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Implementation of Fuzzy Logic in Detecting Air Temperature Based on Microcontroller

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ABSTRACT

The environment, technology, and many facets of daily living are all significantly impacted by temperature conditions. Knowing environmental health, agriculture, industry, electrical technology, weather and natural disasters, transportation, and even scientific research are just a few of the many reasons why temperature conditions are crucial. Fuzzy algorithms are used to more flexibly process temperature data while creating a temperature detector employing fuzzy logic. We can base our conclusions on a wider range of criteria than merely right or wrong thanks to fuzzy logic. A temperature sensor, microprocessor, and display (such an LCD or LED screen) are some basic electronic components that can be used to create a temperature detector.

INTRODUCTION

Fuzzy logic is a mathematical method for reducing ambiguity in decision-making. In fuzzy logic, the concept of truth is stated in terms of degrees of membership, whereas in binary (conventional) logic a statement can only be true or false (Tonni Limbong, Muttaqin, Akbar Iskandar, Agus Perdana Windarto, Dr. Janner Simarmata, S.T., M.Kom, Mesran, Oris Krianto Sulaiman, M.Kom, Dodi Siregar, Dicky Nofriansyah, Dr. Darmawan Napitupulu, S.T., M.Kom, Anjar Wanto, 2020) . Binary logic, for instance, determines whether the phrase "low temperature" is true or false depending on whether the temperature is above or below a predetermined threshold. If the temperature is low enough, fuzzy logic will assign the statement a degree of membership that runs from 0 to 1 (Atma et al., n.d.).

Temperature is a gauge or indicator of how warm or chilly an object or environment is. It gauges how quickly molecules and other particles move through theory, an element's membership in a set is indicated by the degree of membership (membership values) whose value falls inside the range [0,1] (Infotama et al., 2013).

Membership Function

The membership function is a graph that shows the level of each input variable's membership in the range from 0 to 1. The symbol (x) denotes the degree of membership of a variable x. The membership value is weighted by the rules to determine its impact on inferences and conclusions (Utara et al., 2018).

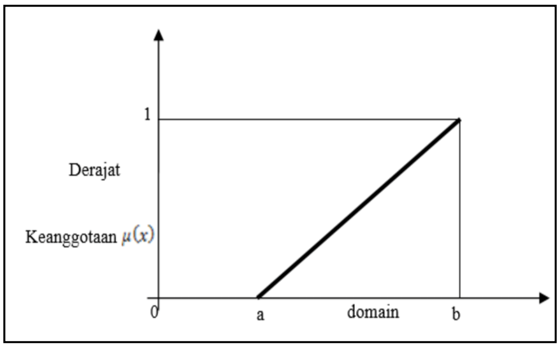

Figure 1. Linear Rising

Linear Rising Formula

$$x \le a \; [x, a, b] = \begin{cases} 0; & x \le a \\ (x-a)/(b-a); & a \le x \le b \\ 1; & x \ge b \end{cases} \quad (2.2)$$

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Information:
a = domain value that has zero degree of membership
b = domain value that has a membership degree of one
x = input value that will be converted into fuzzy numbers

Fuzzification

Fuzzification is the process of changing an input from a crisp form to a fuzzy (inguistic variable), which is often expressed in the form of fuzzy sets with a membership function each. The membership function is set when the required number of inputs and outputs has been determined (Koroglu & Wotawa, 2019). There are four functions that are frequently employed: the sigmoid function, the phi function, the trapezoidal function, and the triangle function.

Rules Evaluation

Rule assessment is carried out after fuzzification. We'll investigate how fuzzy input is used by the rules to decide how to operate the system (Tonni Limbong, Muttaqin, Akbar Iskandar, Agus Perdana Windarto, Dr. Janner Simarmata, S.T., M.Kom, Mesran, Oris Krianto Sulaiman, M.Kom, Dodi Siregar, Dicky Nofriansyah, Dr. Darmawan Napitupulu, S.T., M.Kom, Anjar Wanto, 2020). The additive method, the probabilistic method, and the max method are the three techniques utilized to achieve fuzzy system inference.

Microcontroller

A microcontroller is an entire microprocessor system housed on a chip. A microcontroller typically includes basic system support components for the microprocessor, such as memory and the I/O interface, whereas a microprocessor typically only has the CPU (Suhada & Helmi, 2019). This distinguishes microcontrollers from general-purpose microprocessors used in a PC.

