A System based on Fuzzy Logic Approach to Control Humidity and Temperature in Fungus Cultivation

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***Abstract*— An environmental condition such as temperature and humidity keys factor for fungus cultivation. A fuzzy logic approach to control humidity and temperature was developed using LabVIEW Programming and implemented on fungus cultivation. The system is consist of hardware (DHT11, microcontroller, relay, electric pump, lamp and Personal Computer) and software (Arduino IDE, LabVIEW). The fuzzy logic approach was design on LabVIEW programming for controlling temperature and humidity. The system was successfully preserved humidity on range 80-90% and temperature on range 20-28 C using fuzzy logic approach.**

Keywords*— Fuzzy logic; Microcontroller; Sensor DHT11, LabVIEW; fungus

I. INTRODUCTION

The keys factor for fungus cultivation are environmental condition such as temperature and humidity. A premiely research about temperature and humidity control was investigate the use of heating, ventilation and air conditioning (HVAC) system to control room, space or building [1,2,4].

This work present humidity and temperature controller which has been constructed using hardware sensor DHT11, microcontroller, and personal computer. DHT11 is using to sensing temperature and humidity. Arduino Uno as the microcontroller board. DHT is a composite sensor that have resistive sense of wet components an NTC temperature measurement devices, and connected with a high performance 8 -bit microcontroller.

LabVIEW is a highly productive development environment for creating custom applications that interact with real-world data or signals in fields such as science and engineering. It has numerous components, several of which are required for any type of test, measurement, or control application. LabVIEW can integrated with input of sensor and processing the data from that sensor [3,5].

The fuzzy control is a method to replicate and execute a (smart) human's knowledge about how to control a system. Various studies using intelligent and soft computing methods were presented. One of these intelligent methods is artificial fuzzy method. There are many advantages of fuzziness, one of which is the ability to handle the complex system [1-4]. The fuzzy control can applied in many controller in example on ventilation controller. Fuzzy controllers can control nonlinear process model and time-delay process model significantly better than classical controller [1]. The fuzzy ventilation controllers primarily aim to improve energy consumption and comfort conditions with respect to cooling, dehumidification and air quality [4]. It is possible to use ambient cooling because zone temperatures often rise above outside temperature due to solar and occupant gains within the zone. This allows the zone temperature to decrease by introducing cooler fresh outdoor air. The upper and lower set point limits and the preferred set point for fuzzy ventilation control purposes are set to ensure fungus cultivation. Situations rarely occur when the outdoor temperature is above that of the zone and HVAC (heating, ventilating, and air-conditioning) plant is required to be operational due to the zone temperature. Combination of the adaptive and steady state approaches to thermal comfort have been considered to define the set point ranges and preferred set points (upper and lower set points)[4].

In this paper, we found the exact humidity and temperature that would be used for fungus cultivation with fuzzy logic control.

II. DESIGN

The fuzzy logic system for controlling temperature and humidity in fungus cultivation room was designed using both hardware and software. The hardware consists of temperature and humidity sensor DHT11, microcontroller, relay, electric lamp and water pump. Figure 1 shows hardware layout of controlling room.

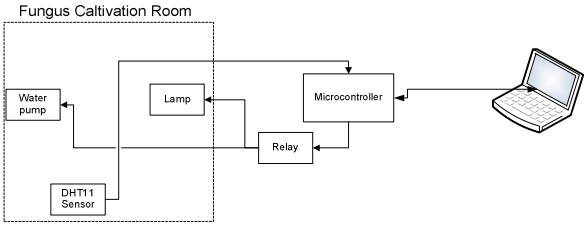

Fig. 1. Layout of Controlling Room of Fungus Cultivation

A. Sensor

In this system we use the DHT11 Sensor to controlled temperature and humidity fungus cultivation room. A DHT11 temperature humidity sensor features a calibrated a signal output. It has temperature range 0-50 °C with error of ± 2 °C and humidity range 20-90% RH with ± 5% RH error. This system need 5 volt power supply for powering sensor.

