Implementation of Rule Base-Fuzzy Logic on Android based Plant Watering System with Internet of Things Technology

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ABSTRACT

In this paper, Fuzzy Logic Implementation on Android Based Plant Watering System with Internet of Things Technology is a research aimed at Create an automatic, automatically adjustable plant watering automation system using Android applications and Internet of Things (IoT) technology. The Internet of Things (IoT) is a network of computers, mechanical and smart machinery, objects, people, and living creatures. These devices are connected to the internet through the web, automatically evaluate and control themselves, have tools, online networks, and other equipment[1]. Rule base systems based on fuzzy logic decisions are used to combine collected data and to provide intelligent and optimal decisions to manage watering and monitor crop state [2]. In addition, the author also uses IoT technology to connect the plant watering system with an Android application. Using the Android application, users can set changes in system settings, as well as monitor the condition of plants in real time. Soil and water samples are monitored and analyzed using a moisture prediction system with sensors. By utilizing this prototype, farmers or gardeners can monitor soil dryness levels in site-specific analysis and easily monitor soil status through an Android app. This prototype model helps with monitoring soil fertility at minimal cost[3].Results of This research shows that the system of automation of watering plants with using Fuzzy Logic methods and IoT technology can produce more efficient and timely watering of plants, as well as ease Users in controlling and monitoring the system remotely through the application Android.

Keywords

Fuzzy Logic, Firebase, Internet of Things (IoT), Automatic flush, Smart Garden

1. INTRODUCTION

The Internet of Things (IoT) is an object that can transmit data to computers over the network without human intervention. Internet of Things (IoT) is an object with the ability to move data over a network, either from source to destination or from human to computer, without the need for interaction human to human. One of the technologies that can be made or utilized is the technology of automatic watering of plants.

Many people generally use plants as decoration for everything like residential houses. Aglaonema is one of the ornamental plants are popular and widely cultivated in Indonesia. To obtaining good growth and productivity of aglaonema plants Efforts are needed to improve plant cultivation, among others, by: availability of seeds that are good in quality and quantity. In progress maintenance, rose plants do not require special means, with 2 very relatively standard maintenance as in watering and fertilizing such plants regularly. If this can be fulfilled, plant flowers Such aglaonema can be productive by displaying beautiful leaves.

When the plant owner works or is not at home leave the plant that belongs to him so that no one watered the plant his, it is already a risk so that the plants are not well maintained because of his busyness. This causes plants to get less sufficient moisture content so that aglaonema wilts easily.

Soil moisture level monitoring uses the Internet of Things to measure moisture levels and control when the water pump system is turned on and off. Smart agriculture uses soil moisture and air humidity sensors, which are controlled by microcontrollers. Low-cost weather monitoring and circuit connection, are designed to improve work efficiency [4].

2. LITERATURE SURVEY

In the rapid changing times, automatic systems are made to reduce human labor. Internet of Thing (IoT) is easy to use because it can be controlled and monitored through mobile phones with the help of internet signals. The following are some of the works that have been successfully developed in the field of automation with the Internet:

Discusses about automatic watering tools for plants. The tool is used for automatic watering with the help of temperature sensors and humidity sensors installed on plants. DC pump as a device for spraying water when temperature and humidity sensors detect plants it's time to do watering. Then automatically the DC pump will work. The temperature sensor (DS18B20) takes an initial ambient temperature reading of 28°C. This value is read through the serial monitor in the Arduino IDE. The Capacitive Soil Sensor reads soil moisture in pots at 82% RH. The light sensor (BH1750) performs a light index reading around the sensor in the range of 29-30 Lux. This value is read through serial monitoring in the Arduino IDE. The value of the light index is very influential on the amount of light captured by the sensor, so the placement of the light sensor must face up or in the direction of the light coming and not be positioned upside down. Because this can have an impact on the reading of the input value of the light index so that the output value of the amount of water can be different. Esp -32 is a microcontroller used in this agricultural tool. Based on the tests and analysis conducted, it was concluded that IoT-Based Smart Agriculture using Fuzzy Logic can work well [5].

This researcher developed a monitoring and control system for citrus Siam Banjar plants based on IoT (Internet of Things) and Fuzzy Logic Control. The goal was to find out the performance of the Fuzzy Logic Control method in predicting the watering time of plants based on temperature and soil moisture. The prototype consisted of a Wemos D1 R1 microcontroller with DHT22 and an FC-28 humidity sensor. Two input parameters, temperature, and soil moisture are used in the Fuzzy Logic Calculation control. The output is the duration of the watering time of seconds [6].

In this case, discussing the cultivation of chili plants which still has many problems, especially uncertain climate, then innovations emerged to create a system that allows efficient control of the water needs of chili plants. The stability of the system to run well is collaborated with the fuzzy logic method because it is able to provide the right and fast decisions [7].

