AUTOMATIC IRRIGATION SYSTEM BASED ON FUZZY LOGIC

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Abstract

Rice plant which is a source of food for the people, it needs enough temperature, air humidity and high water for maximum growth. The irrigation system is a major requirement in the field of agriculture, especially for rice plant. Some constraints in conventional irrigation, so they need irrigation system automatically. Some previous studies about automatic irrigation were only used one or two parameters and only used fuzzy or IoT. The method offered in this study uses fuzzy logic using 3 inputs and combines the monitoring system in real time based on IoT. The purpose of this study is to determine the effectiveness of fuzzy logic using three inputs to control the automatic irrigation system byreal time monitoring usingIoT. Data obtained by testing in themorning, afternoon, evening, night and using heat and rain treatment then compared using Matlab calculation. From the tool testing, the average precision of the tool comparison using the calculation is 77.13%.

Keywords:*Automatic Irrigation, IoT*,*Fuzzy Logic*

1. Introduction

Rice plant that is the main source of the community’s food will grow optimally if it is planted in the right height of the soil, air temperature, humidity and the height of water in each phase of paddy’s growth. The plant itself also needs a good irrigation distribution channel to fulfill the need of water during the optimal growth period of rice plants[1].

The maintenance and arrangement of irrigation in paddy field still use conventional methods. Of course this irrigation system is uneffective and unefficient which needs to get the right touch of technology to solve that problem[2].

Various studies and methods have been carried out to make an automatic irrigation design, that included water level indicators based on SMS[3], fuzzy logic[4] or a wireless sensor network. Previous research parameters are only one or two like water level[3] and temperature[5], there are even just scheduling just open the sluice. The use of one sensor as input is less than optimal because the measurement of the temperature of the entire space is less stable.

Several methods of artificial intelligence such as an expert system, artificial neural network, fuzzy logic and genetic algorithm can be used as a method in automatic irrigation design[5]. This study combined fuzzy logic in the watering control system and IoT to monitor the status of sensor and to report the status of system in real time[6].

2. Method

System Architecture

This research model is the design of an IoT-based automatic irrigation system prototype with fuzzy logic method to adjust the watering duration as shown in Figure 1. The working system in this research was that temperature, humidity and water level are factors for the sluice control input. Fuzzy logic in the microcontroller will process input data so that the output of the sluice gate will open and close according to the conditions of need.

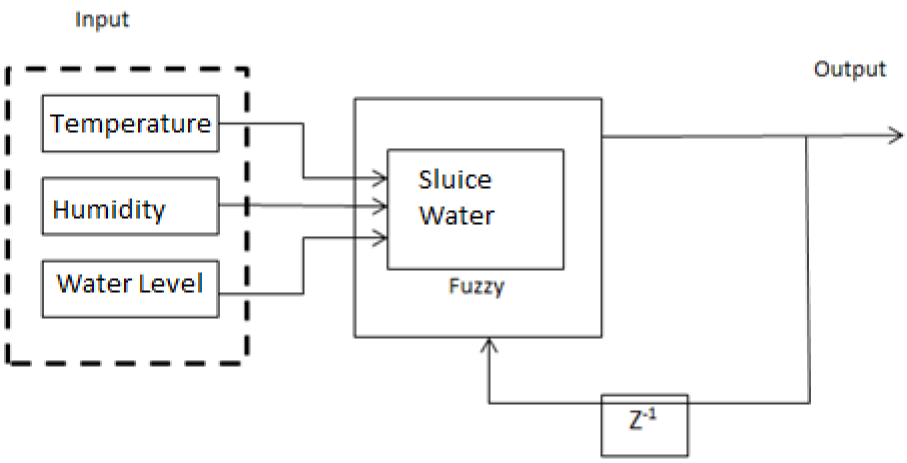

Figure 1. System Architecture

Research parameters

The basic parameters used in this study are monitoring the temperature, humidity and water level as the initial set point known as the requirement for the rice plants to grow in the lowlands (0-650 m dpl) as shown in table 1.

Table 1. Parameter set point

No	Parameter	Information
1	Temperature	22°C-29°C[7]
2	Water level age of rice plants 4-8 days	5 - 7 cm[8]
3	Humidity	50% - 80% [7]

Proposed System Design

There are several parts needed in this study: sensors, microcontrollers, and actuators that are shown in Figure 2 system block diagram. The sensor used is DHT22 which can detect air temperature and humidity and HC-SR04 to detect water level. Arduino Uno is used as the brain of the control, by entering fuzzy logic into program form (sketch). A servo motor as an actuator can regulate the duration of watering. Furthermore, the results will be displayed in 20x04 LCD as it can be monitored remotely with the internet which is connected to ESP8266.