B. Microcontroller

Arduino Uno R3 is a microcontroller-based system-board minimum ATmega328P type of AVR. Arduino Uno R3 has 14 digital input / output (6 of which can be used for PWM outputs), 6 analog inputs, 16 MHz crystal oscillator, a USB connection, a power jack, ICSP header and a reset button. Fungus Cultivation Room Controller can be illustrated as shown Fig. 2

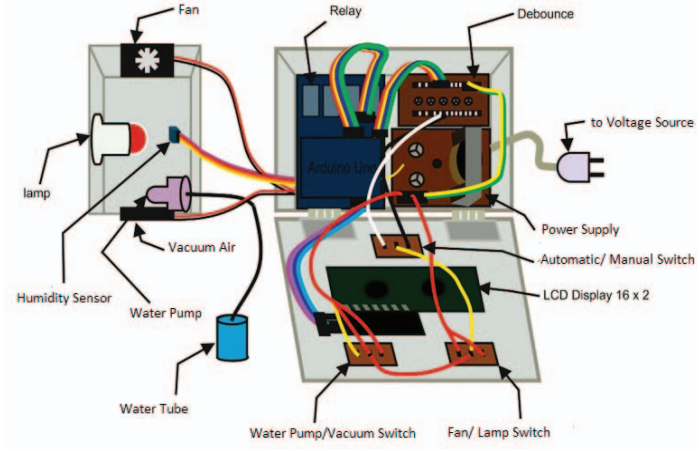

Fig. 2. Fungus Cultivation Room Controller Scheme

C. Fuzzy Logic Control for Fungus Cultivation Room

The overall of the diagram scheme of Fuzzy Logic Control for Fungus Cultivation Room is shown in Fig. 3. There are inputs to the controller that are temperature, change of temperature and relative humidity.

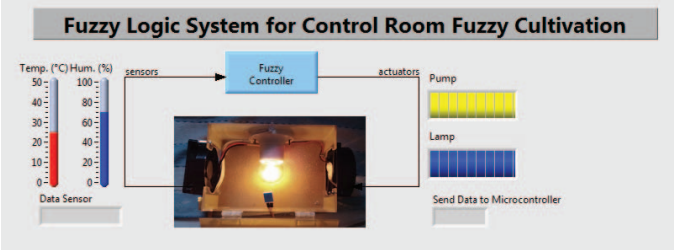

Fig. 3. Fuzzy Logic Controll for Fungus Cultivation Room

Fuzzy condition of the room for fungus cultivation can be shown in figure 4.

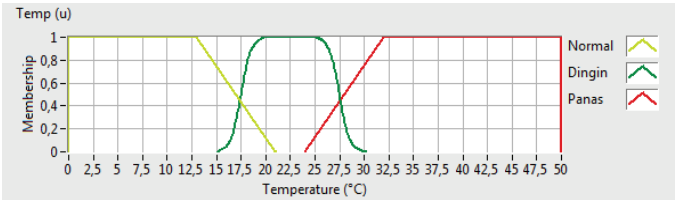

Fig. 4. Fuzzy Condition

In order to get proper condition for fungus cultivation, the room should be controlled for humidity on range 80-90% and temperature on range 20-28 ^{0}C. Fig. 5 and Fig. 6 show the inputs and outputs membership functions (MFs) of the fuzzy controller.

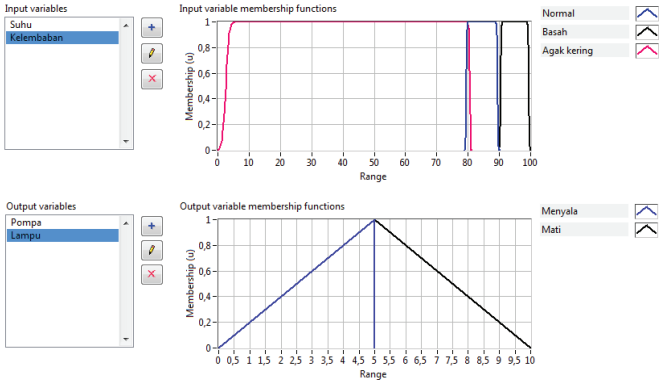

Fig. 5. Memberships function for Inputs Variable Humidity and Outputs Variable Lamp

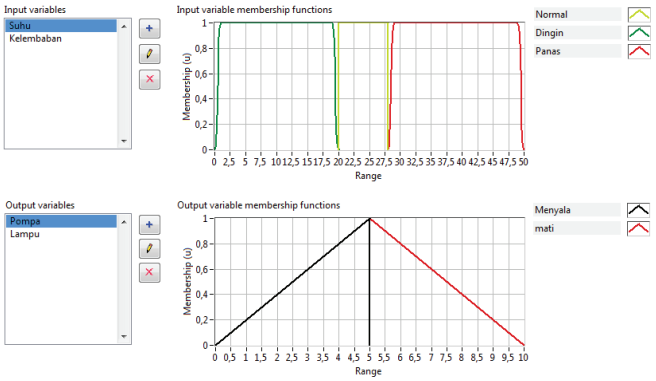

Fig. 6. Memberships function for Inputs Variable Temperature and Outputs Variable Pump

D. Flowchart of Process Design

The flowchart of process design for control room system using fuzzy logic on fungus cultivation is shows on fig 2.

