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Real Time Monitoring System for Peat Soil

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Abstract: This work is about real-time monitoring of peat soil temperature and humidity based on Internet of Things (IoT) technology. Fires in peatland forests often occur, especially during hot weather, and it takes a long time to put them out. This is because the fire spreads on the surface and in the peat soil, making it difficult to extinguish. However, most researchers have developed a forest fire monitoring system by measuring the temperature in the surrounding area or on the peat surface. This results in inaccurate temperature and humidity readings of the peat soil. Hence, soil bottom temperature and humidity readings are important and need to be obtained immediately to prevent fires. In this work, a bucket height of 30 cm and a volume of 18 liters are used, filled with peat soil. Temperature and humidity sensors are placed in three positions: sensor 1 (surrounding the soil), sensor 2 (soil surface), and sensor 3 (soil bottom). The system is tested and placed outside the building. Data is collected at 10 am, 12 pm, and 3 pm each day. Based on the results from day one, the temperature of the surrounding sensor has an average value of 30.5°C, the soil surface is 29.7°C, and the soil bottom is 28.7°C. The humidity of the surrounding sensor has an average percentage of 69.1%, the soil surface is 91.1%, and the soil bottom is 96.7%. The average temperature and humidity results show a correlation between the humidity and temperature of the soil. When the temperature is hot, the humidity decreases, which is observed in all three sensors. For monitoring purposes, this system is equipped with message notifications connected to the Telegram channel. The average reading of these sensors is set to low temperature (reading < 20°C), medium temperature (reading 21°C-36°C), and hot temperature (reading 37°C and above). Referring to day one, the average soil temperature indicates that the soil condition is moderate.

Keywords: Internet Of Things (Iot), Peat Soil Temperature, Humidity

1. Introduction

The Internet of Things (IoT) system is a network of connected devices that can share and gather data through the internet. It is now widely used in a variety of technological applications. This study outlines a method for real time monitoring system for peat soil which includes using temperature and humidity sensors to detect peat soil condition and deliver real-time readings to update peat soil condition.

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This IoT system can be used to aid monitoring process of peat soil, an important soil or natural substance used in agriculture and as a recreational area in Malaysia. The system is needed as the soil area can be a threat to Malaysia during the drought season, the dry soil formed from the decay of dead plants microorganism, has natural coal characteristic; dried leaves falling could easily ignite the fire, and putting out the fire could take days depending on the size of the fire [1].

1.1 Smart Environmental Monitoring (SEM) Concept

Environmental monitoring system entails gathering any data that can be used to demonstrate how the planet works, how it affects our lives, and how it can be regulated. Data from natural sources, such as rainfall or soil composition, are included in environmental monitoring data, and human waste or car emissions are data from human or industrial operations [2].

1.2 IoT in Environmental

With the IoT technology, a smart monitoring system could track and control environmental events and industrial processes that could hurt the environment, such as natural disasters and toxic waste from industrial processes or trash made by people. These systems also able to collect human statistics like population growth and human activities affecting the environment. Monitoring and control programmes look at a wide range of inputs. For example, marine biologists study how fishing limits affect seafood stocks and how plastic waste affects marine life. Environmental psychologists look at data from sensors, actuators, and automated services to determine how the environment affects people's health and behaviour. The data could be sent to the other side and monitored for research or prevention work [3].

2. Materials and Methods

The main aim of this work is to monitor the temperature and humidity of peat soil based on IoT technology. By developing this work, it may help the authority to monitor the temperature and humidity of the soil remotely, anytime and anywhere.

The real time monitoring system using IoT technology developed in this work consists of two parts, first part is the hardware part which includes the components used to design IoT sensor node device, while the second part includes microcontroller’s software programming, which need to be programmed in the device in order to enable the communication between the microcontroller, sensors and server.

2.1 Hardware Components

Table 1 shows the list of components used in this work. In developing the IoT sensor node device, ESP32 has been used as the main microcontroller board. As can be seen in this table, three types of the humidity and temperature sensor modules have been selected. Furthermore, the developed IoT sensor node device has been included with the OLED display to ease monitoring of the device functionality while connecting to internet.

Table 1: List of components

Components	Quantity
ESP32	1
FS200-SHT10 (humidity and temperature sensor)	1
FS200-SHT20 (humidity and temperature sensor)	1
DHT11(humidity and temperature sensor)	1
OLED display	1

Figure 1 shows IoT sensor node device developed in this work, which used ESP32 microcontroller board and has been connected to the sensors and the LED display.

Figure 1: The real time monitoring system connection

2.2 Software Application

An Arduino IDE software is used to write and upload the code to the developed IoT sensor node device. It enables the microcontroller ESP board to read the temperature and humidity values of the monitored soil and send the values to the Blynk App platform. When the sensor values reach the threshold value, a notification will be sent to the user through the Telegram.

2.3 Methods

Figure 2 shows the flowchart of this work. The process development starts with the developed IoT sensor node device placed in the designated areas. Next, the sensors data detected by the microcontroller of the device will be displayed through the OLED display. Based on this flowchart, as the detected sensor values reach 37ºC, the device will send a notification to the user. On the other hand, as the sensor value is below the threshold value, it will be sent to the Blynk App platform.