The method of fogging plants in greenhouses has an important role in maintaining the moisture needed by plants. With the constraints of conventional tools in measuring room temperature, an automatic drizzle system was made on plants in the greenhouse using fuzzy logic methods because to map the problem of input data to output data in carrying out blur control. The logic of this method corresponds to the conditions required in a glass room [8].

Chili plants often fail to harvest in the cultivation process due to improper irrigation. Soil temperature and moisture are important parameters that affect the amount of water that plants need in the process of watering. This study aims to apply fuzzy logic to the irrigation system of chili plants. The function of this system is to regulate the watering needs of Chili plants automatically and real-time. Sugeno's fuzzy inference system (FIS) is embedded in a microcontroller to precisely adjust water based on plant needs. The system was tested on chili plants located in the iSurf Computer Science Lab greenhouse of IPB University. After four days of testing, the soil moisture sensor results were stable at optimal conditions, between 60%-80% after watering [9].

Current needs, one of which is in watering plants which is still done manually. Treatment of plants is not optimal. Sometimes the plant forgets to water, so the plant quickly withers due to lack of water. And often watering plants repeatedly, regardless that the moisture content in the soil is too much, which causes plants to rot easily. With this controller, it can be applied to various fields such as home, plantations, and agriculture. The application of automatic watering control can be overcome in case of water overcapacity, Here there is an alarm as a warning when the weather is rainy, by using a soil moisture sensor to detect moisture content in the soil, a light sensor to control the tool can only function in the morning and afternoon because if at night the plants are watered it is not good for plant growth controlled on the Arduino microcontroller, and using fuzzy logic methods to determine the process parameter parameters of the sensor control. The results of tool tests that are tested periodically can work synchronously based on parameters applied using the fuzzy logic method [10].

Araceae plants are very popular among plant lovers around the world. The Araceae family has more than 100 species and thousands of species. Despite the ever-evolving times, the plant has a high market value and challenging breeding methods. To achieve optimal quality, it is important to maintain humidity and temperature appropriate to the natural conditions of such plants in tropical rain forests. The ESP32 MCU node is a processor for instructions from room temperature sensors, room humidity sensors, and soil moisture sensors. In addition, this component controls the blower and misting system as output, which will be processed through LoRa technology to transmit monitoring data to the Blynk software. This study used fuzzy logic to categorize room temperature, humidity, soil moisture, and the output of different Araceae plants. LoRa technology is used to transmit monitoring data efficiently in the process of data transmission. When retrieving data using remote technology, it is known that there is a delay of approximately 5 seconds between the receiver and transmitter at a distance of 700 meters. The obstacles that cause problems with this remote technology are influenced by wind that affects the strength of the antenna signal, as well as the presence of trees and buildings as barriers. The monitoring results showed the average temperature in normal conditions and the average humidity in wet conditions. At the same time, soil moisture is monitored to maintain normal moisture, so that all output is inactive [10].

3. METHODOLOGY

3.1 Hardware Design

Hardware requirements analysis is determining devices hard required in the creation of applications. The hardware used is shown in figure 1 below.

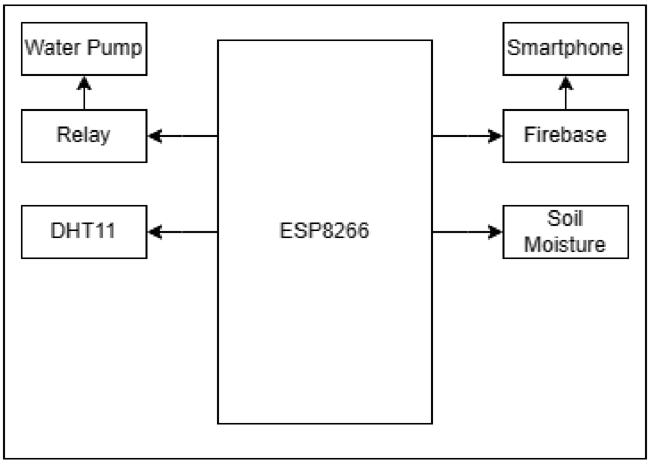

Fig 1 : Block Diagram

In this case, using a microcontroller in the form of a ESP8266 as a place for the program to be run, soil moisture sensor is used as soil moisture detection, DHT11 as an air humidity detection sensor, relay as a water pump voltage breaker and Firebase platform that functions to exchange data with smartphones so that the tool can be controlled via an Android smartphone.

3.2 Software Design

Flowchat in figure 2 represents a general system workflow, starting from the beginning (Start) then read the DHT11 sensor and Soil Moisture continued by displaying the sensor results which then the resulting value will be Validated according to the existing rule base flow in Arduino code.