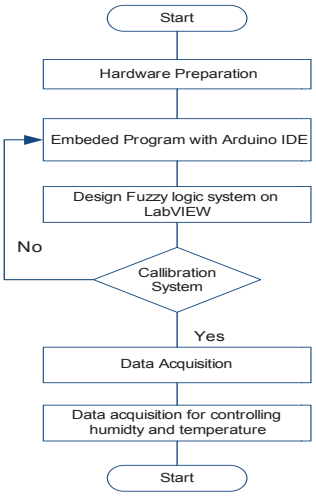

Fig.7. Process Design of Fuzzy Logic on Fungus Cultivation

III. Software Preparation

The fuzzy logic control for temperature and humidity system was developed using 2 software platforms, i.e., Arduino Integrated Development for Environmental (IDE) and LabVIEW. Arduino IDE was used as embeded program into microcontroller. The displaying data acquisition on PC worked on LabVIEW platform. The fuzzy system was design using LabVIEW control and simulation tool.

A. Arduino IDE

The arduino's integrated development environment (IDE) is a cross-platform application written in Java language. It is derived from the IDE for the processing programming language and the wiring projects. Arduino programs are written in C or C++ [8].

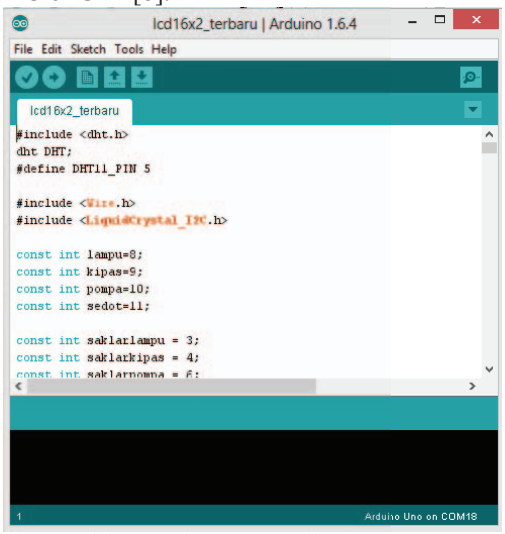

Fig. 8 Input Data Arduino IDE for Fungus Cultivation Rooms

B. LabVIEW

The LabVIEW software is used as the integrating platform for acquiring, processing and transmitting the physiological data since it is an excellent graphical programming environment to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart.

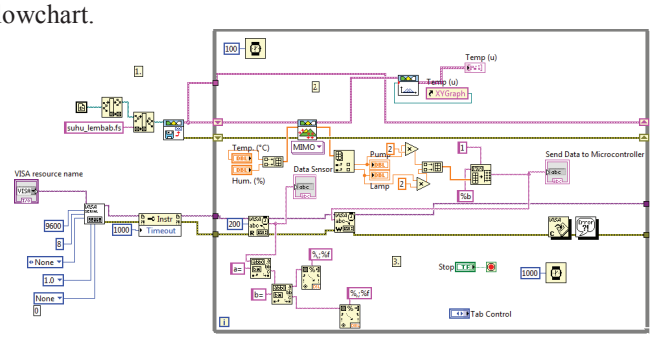

Fig. 9 LabVIEW graphical language programing

IV. Result and Discussion

The fuzzy logic system in this research is implemented to control humidity and temperature in fungus cultivation. The system is constructed by controller, fungus room and PC for LabVIEW. The result of controller has been simply made and shown in fig. 10.

