the system, the maximum number of 800 people, to avoid system failure. Experiments showed better accuracy in determining the degree of rotation of potentials and relays when the Tsukamoto fuzzy logic model was implemented. The system is more stable and the average value obtained is 34.1%.

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1. INTRODUCTION

Technological developments keep up with the times, in which everything we do can be supported by technology. Technology makes it easier for us to carry out various human activities. In the application of computer science, especially in the field of soft computing and intelligent system computing, it can be implemented at this time, where all tools will be fully automated (Siregar, 2017). The scope of discussion of soft computing, namely on its calculations in the field of computer science, which aims to overcome the problem of tolerance for uncertainty, inaccuracy, and partial truth. The application of technology is contained in electronics that we already use in everyday life, such as air conditioners, refrigerators, washing machines, and many other electronic devices that apply soft computing (Siregar, 2019). The electronic device has been embedded with a fuzzy logic method. Fuzzy logic is a branch of Artificial Intelligence, which is knowledge that enables computers and electronic devices to do things that humans normally do.
controller design on fuzzy logic can be controlled by genetic algorithms to further optimize the controller parameters (Siregar, 2019). Fuzzy Logic Controller is an alternative to modern control systems that have a stable system response. In designing a control system using fuzzy logic, there are three processes: fuzification, rule evaluation and defuzzification. Each of these processes will affect the response of the

system being controlled (Achtelik et al., 2009). Fuzzy logic can be applied in making decisions regarding temperature which increases with the number of people entering the room, which is given a variable based on behavior / the number of people entering the room, where the parameter particle swarm optimization (PSO) is used. The application of fuzzy logic can be applied to the microcontroller concept (Andi, 2010).

Fuzzy logic functions can be combined with soft computing techniques to control the balance of a wheeled robot (Bobby, 2015). Fuzzy logic on multiple microcontrollers can be made for robot prototype models, where fuzzy logic is built using a behavior-based approach (Siregar, 2019). Communication with fuzzy logic commands can also be applied to control the amount of water discharge against the intensity of the number of people entering the room, where the communication between the microcontroller and the sensor is about the movement received by the sensor. In this regard, there is a new thought to continue previous research, in which this research is focused on creating a fuzzy logic method to control water discharge for the number of people entering. So that the application of this fuzzy logic can stabilize or overcome the amount of water discharge, so that there is no shortage of water when it is needed. Variables that are categorized as a small amount, a moderate amount, and a large amount. The selection of input variables is from the ultrasonic and infrared sensors contained in the design.

A. Arduino Uno (Microcontroller)

The minimum system requires only clocking system and input output interfaces. The microcontroller can be connected to a computer using a USB cable and is programmed using the txt-based scratch software system. ATmega328 is the microcontroller chip that is popularly used for the Arduino system (Siregar, 2022).

B. Fuzzy Logic

Fuzzy logic is a method that is used to certify uncertain problems. Have a membership degree in the range of 0 (zero) to 1 (one). Then the value in the classification becomes the part specified by the programmer. The use of fuzzy logic in this paper to analyze each object to be removed. There are several output values that will be used to process the control system (Saefullah, 2015).

C. Inference Process

The process of inference is done to map the logic of decision makers. In this section illustrated by the FAM table (Fuzzy Associative Map). Decision making for fuzzy output is determined by the operator that makes the fuzzy logic. This process is a statement of implications “IF-Then Rules” (Saefullah, 2015).

D. Membership Functions

The membership function is a curve that shows the mapping of datainput points into membership degrees whose value is between 0 and 1. The method used to obtain membership values is through a function approach.

E. Fuzzy Sets

Fuzzy sets are a set of x objects where each object has a membership function "µ" or also called the truth value [8]. If X is a set of objects and its members are expressed as x then fuzzy sets of A in X are sets with a pair of members or can be expressed as:

A= {µA(x) | x:x €X, (x) €[0,1] € R }.

Fuzzy set has 2 (two) attributes, that is:

-Linguistics, namely naming certain conditions, such as: Few, Medium, Much.

- Numerical, that is, the value (number) shows the size of the variable, such as: 200, 400, 800.

2. RESEARCH METHOD

In this study, the authors apply the fuzzy logic approach method. Which do uTo stabilize in adjusting the amount of water discharge to the number of people who enter the room. The sensor is assigned to provide an input signal to the microcontroller, after the input is received, a relay process is carried out for each input that has been given, and a fuzzification test is carried out for each process. It is hoped that the application of this fuzzy logic system will be able to overcome water shortages when there are an increasing number of people. Fuzzy logic control is carried out on the microcontroller against relay contacts.

In order to implement the proposed system, a working flowchart is performed as in Figure 1. The goal is to ensure the robot works properly and the fuzzy logic program is easily implemented.