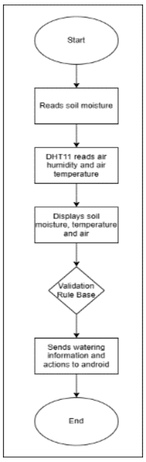

Fig 2 : System Flowchart

In the workflow this system has several stages shown in figure 2. Starting is the initial part of starting, then the soil moisture sensor and DHT11 read air and soil moisture, the data that is successfully taken will be sent to a smartphone bridged by the firebase platform, the data is then processed in a microcontroller (ESP8266) with a rule base that aims to decide that the soil is in a condition to be watered or not, the results and history of the action will be sent to the smartphone.

3.3 Rule Base System

In this automatic watering system, there is a sensor that will be the input Fuzzy i.e. soil moisture and air temperature. Both inputs will be made rule base into table form. Three linguistic values are used for soil moisture sensor output i.e. dry, normal, wet. Scale The soil moisture in the pot is usually indicated by a sensor with a value Digital 0-500 for wet, 501 -600 for humid and 601 -750 for Dry.

Description of Membership Function :

Wet = 0-500

Normal = 501-600

Dry = 601-750

As for the output of the temperature sensor, four linguistic values are used i.e. cold, normal, hot and hot. The temperature sensor output has 27 Minimum value range 0°C and maximum 35°C Function Description Membership:

Cold = 0-20°C

Normal = 20-25 °C

Heat = 25-30 °C

Very hot = 30-35°C

After that to be able to compile the algorithm that will be used to Watering plants, then the author compiled rules that have been adjusted with conditions in the field.

Table 1. Rule Base

Temperature	Soil moisture	Action
0-20°C	0-500	No watering
	501-600	No watering
	601-750	Watering
20-25°C	0-500	No watering
	501-600	No watering
	601-750	Watering
25-30°C	0-500	No watering
	501-600	Watering
	601-750	Watering
30-35°C	0-500	No watering
	501-600	Watering
	601-750	Watering

From the rules or rules that have been made in table 1, the rules will be converted into code that will be poured into the program code.

3.4 Implementation Of The Rule Base Into The Code

On the figure 3 after producing a rule base that is in accordance with the soil conditions, after that a code is made according to the results of the rule base arrangement so that the tool will work according to the existing rules. The code is compiled using the Arduino IDE so that it can be injected into ESP8266 microcontroller.

Fig 3 : Code Rule Base

3.5 Connection System

The connection used to connect hardware with smartphone controls especially android using the help of Firebase and Thingspeak platforms.

4. IMPLEMENTATION

4.1 Security code page implementation

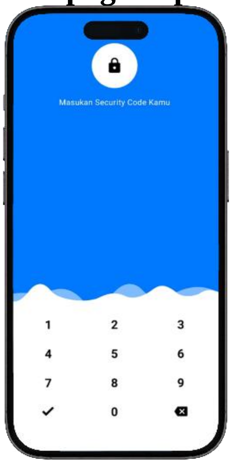

Fig 4 : Scurity Code Page

In the implementation of this security code page is an implementation of an android page that aims to validate users who can access only users who know the security code so that not everyone can access it.

4.2 Dashboard page implementation

In the implementation of this dashboard page is an android page implementation that aims to monitor or observe the value of the DHT11 sensor and Soil Moisture, and can choose manual or automatic mode and choose watering that can be used in manual mode only, besides that there is also a button to move to the watering history page.

Fig 5 : Dashboard Page

4.3 Implementation of watering history page

Fig 6 : History Page

In the implementation of this watering history page is an android page that aims to record successful watering by the system.

4.4 Implementation of watering

Fig 7 : The system successfully watered the plants

Figure 7 shows when the system is instructed to water in automatic mode, the pump turns on automatically and releases water so that the soil on the plants can get wet again.

Fig 8 : The system does not water the plant

Figure 8 shows that when the system detects that the soil is still wet, it will not perform watering actions on plants, while if in manual mode the user can turn off or turn on the pump manually without detecting dry or wet soil.

5. CONCLUSION

Based on the discussion that has been described, it can be concluded that the implementation of fuzzy logic in an android-based plant watering system with internet of things technology can be made using ESP8266 modules, temperature and humidity sensors (DHT11), soil moisture sensors (Soil Moisture), and water pumps connected to the android application to make it easier for users to receive soil information on plants and can do watering automatically or manually with Android application, so this application can replace the conventional way that was done before. Suggestions for future development are that this research must pay attention to conditions if the power goes out then the system will stop then this research requires energy reserves so that the system runs well, then in watering must pay attention to the watering plant because some plants are not suitable for watering in a certain time.

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