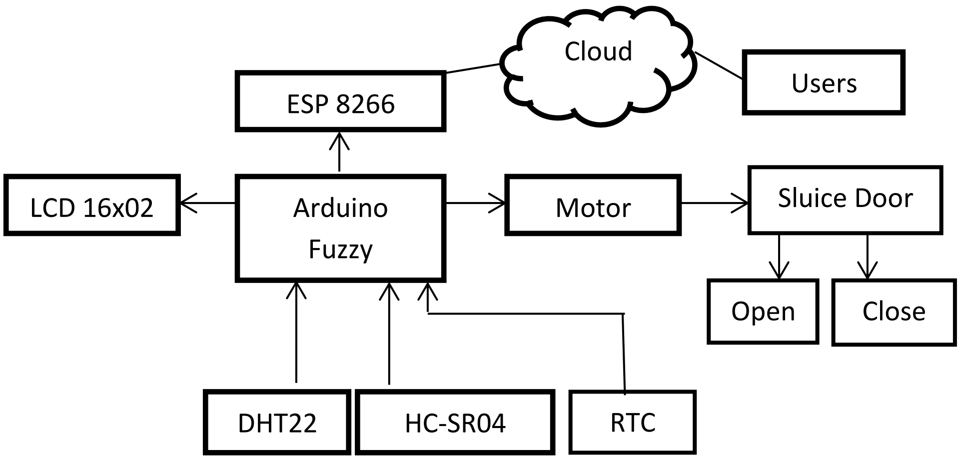

Figure 3. System Block Diagram

The Working Principles of the system block diagram as shown in Figure 3 are as follows:

1. RTC sets the input time on the arduino to be outputed to the LCD

2. The temperature and humidity values of the air will be measured by using DHT22 and the water level will be measured by HC-SR04.
3. The data received from all sensors will be read and processed by Arduino which is combined to fuzzy logic by following the basic rules.
4. The result of Arduino processing control with fuzzy logic will drive the servo motor as an actuator that will open and close the sluice door.
5. The values that are displayed on the sensor and actuator are displayed by 20x04 LCD and can be monitored through the internet network by ESP 8266 module.

There are 3 inputs in Arduino programming (DHT22, HC-SR04, RTC) and 3 outputs (20x04 LCD, 8266 ESP, Servo Motor).