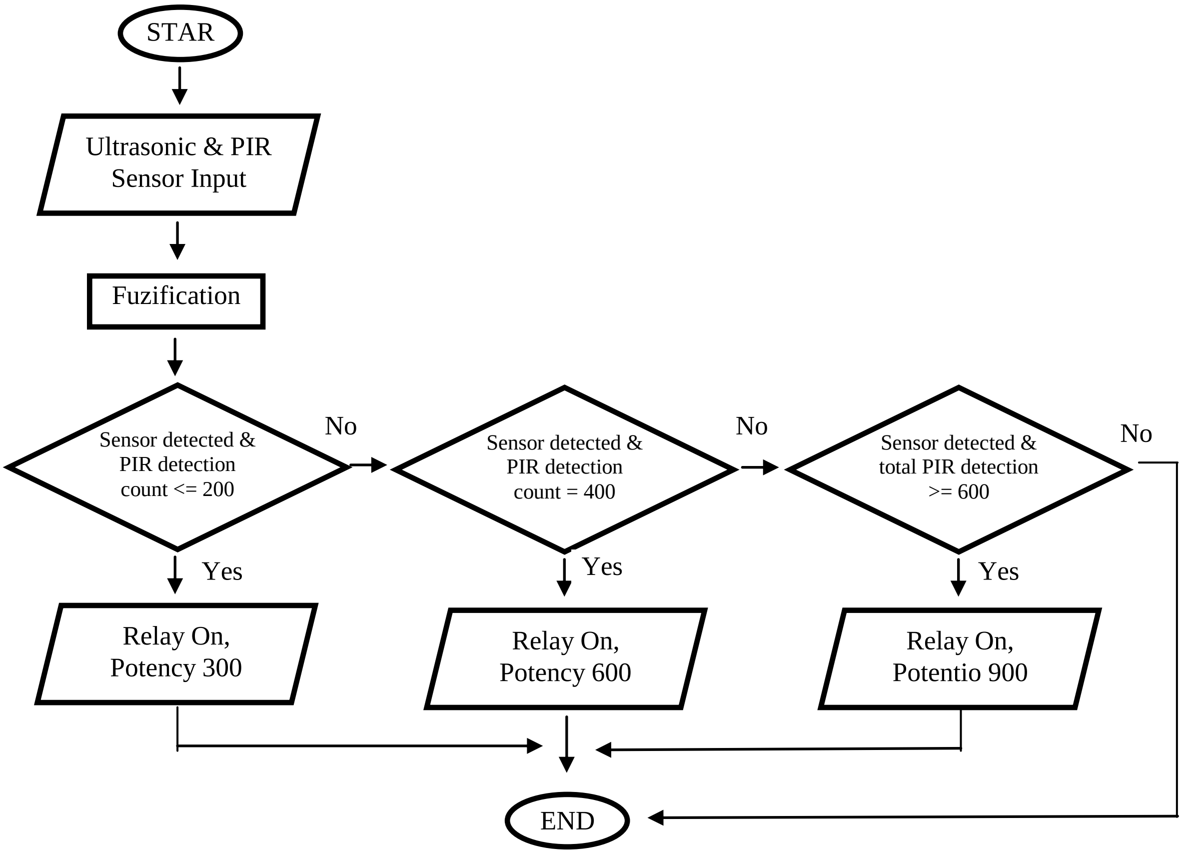

Figure 1. System Flowchart For Process Sensors And Relays

A. System Work

The system is started by checking the mass of objects using mass sensors. Data obtained from mass sensors is analyzed using fuzzy logic within the microcontroller program. After the load data is analyzed, the load is lifted. Relay & Potentiometer motors are working together.

B. Load Variables

The design of fuzzy membership functions for load variables consists of 3 linguistic attributes, namely with values M(Few) (0-300), M(Medium) (200 - 600), H(Much) (500 - 800) as depicted in Figure 2.

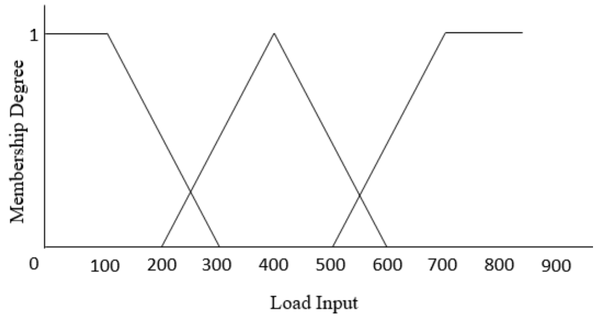

Figure 2. Fuzzy Membership Functions

The membership function of variable input can be calculated by the following formula set:

Set for variable sensor$_{(Few)}$:

$$\mu Load_{M[x]}= \begin{cases} 1, x \leq 200 \\ \frac{300-x}{300-200}, 200 \leq x \leq 300 \\ 0, x \geq 300 \end{cases} \quad \text{......(1)}$$

Setfor variable sensor$_{(Medium)}$:

$$\mu Load_{M[x]}= \begin{cases} 1, x = 400 \\ \frac{x-200}{400-200}, 200 \leq x \leq 400 \\ \frac{600-x}{600-400}, 400 \leq x \leq 600 \\ 0, x \leq 200, x \geq 600 \end{cases} \quad \text{......(2)}$$

Set for variable sensor$_{(Much)}$:

$$\mu Load_{H[x]}= \begin{cases} 1, x \geq 600 \\ \frac{x-500}{600-500}, 500 \leq x \leq 600 \\ 0, x \leq 500 \end{cases} \quad \text{......(3)}$$

C. *Fuzzy Rules*

The fuzzy rules which use in this research are defined for Tsukamoto's fuzzy inference system. there are 3 rules for each Relay & Potentiometer which on Table 1.

Table 1. Fuzzy Rules On Ultra Sonic - Infra Red And Relay – Potentiometer

D.

Rules		Ultrasonic & PIR		Relays & Potentiometer
1	IF	Few	THEN	Low
2	IF	Medium	THEN	Middle
3	IF	Much	THEN	high

The rule for the degrees percentages are:

1. Few : 30%
2. Medium : 60%
3. Much : 90%

Rule for Relay & Potentiometer

[R2] IF Ultra Sonic & PIR = Few THEN Relay & Potentiometer = Low

α-predicate1 = min $\mu_{Few}(50)$

= min(1) = 1

[R2] IF Ultra Sonic & PIR = Medium THEN Relay & Potentiometer = Middle

α-predicate2 = min $\mu_{Medium}(50)$

= min(0) = 0

[R3] IF Ultra Sonic & PIR = Much THEN Relay & Potentiometer = High

α-predicate3 = min $\mu_{Much}(50)$
= min(0) = 0

[Z1] Zmax – α-p1 (Zmax – Zmin)

= 90 – 1 . (90 – 30)

= 90 – 60 = 30

[Z2] Zmax – α-p2 (Zmax – Zmin)

= 90 – 0 . (90-60)

= 90 – 0 = 90

[Z3] Zmax – α-p3 (Zmax – Zmin)

= 90 – 0 . (90-90)

= 90 – 0 = 90

Defuzzification Process in Relay & Potensiometer

The defuzzification process uses the Tsukamoto model inference in testing Relay & Potensiometer as follows

$$Z\ Total = \frac{(\alpha\text{-}p1 * Z1) + (\alpha\text{-}p2 * Z2) + (\alpha\text{-}p3 * Z3)}{(\alpha\text{-}p1 + \alpha\text{-}p2 + \alpha\text{-}p3)}$$

$$= \frac{(1 * 30) + (0 * 90) + (0 * 90)}{(1 + 0 + 0)}$$

$$= 30$$

Test the defuzzification process 10 times in order to get maximum results for time accuracy and success.

3. RESULTS AND DISCUSSIONS

The degree of Potensio for ultrasonic & PIR, increases in Relay & Potentio initial speed. From the test that has been done 10 times, the results of the percentage of relay & Potensio have been obtained against the given sensor input. Which image can be seen in Figure 3.

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily (Grieshaber, 2020). The discussion can be made in several sub-chapters.

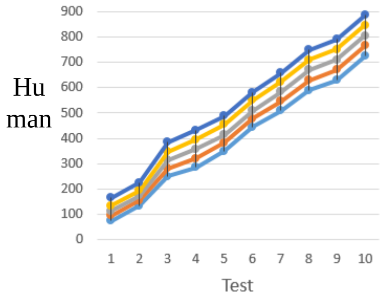

Figure 3. Testing of 10 Data Sensor Inputs

From Figure 3 it can be concluded that the movements of the relay & potential to be stable towards the given sensor input. The higher the load is given, the percent will go up too, and the increase is always stable against all for relay & potential. From the relay & potentiometer, the average value of each % degree can be taken, that is by adding each percent of the test, then divided by the number of inputs. So that the average yield of relay & potential = 34.11%.

4. CONCLUSION

Based on the experiments, it is concluded that the shifting potential and relay obtained by Tsukamoto's fuzzy logic model has a good degree of accuracy in determining the volume of water. Fuzzy logic results in better controlling the stability of the movement. The stability can be seen from the percentage value of the Relay & Potentiometer gets 34.1%. Meanwhile, without using this method, the value obtained from the Relay & Potentiometer slope is fixed, and the work simulation is not good in the process of lifting an object.

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