

SOIL QUALITY MONITORING PROTOTYPE WITH HUMIDITY AND TEMPERATURE PARAMETERS FOR PADDY PLANTS

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ABSTRACT

Paddy is one of the most important plants in Indonesia because most of the Indonesian main food is rice. Paddy productivity can be increased by utilizing technological development. This study aims to design and make a measurement tool for soil temperature and humidity in paddy fields in the Karawang regency. This measurement tool uses Arduino mega and several sensors, the DS18B20 sensor which functions as a ground temperature sensor. Grove moisture sensor that functions as a sensor to detect soil moisture. Information for the value of these parameters will be listed on the LCD that has been installed. Data was collected in the paddy fields of Telukjambe sub-district, Karawang Regency, data collection was carried out with a depth of 2 cm and a depth of 4 cm. At a depth of 4 cm, the temperature and humidity parameters are stable, while at a depth of 2 cm the temperature parameter is stable while the humidity is unstable, and the best humidity value is at a depth of 4 cm.

Keywords: Temperature; Humidity; Soil.

Introduction

Karawang is known as a granary, based on data from the Karawang Regency's Agriculture, Forestry, Plantation and Animal Husbandry Office, It has an area of 200,168 hectares of paddy fields and can produce paddy reaching 1,458,126 GKP tons in 2016.¹ With that amount of paddy production, Karawang contributes 9% paddy in West Java Province, around 2.2 million more people work as farmers.²

One effort to increase paddy productivity is the use of technology which can support that. The physical parameters of the soil need to be considered. Each type of plant requires a different temperature, depending on the type of plant and also the growth rate.³

Soil moisture is water that fills some or all of the pores of the soil which is above the water table.

High levels of soil moisture can cause problems, and soil conditions that are too moist cause difficulties in carrying out permanent activities of agricultural or forestry products using mechanical tools.⁴ Therefore, it is necessary to measure the temperature and humidity of paddy fields to monitor automatically.

The factors that determine soil moisture are rainfall, soil type, and evapotranspiration rate. Soil moisture will determine the availability of water in the soil for plant growth.⁵

Methods

Temperature and humidity measurement devices are based on microcontrollers and sensors. Microcontrollers can be programmed to take data from temperature and humidity sensors and display it on a display device. The stages of the research are:

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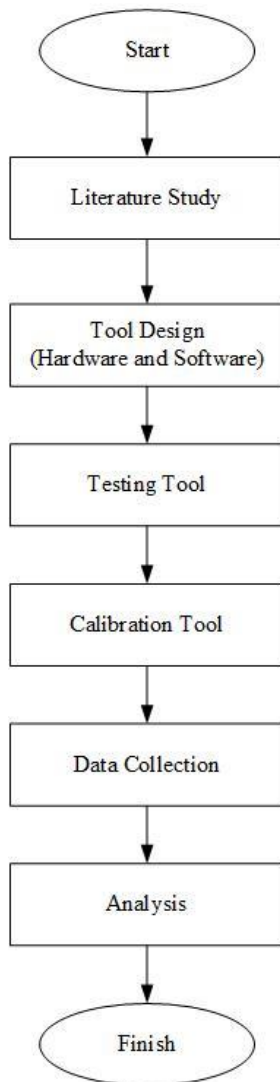


Figure 1. Research flowchart

The first stage is to study literature, collect information related to the research. The next step is making a design.

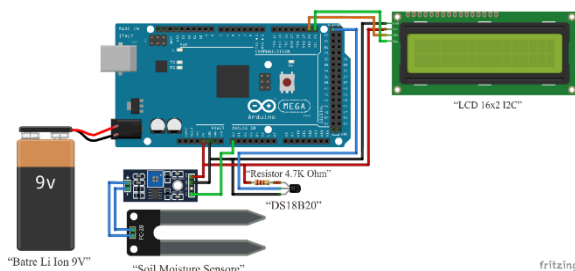


Figure 2. Research scheme

After making the tool design, then encode the Arduino software.

This tool uses an Arduino Mega 2560 microcontroller and the sensor used is the Grove Moisture Sensor as a soil moisture

sensor and DS18B20 as a ground temperature sensor. Information about the temperature and humidity will be displayed on the LCD screen and the data is stored in real-time on a memory card installed on the device.

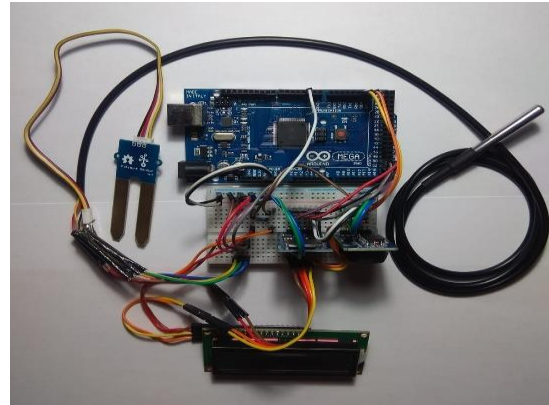


Figure 3. Research instrumentation

The next stage is testing tools, testing tools is the most important stage in making a tool because with the existence of a test can be known the performance of the tool. Calibration aims to find out the difference (deviation) between the measured values compared with the tested instrument. This really needs to be done to calculate the accuracy of measuring instruments made. The calibrator used is the Digital Soil pH Instrument 4 in 1 AMT-300 to measure the temperature and humidity of paddy fields.