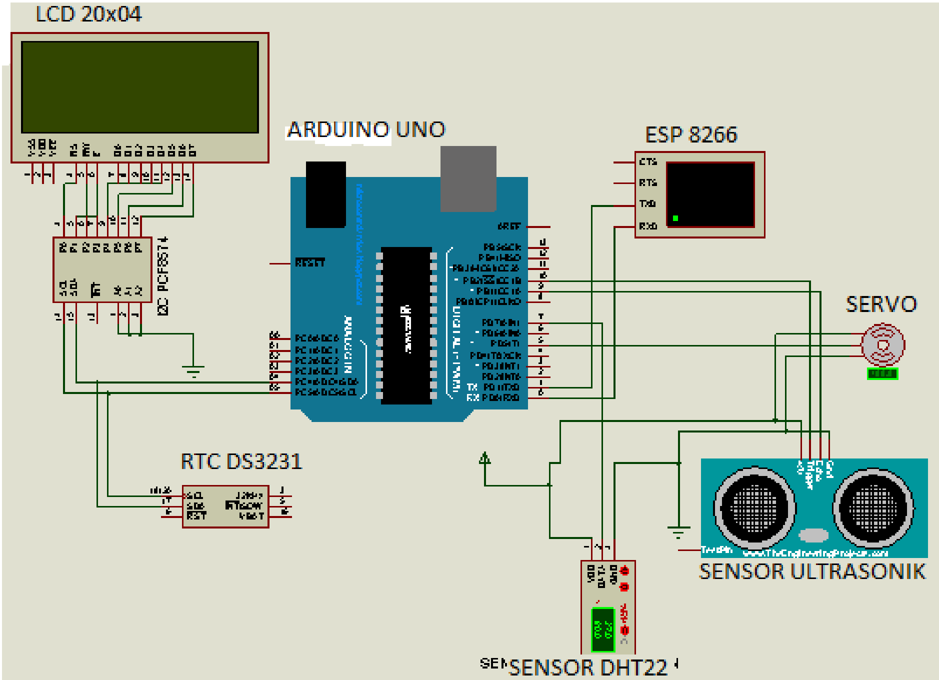

Figure 4. Set of tools

3. Results and Analysis

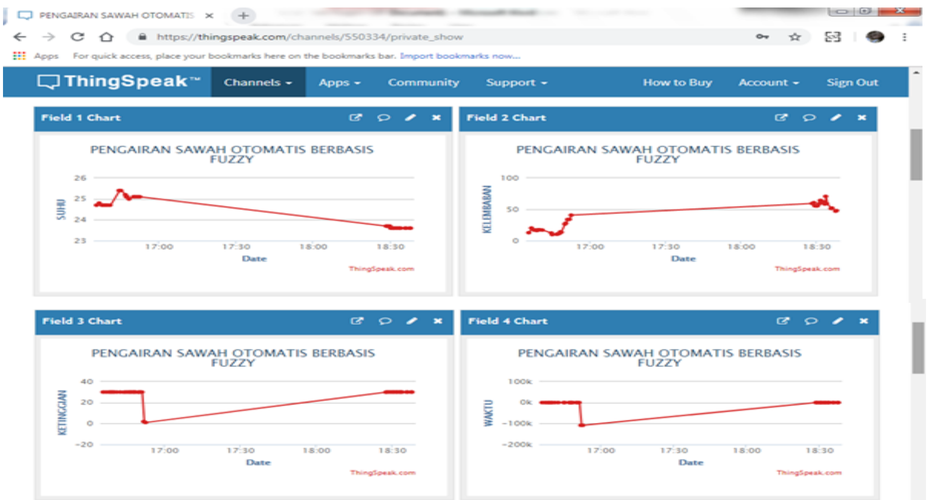

Figure 5. Test Results

Tool testing needs to be conducted to get specific data from the tools that have been made. Tests are conducted experimentally in the morning, daylight, afternoon, and evening as well as in the high temperature condition and rain. The preparation process of testing on tools can be seen in Figure 5.

Table 1. Precision of Measurement

No	Temperature	Humidity	Water Level	Watering	Watering Duration (Calculation Value)	Precision Level
1	28,3	60,1	3,32	33,76	29,3	86,78
2	28,24	61,2	3,32	33,77	29,3	86,76
3	27,78	64,13	3,28	33,75	29,7	88
4	28,01	59,05	4,22	31,42	21	66,83
5	29,12	59,62	3,33	33	29,5	89,39
6	28,93	60,3	3,2	33,21	30,9	93,04
7	29,3	60,3	3,2	33,88	30,9	91,20
8	29,3	60,3	3,2	33,88	30,9	91,20
9	29,12	59,62	3,33	33,23	29,5	88,77
10	29,23	60,71	3,5	33,63	27,1	80,58
11	28,29	61,55	4,18	31,22	20,5	65,66
12	24,4	76,51	2,23	34	34	100
13	24,98	76,34	2,23	34	34	100
14	25,44	75,81	3,36	34	28,7	84,41
15	25,87	75,23	3,6	33,42	26	77,79
16	25,82	73,11	3,32	33,83	28,9	85,42
17	24,42	73,07	3,87	32,7	23,3	71,25
18	25,23	73,92	4,23	31,3	20,1	64,21
19	25,07	74,04	2,29	34	34	100
20	24,88	75,6	2,57	34	34	100
21	25,31	74,08	2,31	34	34	100
22	25,07	75,86	2,2	34	34	100
23	25,66	74,98	2,59	34	34	100
24	26,22	74,7	3,63	32,54	25,7	78,97
25	31,22	58,21	4,5	31,1	19,7	63,34
26	31,45	58,3	5,61	30,34	18,6	61,30
27	31,34	58,2	5,61	30,2	18,5	61,25
28	31,7	59,04	5,21	30,5	18,8	61,63
29	32,4	59,71	4,86	31,1	20,1	64,63
30	32,21	62,06	5,22	31	19,5	62,90
31	33,4	65,83	5,63	31,9	21,2	66,45
32	32,12	63,04	5,83	31,2	20	64,10
33	32,11	58,02	4,92	29,3	20,1	68,60
34	31,2	59,36	3,77	30,31	24,9	82,15
35	30,89	60,1	3,02	34	33,6	98,82
36	31,09	60,2	4,87	30	18	60