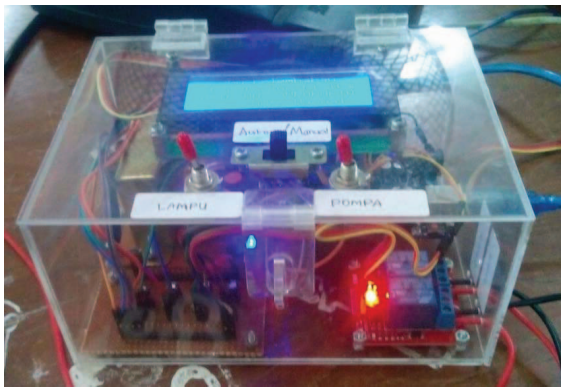

Fig. 10. Result of box controller

Based on figure 10, a control system in this research are implemented with manual and automatic mode. Table I shows that when the system performs a manual mode control system, the relay provides the same response to the condition of the switch. And when the control system performs the automatic mode, the relay provides response according to the humidity and temperature condition as shown in the Table II.

TABLE I MANUAL MODE CONTROL SYSTEM

No	Switch Condition		Relay Condition	
	Water pump	*Lamp*	*Water pump*	*lamp*
1	On	Off	On	Off
2	Off	Off	Off	Off
3	On	On	On	On
4	Off	On	Off	On

TABLE II AUTOMATIC MODE CONTROL SYSTEM

No	Measuring		Condition	
	Temperature	*Humidity*	*Water pump*	*lamp*
1	>28	<80	On	Off

No	Measuring		Condition	
	Temperature	*Humidity*	*Water pump*	*lamp*
2	>28	>90	Off	Off
3	<20	<80	On	On
4	<20	>90	Off	On

The fuzzy logic control system is done while automatic mode was selected on control system. The data acquisition of temperture and humidity is taken by sensor and processed into microcontroller. PC that installed LabVIEW programming received data of temperature and homidity. Furthermore, The fuzzy system tool on LabVIEW is done by processing data of temperature and humidity. The result of fuzzy controller system is logic data (1 0) which is delivered to box controller for controlling pump or lamp by relay activating.

The following steps on this research is to compare the result that shown in the system with the measurement result based on actual condition both temperature and humidity as shown in figure 11 and 12.

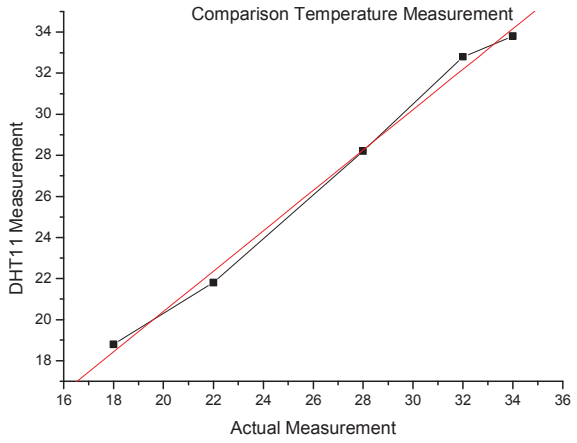

Fig. 11 Temperature measurement

Based on figure 11, the comparison result of temperature measurement, the correlation coefficient (R) is 0.9972 and standard deviation (sd) is 0,5639. In addition, the comparison result of humidity measurement, the correlation coefficient (R) is 0.9999 and standard deviation (sd) is 0,17542.

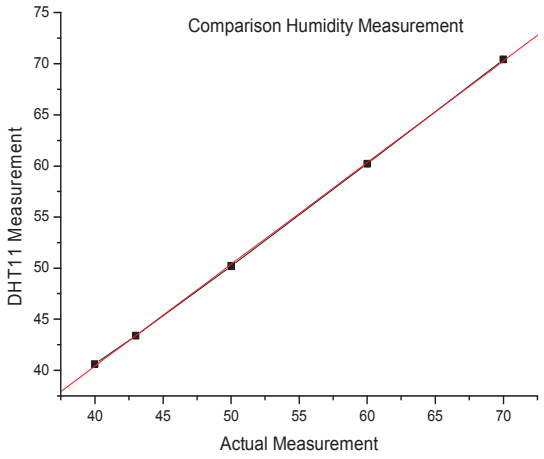

Fig. 12 Humidity measurement

V. CONCLUSION

In general implementation, this research successfully created devices to controll the temperature and humidity of the fungus cultivation room by using temperature and humidity sensors DHT11 and Arduino Uno with data display on the LCD Display 16x2. The data processed by LabVIEW and provided the output data which can be compared. The device have been created to control the temperature and humidity of the room by using temperature and humidity sensors DHT11 and ATmega328 microcontroller that can work in automatic or manual mode. Fuzzy logic controll method have been conducted to addapt the proper condition of the room for better fungus cultivation.

ACKNOWLEDGMENT

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