Figure 4. Digital Soil pH Instrument 4 in 1 AMT-300

The next stage is data collection. Data retrieval is done by using two tools, the tools

that have been made and the temperature calibrators.



Figure 5. Retrieval of data

After all, data is fulfilled, an analysis is carried out, so it can be concluded measurements that have been made. Data analysis to determine the level of accuracy using variance and standard deviations. This is useful for calculating the level of homogeneity of data. Below is the formula for variance and standard deviation:

$$s^2 = \frac{\sum(xi - \bar{x})^2}{n - 1} \quad (1)$$

$$s = \sqrt{\frac{\sum(xi - \bar{x})^2}{n - 1}} \quad (2)$$

S² = Sample variance

S = Sample standard deviation

From this standard deviation value, we can also calculate the coefficient of variance (I.V) which is useful for knowing the average percentage relative to a measurement.

$$I.V = \frac{s}{rata-rata} \times 100\% \quad (3)$$

Meanwhile, to calculate the error value using the formula:

$$\%error = \left| \frac{a - b}{a} \right| \times 100\% \quad (4)$$

Result and Discussion

The results of this research are the creation of temperature and soil moisture measurement

tools. The humidity sensor used is *Grove Moisture* Sensor and the soil temperature sensor used is DS18B2.



Figure 6. Soil temperature and humidity measurement tools.

The hardware used in conducting this research can be seen in Figure 6. The DS18B20 sensor has 3 pins that are connected to the Arduino Mega 2560. The black ground pin cable is connected to the Arduino Mega 2560 ground pin. The red cable is the 5 volt Vcc pin is connected to the Arduino Mega 2560 Vcc pin. The yellow data pin (D0) cable is connected by digital pin to pin 2 on the Arduino Mega 256 and add a 4k7 resistor between the VCC pin and data pin (D0) as a pull up. The Grove Moisture Sensor series has 3 pins including VCC, GND and A₀, the black ground pin cable connected to the Arduino Mega 2560 ground pin, the red 5Volt VCC pin cable is connected to the Arduino Mega 2560 VCC pin, the yellow data pin cable (A₀) is connected to the 0 Analog pin on the Arduino Mega 2560. RTC DS3231 has 6 pins namely 32K, SQW, SCL, SDA, Vcc and GND, however, only 4 pins are used in the circuit including SCL, SDA, Vcc and GND, the SCL pin is connected to the Arduino Mega 2560 - 20th digital pin. The SDA pin is connected to the digital pin to 21 Arduino Mega 2560, the GND pin is connected to the Arduino Mega 2560 GND pin and the 5 Volt Vcc pin cable is connected to the Arduino Mega 2560 Vcc pin. The LCD used is a 16x2 + I2C LCD that has four pins including GND, VCC, SDA, and

SDL, the SCL pin is connected to the 20th Arduino Mega 2560 digital pin in parallel. The SDA pin is connected to the digital pin to 21 Arduino Mega 2560 in parallel, the GND pin is connected to the Arduino Mega 2560 GND pin and the 5Volt VCC pin cable is connected to the Arduino Mega 2560 VCC pin.

The MicroSD Card Module or data logger circuit has six pins namely GND, VSS, MISO, MOSI, SCK CS, the GND pin is connected to the Arduino Mega 2560 GND pin, the 5 Volt VCC pin is connected to the Arduino Mega 2560 Vcc pin. The Miso pin is connected to the digital pin 50 Arduino Mega 2560, the Mosi pin is connected to the digital pin 51 Arduino Mega 2560. SCK pin is connected to digital pin 52 Arduino Mega 2560, CS pin is connected to 53 digital pins Arduino Mega 2560.



Figure 7. Retrieval of data

Data was collected in the area of the Telukjambe-Karawang paddy field. Data retrieval is done by using two measuring tools. A first measurement tool is a tool that researchers have made and the second measuring tool that is Ituin as a comparison.

In the research process, researchers took test data for 15 minutes with a delay in the value input time of 5 seconds and measure 2 depth variations that are 2 cm and 4 cm. The first data collection on paddy land with a 2 cm step depth starts at 09:22 until 09:37 WIB and with a 4 cm depth at 09:44 to 09:59 WIB. Each data collection of each measurement amounted to 160 data. Tests are carried out in wetland soil under growing conditions so that the paddy fields are runny or wet.

Discussion

This study aims to determine the performance of devices that have been assembled and compared with tools that have been standardized namely iTuin 4 in 1 Soil Survey Instrument.