LITERATURE REVIEW

Fuzzy Logic

Generally speaking, fuzzy systems are excellent for approximative reasoning, especially for systems that deal with issues that are challenging to explain using a mathematical model. For instance, it might be challenging to build a mathematical model when the input values and parameters of a system are incorrect or ambiguous. When compared to conventional systems, fuzzy systems provide a variety of advantages, such as the usage of fewer rules (Utara et al., 2018). The initial processing of a large number of values into a membership degree value in a fuzzy system reduces the number of values into a membership degree value in a fuzzy system, which lowers the number of values that must be employed by the controller to make a decision. Additionally, the fuzzy system's capacity for reasoning is a benefit.. (Informatika & Komputer, n.d.)

Fuzzy Set

A collection that has some uncertainty in it is said to be fuzzy. The major point of this set creates a many-valued logic that has a neutral third value in addition to a true or false value for the main proposition (Bidar et al., 2017). According to fuzzy set

METHOD

The authors use the fuzzy logic approach method in this investigation. What can you do to maintain stability while adjusting the volume to the number of visitors? The sensor is tasked with sending a signal of input to the microcontroller. Once the input has been received, each input is relayed, and each relay process is tested for fuzzification. The use of this fuzzy logic system is intended to be able to overcome temporality in situations where there are growing numbers of people (Atma et al., n.d.). On the microcontroller, fuzzy logic control is applied to relay contacts. A functioning flowchart is created as shown in order to implement the suggested system (Utara et al., 2018).

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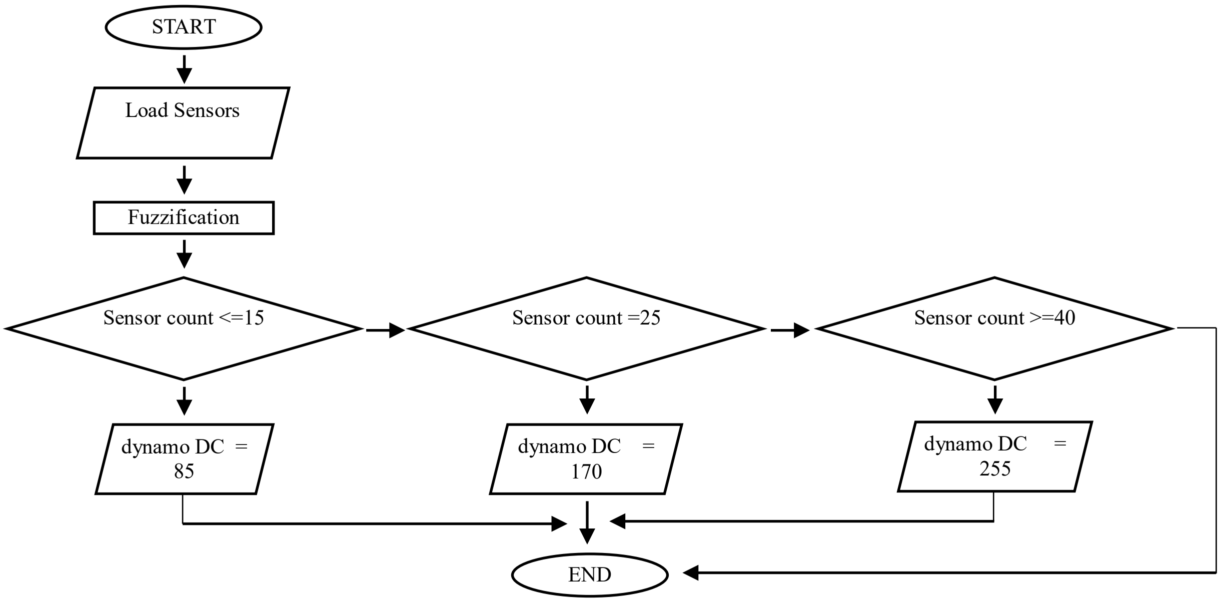

Figure 2. System Flowchart For Process Sensors And Relays

System Work

The technique begins by using mass sensors to determine an object's mass. The microcontroller program analyzes data from mass sensors using fuzzy logic. The load is lifted following the analysis of the load data. Potentiometer motors and relays operate together (Zulita, 2016).

Microcontroller Arduino Uno

The basic minimum system only requires an input/output interface and clocking system. When connected to a computer via a USB cable, the text-based scratch software system can be used to program the microcontroller. the widely used Arduino microcontroller chip is ATmega328 (Kamide, 2020).

Fuzzy Logic

Fuzzy logic can be used to certify uncertain issues. own a membership degree ranging from 0 (zero) to 1. The value in the categorization then serves as a representation of the component that the programmer supplied (Rahakbauw, 2015). In this study, fuzzy logic is used to assess each object that will be destroyed. A variety of output values will be used to process the control system. (Zulkifli et al., 2020).

