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Water Temperature, Humidity and PH Measuring Device to Maintain Plant Growth Using Fuzzy Logic Method

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ABSTRACT

Objective: *This study aims to develop an automatic plant watering system using fuzzy logic to maintain optimal plant growth conditions based on environmental factors.* ***Method:*** *The system was designed using an Arduino Uno microcontroller integrated with a DHT22 temperature sensor, soil moisture sensor, and water pH sensor to monitor environmental parameters. Fuzzy logic was applied to process temperature, soil moisture, and pH data to determine appropriate watering patterns automatically. The research involved two design stages: hardware design, including block diagrams and circuit layouts, and software design, represented through flowcharts explaining the system's operational logic.* ***Results:*** *The developed prototype successfully demonstrated automatic control of plant watering, responding effectively to environmental changes and maintaining soil and water conditions suitable for plant growth.* ***Novelty:*** *This study introduces an intelligent, low-cost, and efficient irrigation system utilizing fuzzy logic, contributing to the advancement of smart agriculture by optimizing water usage and supporting sustainable plant care practices.*

INTRODUCTION

There are many things that must be done routinely in everyday life, one of which is maintaining and caring for plants so they grow well. Watering is a crucial part of this process [1]. One of the most important things is getting enough water. As technology advances, automation systems will certainly be very helpful in human life, including watering plants. With the help of tools, plant watering can be done automatically. This will be very helpful and make plant care easier. Automatic watering devices were created after that [2].

Plant growth is determined by soil moisture levels and temperature. To keep plants healthy, we must pay attention to their water needs. Plants will thrive when the soil, temperature, and moisture content are at the right levels [3]. This, of course, will impact the amount and frequency of watering [4]. If planted in a pot, the same plant will require more frequent watering than if planted directly in the ground, but the amount of water required will be less. Furthermore, the right timing for watering must be considered when making decisions about the watering process so that the plant receives an adequate amount of water [4].

To ensure plants continue to receive adequate nutrition, the soil must have a moisture content between 0 and 100%. To achieve this moisture content, plants must receive at least 80% of their total moisture [6]. For plants to grow well, the ideal temperature is between 15°C and 35°C. [7]. Then, each plant requires a different amount of water. Therefore, maintaining and caring for plants means watering them [5].

Based on these problems, the author created a tool concept that can use fuzzy logic. [9]. with three parameters, namely temperature, soil moisture, and water pH, to water plants automatically [10].

Fuzzy logic will be used to process temperature, soil moisture, and water pH values to produce plant watering output that is appropriate to the surrounding conditions [6]. Fuzzy logic theory is also known as fuzzy logic because it transforms Boolean set theory (0 and 1) into sets that have ambiguous membership values (between 0 and 1) [12]. by explaining mathematical calculations based on set theory to describe ambiguity in the form of linguistic variables [7]. The set between 0 and 1 will be read using this reasoning, which leads to more accurate analysis results [8], [15].

Therefore, this research will create a tool to control plant conditions using an Arduino Uno microcontroller, DHT22 temperature sensor, soil moisture, and water pH sensor to maintain plant growth.

RESEARCH METHOD

The design of this system use Fuzzy Logic method which has connected with Arduino Uno program for produce data desired. There are two stage in design this: design device hard and design device soft. Design device hard involving block diagram creation and design cable. Design device soft consists of from the detailed flowchart method used.

A. Block Diagram

For make it easier design device, block diagram the entire system is created. Following is Tool block diagram Gauge Temperature, Humidity and pH of Water for Guard Growth Plant Use Fuzzy Logic Method.

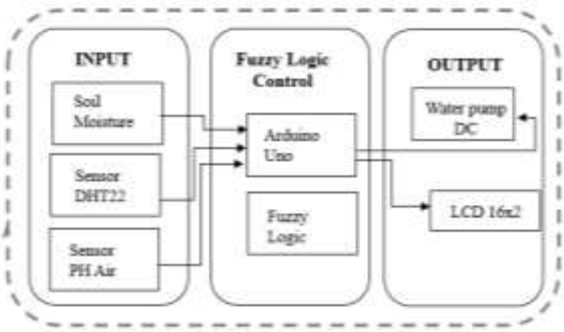

Figure 1 Block Diagram

To facilitate the tool creation and fabrication, a block diagram of the entire system was created, involving several components, including soil moisture, DHT22 sensor, water pH sensor, ESP32, DC water pump, and 16x2 i2c LCD. The block diagram is shown in Figure 1.