Table 1. Results of data collection on paddy fields with a depth of 2 cm

No	Temp°C	Temp °C (Ituin)	Humidity		
			Information	%RH	analog
1	29.75	30	Moist	56.99	583
2	29.75	30	Moist	56.70	580
3	29.75	31	Moist	56.70	580
4	29.75	31	Moist	56.50	578
5	29.75	31	Moist	56.21	575
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160	29.75	31	Moist	31	584

Table 2. Results of data collection on paddy fields with a depth of 4 cm

No	Temp°C	Temp°C (Ituin)	Humidity		
			Information	%RH	Analog
1	29.06	29	Moist	53.76	550
2	29.06	29	Moist	53.37	546
3	29.06	29	Moist	53.37	546
4	29.06	29	Moist	53.37	546
5	29.06	29	Moist	53.37	546
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159	29.75	31	Moist	52.10	533

Table 1 and Table 2 only present a portion of the data. From the data obtained then calculated the average value of the temperature measured using a tool that has been made that is 29.63 °C and using standardized tool get an average value of 30.75 °C with a difference of 1.13 °C and calculated using equation 4 by comparing the results of temperature measurements using a tool that has been made researchers with standardized tools get an error value of 3.67%. The standard deviation value at a depth of 2cm

is 0.058 with a variance index of 0.203. While at a depth of 4 cm the standard deviation is 0.033 with a variance index value of 0.114. analyzing the value of the coefficient of variation can be seen that the data generated from the designed tool and Ituin are both homogeneous or uniform. However, the temperature data obtained in the device designed by researchers are more homogeneous and better when compared with data generated from Ituin.

Table 3. Time, temperature and humidity data with a depth of 2 cm.

No	Time	Temp °C	Humidity (%)
1	10.41.02	29.75	56.99
2	10.41.07	29.75	56.70
3	10.41.13	29.75	56.70
4	10.41.19	29.75	56.50
5	10.41.24	29.75	56.21
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.	.	.	.
160	10.56.03	30.06	57.09

Table 4. Time, temperature and humidity data with a depth of 4 cm.

No	Time	Temp °C	Humidity (%)
1	09.44.03	29.06	53.76
2	09.44.08	29.06	53.37
3	09.44.14	29.06	53.37
4	09.44.20	29.06	53.37
5	09.44.25	29.06	53.37
-	-	-	-
-	-	-	-
160	09.59.04	30.19	51.81

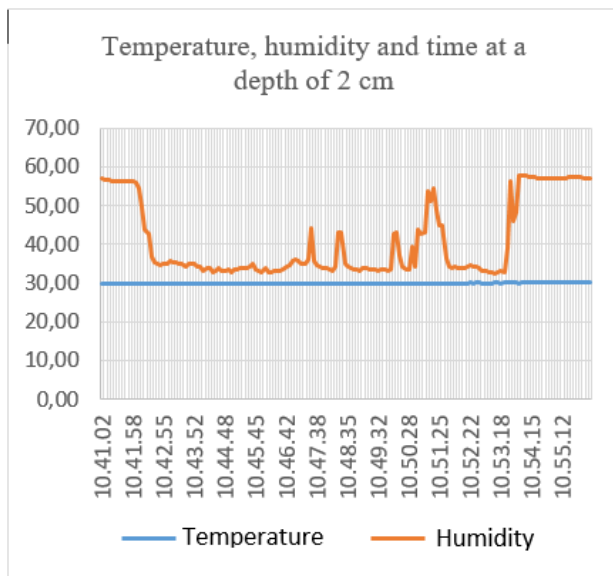


Figure 8. Temperature, humidity and time at a depth of 2 cm

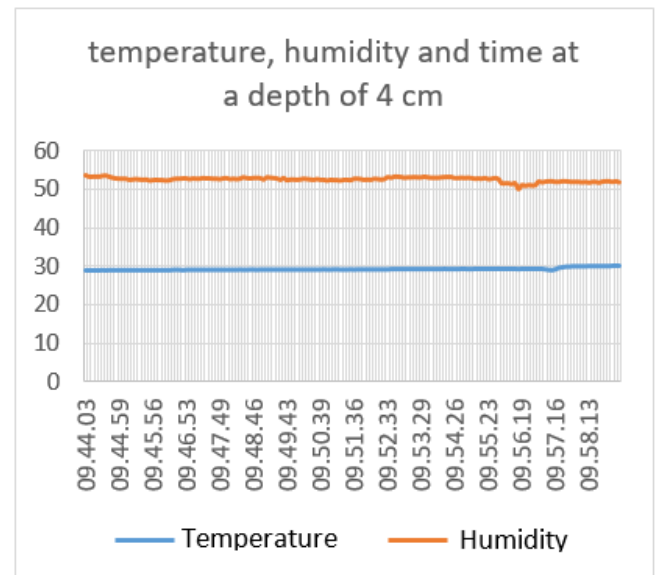


Figure 9. Temperature, humidity and time at a depth of 4 cm

Measurements were made at the same point, from Figure 8 and Figure 9 that the temperature value is relatively stable at a depth of 2cm but the soil moisture value at a depth of 2 cm is not stable. While the temperature and humidity values at a depth of 4 cm are relatively stable. From these data, the best moisture value is at a depth of 4cm, which is 53% RH.

Conclusion

Based on the results of research, it can be concluded that measuring soil temperature and soil moisture can work well and planting should be done at a minimum depth of 4 cm because many factors can affect the value of these parameters.

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