37	32,02	64,79	4,2	31,5	20,4	64,76
38	32,18	63,24	5,22	31	19,5	62,90
39	32,08	65,24	5,63	32	19,3	60,31
40	31,77	63,24	5,63	32	18,9	59,06
41	31	35,5	9,45	29,2	17,8	60,95
42	30,9	35,8	9,5	33,8	17,7	52,36
43	30,9	36,3	9,76	33,9	17,7	52,21
44	35,3	34,9	7,23	32,1	24,2	75,38

Tools testing was carried out at 07.53 - 08.49, 13.19 - 14.17, at 16.33 -17.47, at 22.18 - 23.44, and tested with heat and rain treatment that was carried out at 14.21-14.41. The following is the data obtained from the test showed in table 1. The calculation table above can be made into a graph as in Figure 6.

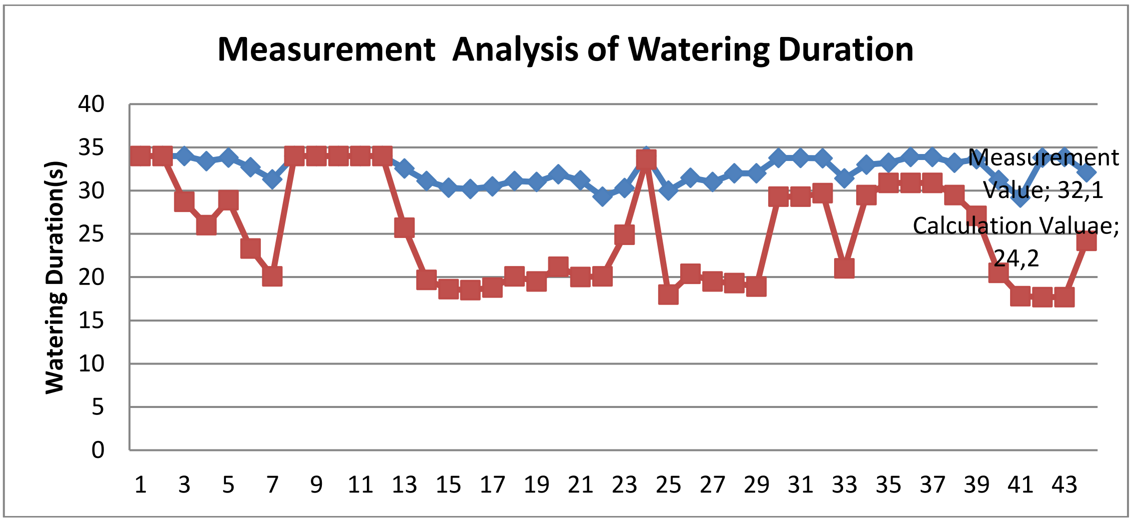

Figure 6 Comparison of Measurement and Calculation Values

In Figure 6. there are 6 data sections, namely 13 morning data, 8 daylight data, 8 afternoon data, 11 evening data and 4 data with heat and rain treatment. The morning data reached the highest precision value of the tool is 100%, the lowest precision value is 64.22% and the average precision value of the tool at morning measurement is 89.39%. The daylight data that is obtained showed that the lowest precision level is 61.26%, the highest reaches 66.46% and the average precision at daylight measurement is 63.21%. The afternoon data obtained showed that the lowest precision level is 59.06%, the highest reaches 98.82% and the average precision at the afternoon measurement is 69.57%. The evening data showed that the lowest precision level is 65.66%, the highest reaches 93.04% and the average precision at evening measurement is 84.38%. Last, the heat and rain treatment showed that the lowest precision level is 52.21%, the highest is 75.38% and the average precision at evening measurement is 60.23%. Of all the tests obtained the lowest precision value is 52.21%, the highest is 100% and the average is 77.13%.

4. Conclusion

The result of this research can be concluded that the automatic irrigation system that have been successfully built consists of DHT 22 sensor, ultrasonic sensor as the input sensor and servo motor as the output system supported by 8266 esp as a link to the internet by utilizing the control from fuzzy logic method that is reached an average value of 77.13%.

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