Inference Process

The inference method is employed to follow the logic of decision-makers. A fuzzy associative map (FAM) table is used as an example in this section (Infotama et al., 2013). Fuzzy output decisions are made by the operator who developed the fuzzy logic (Soeharwinto et al., 2019). An "IF-Then Rules" declaration of implications is used in this process.

Membership Functions

The membership function, which ranges in value from 0 to 1, is a curve that shows how input data points are transformed into membership degrees. The method used to derive membership values is called the function technique. (Todorovic & Simic, 2020).

Fuzzy Sets

The term "fuzzy set" refers to a group of x objects where each object has a membership function, also called the "frith value" (Fuzzifikasi et al., 2016). If X is a set of objects and its members are written as x, then X is a set of objects (Gencer, 2019), fuzzy sets of A in X are sets with two members.

Fuzzy sets contain two characteristics, including:

- Linguistic traits like the capacity for terms like little, medium, and many.
- Numerical, with values like 75, 125, or 225 that accurately represent the size of the variable.

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Fuzzy Rules

Tsukamoto's fuzzy inference system's defined fuzzy rules are those that were employed in this investigation. There are three regulations for each relay and dynamo, which are shown in Table 1.

Load Variables

Figure 2. shows the three linguistic traits M (few) (0-300), M (medium) (200-600), and H (many) (500-800) that make up the design of fuzzy membership functions for load variables.

RESULT

To start the calculation, we must first establish a membership function table by declaring each movement point for the sensor and relay dynamo (Lee, 2018). The following formula set can be used to determine the membership function of a variable input :

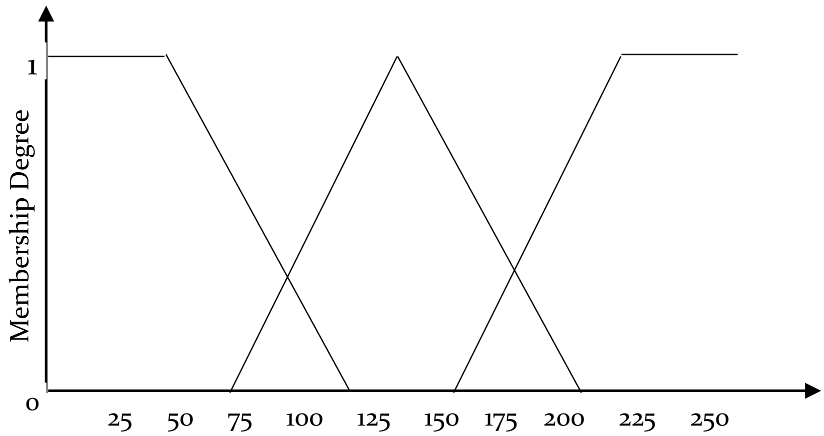

Figure 3. Membership Functions

Set for variable than sensor(little) (Yurindra & Linda, 2018):

$$\mu Load_{L[x]} = \begin{cases} 1, x \leq 75 \\ \frac{125-x}{125-75}, 75 \leq x \leq 125 \\ 0, x \geq 125 \end{cases} \quad \ldots\ldots(1)$$

Set for variable than sensor(medium):

$$\mu Load_{M[x]} = \begin{cases} 1, x = 150 \\ \frac{x-75}{150-75}, 75 \leq x \leq 150 \\ \frac{225-x}{225-150}, 150 \leq x \leq 225 \\ 0, x \leq 75, x \geq 225 \end{cases} \quad \ldots\ldots(2)$$

Set for variable than sensor(many):

$$\mu Load_{H[x]} = \begin{cases} 1, x \geq 225 \\ \frac{x-175}{225-175}, 175 \leq x \leq 225 \\ 0, x \leq 175 \end{cases} \quad \ldots\ldots(3)$$

Table 1. Fuzzy Rules On Ultra Sonic - PIR And Relays — Dynamo

Rules		**Ultrasonic sensor & PIR sensor**		**Relays & Dynamo**
1	IF	Little	THEN	Low
2	IF	Medium	THEN	Middle
3	IF	Many	THEN	High

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The rule for the sensors percentages are:
1. Little : 33%
2. Medium : 68%
3. Many : 100%

Rule for Sensor To Relay & Dynamo (Harahap, 2019)
[R1] IF sensor = Little THEN Relay & Dynamo = Low
α-predicate1 = min µLow
= min(1) = 1

[R2] IF sensor = Medium THEN Relay & Dynamo = Middle
α-predicate2 = min µMedium
= min(0) = 0
[R3] IF sensor = Many THEN Relay & Dynamo = High
α-predicate3 = min µMany
= min(0) = 0