B. Flow chart

Arduino uno programming to control input data from sensors which then become output on the i2c LCD with Arduino IDE software. This system flow diagram shows the process carried out in Arduino uno with the initial process, namely system initialization which functions to read any sensors used, then the sensor reading process starts from water pH, temperature sensors and soil moisture sensors.

Next, after the sensor collects the required data, a fuzzyfication process occurs, converting the sensor data values into fuzzy sets based on their membership functions. For example, if using a soil moisture sensor, the crisp input values from the sensor can be converted into fuzzy sets such as dry, moist, and wet.

After the fuzzyfication process is complete, the system will create inference rules based on the logic created. The next step is defuzzification, which converts the values generated by the inference rules into numerical values, also known as output scripts, that can be used within the system. For example, if a temperature sensor is used, the fuzzy system output can be converted into a temperature value that can be displayed on an LCD and processed by the output we use, namely a water pump.

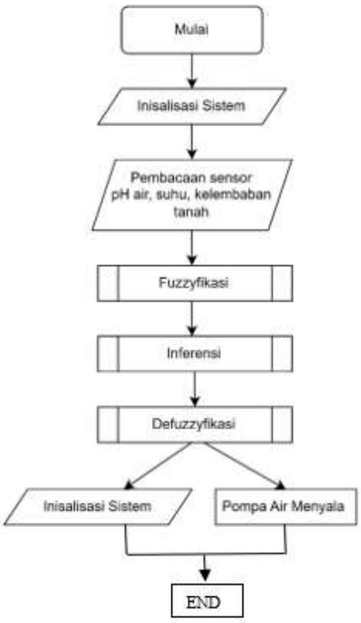

Figure 2 Flowchart

RESULTS AND DISCUSSION

In the research this, data collection was carried out for 3 days from January 26 until by January 28, 2024 with condition placement plant customized with condition experience plant namely No caught sun in a way directly. With read mark from Temperature Sensor (DHT22), Soil Moisture Sensor, Water pH Sensor and also the duration water pump on for water plant.

Table 1 Data Collection

Date	O'clock	Temperature (^{0}C)	Moisture (%)	Water pH	Duration (s)
January 26	Morning	32	36	5.5	4 (fast)
	Afternoon	30	35	5.5	4 (fast)
January 27	Morning	31	35	5.5	6 (fast)
	Afternoon	32	37	5.5	3 (fast)
January 28	Morning	30	36	5.5	5 (fast)
	Afternoon	31	35	5.5	4 (fast)

Data collection based on watering hours plants that have set through fuzzy logic values for prevent Ari evaporate too many plants This watered twice : morning before at 10.00 WIB and in the afternoon after at 15.00 WIB. After the data is sorted, the time watering morning and evening are taken into account. The results are show that plant No need lots of water and watering Enough fast Because temperature and humidity land be at normal point or moist.

CONCLUSION

Fundamental Finding : The testing results of the automatic plant sprinkler system using fuzzy logic indicate that the sensors function effectively as input variables and the water pump motor speed serves as an accurate output variable for regulating irrigation. The system successfully implements fuzzy logic rules for optimal plant watering, demonstrating proper functionality of the weather monitoring unit. **Implication :** These findings suggest that fuzzy logic–based control systems can enhance irrigation efficiency and automation in agricultural applications, contributing to water conservation and improved crop management. **Limitation :** However, discrepancies between the sensor measurement results and reference data indicate potential calibration issues or environmental factors affecting accuracy. **Future Research :** Further studies are recommended to refine the system through sensor recalibration, algorithm optimization, and integration of adaptive learning mechanisms to increase precision, reliability, and consistency in real-time environmental monitoring.

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