[Z1] ZMax – αp1 . (Zmax – Zmin)
= 100 – 1 . (100 – 33)
= 100 – 67 = 33
[Z2] ZMax – αp2 . (Zmax – Zmin)
= 100 – 0 . (100 – 68)
= 100 – 0 = 100
[Z3] ZMax – αp3 . (Zmax – Zmin)
= 100 – 0 . (100 – 100)
= 100 – 0 = 100
Defuzzification Proscess in Relay & Dynamo
The defuzzification process uses the Tsukamoto model inference in testing Relay & Potensiometer as follows

$$Z\ Total = \frac{(\alpha p1 * z1) + (\alpha p2 * z2) + (\alpha p3 * z3)}{(\alpha p1 + \alpha p2 + \alpha p3)}$$

$$= \frac{(1 * 33) + (0 * 100) + (0 * 100)}{(1 + 0 + 0)}$$

$$= 33$$

To acquire the best results in terms of success and time accuracy, test the defuzzification procedure nine (9) times (Tombeng et al., 2018).

DISCUSSION

To acquire the best results in terms of success and time accuracy, test the defuzzification procedure nine (9) times. Relay & Dynamo beginning speed rise as dynamo for PIR & ultrasonic increases. The percentage of the relay and Potensio against the provided sensor input was determined from the test that was run ten times. Which picture is seen in Figure 3.

In this section, the research findings are discussed while also providing a thorough discussion. Results can be shown in tables, graphs, figures, and other formats that are simple for the reader to understand. Multiple sub-chapters can be used to discuss the topic

Figure 3 shows that human movements toward the relay and dynamo are stable when compared to the input from the provided sensor. The percentage will increase along with an increase in load, and this increase is always constant for relay and dynamo applications. By adding each percent of the test and dividing by the total number of inputs, the average value of each percent degree may be calculated from the relay and dynamo. the average yield of the relay and dynamo is thus 54.11%.

In this section, the researchers can give a simple discussion related to the results of the research trials. This section contains the author's opinion about the research results obtained. Common features of the discussion section include the comparison between measured and modeled data or comparison among various modeling methods, the results obtained to solve a specific engineering or scientific problem, and further explanation of new and significant findings.

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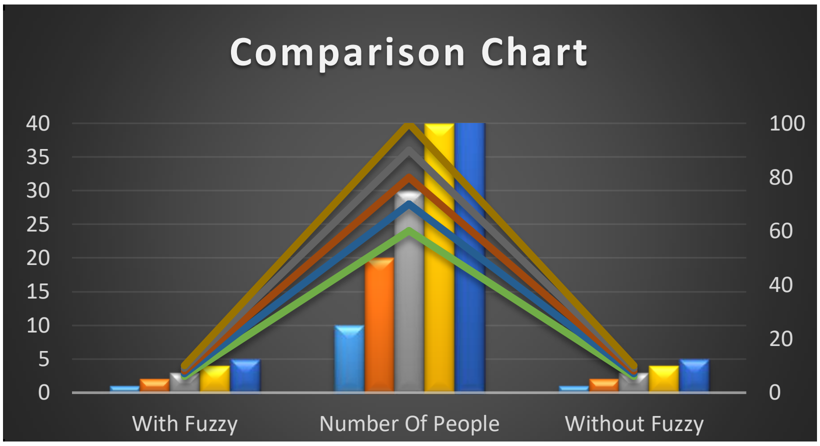

Figure 4. Testing of 9 Data Sensor Inputs

Table 2. Data Sensor Inputs

Performance Expectancy -> Intention to Use	0,052	0,053	0,058	**0,893**	**0,372**
Service Quality -> Intention to Use	0,065	0,068	0,072	**0,905**	**0,366**
Service Quality ->User Satisfaction	0,167	0,177	0,068	2,474	0,013
Social Influence ->Intention to Use	0,263	0,263	0,061	4,302	0,000
System Quality -> Intention to Use	-0,008	-0,005	0,076	**0,107**	**0,915**
System Quality -> User Satisfaction	0,065	0,066	0,072	**0,904**	**0,366**
Attitude ->Intention to Use	0,337	0,331	0,075	4,488	0,000
User Satisfaction ->Net Benefits	0,428	0,430	0,059	7,207	0,000

CONCLUSION

According to the test results, it seems that the system's increased function looks more ideal. This is because the Tsukamoto fuzzy logic model's sensor readings and the shift from the dynamo have a higher level of accuracy in estimating the volume of the number of people in the room. These findings demonstrate that fuzzy logic can increase the capacity to regulate the stability of movement. The sensor to dynamo percentage number, which has increased by 54.11%, can show that the system is becoming more stable. If fuzzy logic is applied to the intended module, it can be concluded that there is an improvement in the system.

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