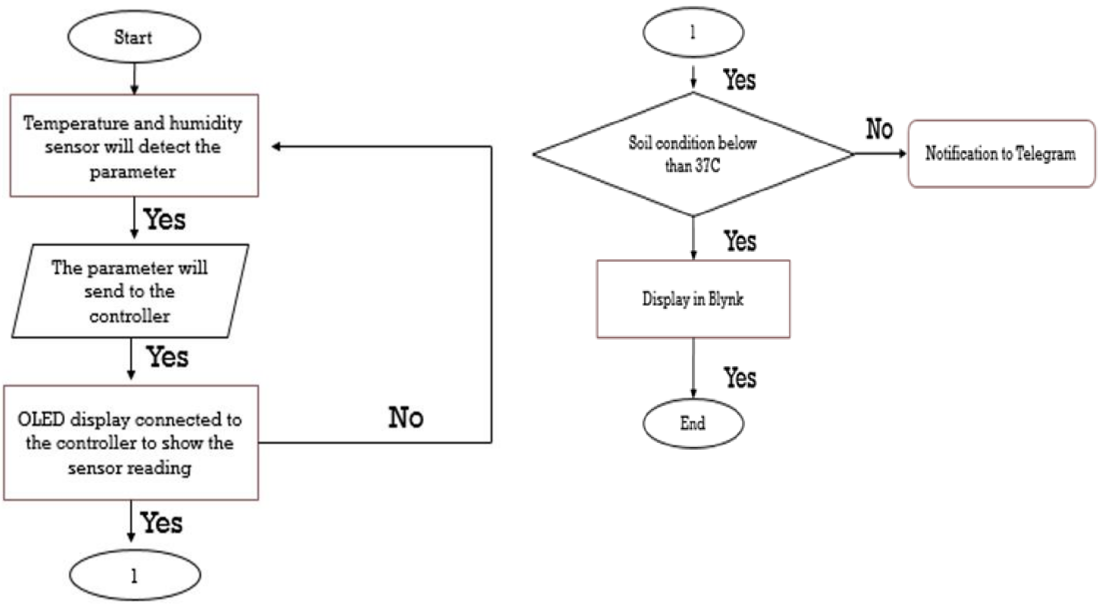

Figure 2: Flowchart of the work

In this work, the developed IoT sensor node device has been used to monitor a bucket of soil samples as shown in Figure 3. Here, the device has been put at about 30cm depth where the bucket was placed unshielded outside of the resident house to ensure the soil receive natural light and the environment close to the actual peat swamp soil. As for analysis purposes, the soil sample has been monitored daily every 10.00 am, 12.00 pm and 3.00 pm for 7continuous days.

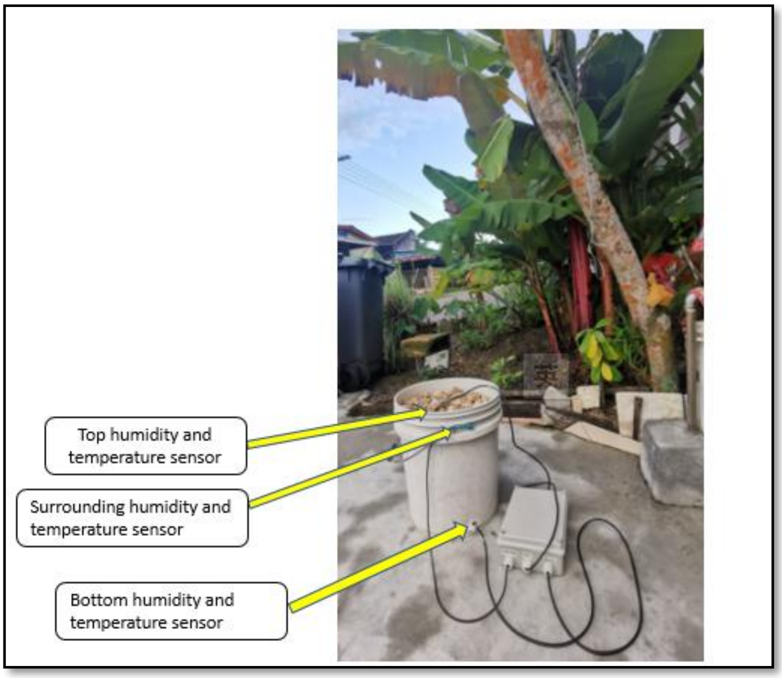

Figure 3: Soil monitoring setup

Figure 4 shows graphical user interface (GUI) of the peat soil monitoring system developed in this work. In this GUI, the values shown in the right column referring to the temperature values while left column shows humidity value. In order to ease the user, the GUI display has been divided into 3 rows with first row is showing the temperature and humidity values of the surrounding area, second row is the top area and the third row is the bottom area. As can be seen, this GUI is also able to show the graph line of the temperature and humidity values of these top and bottom area.

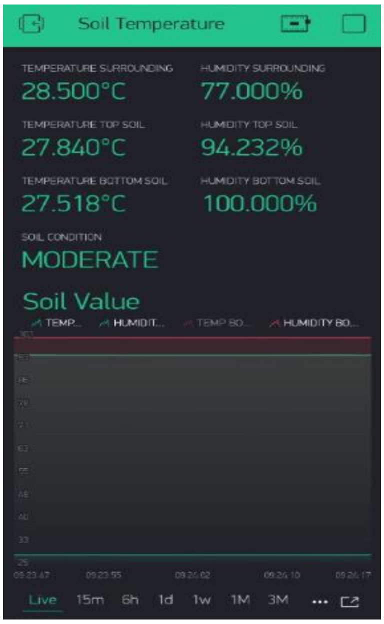

Figure 4: GUI for Blynk Application

2.3 Equations

Referring to the SHT sensor used in this work, the temperature and humidity sensor manual value could be obtained as follow:

Relative Humidity Conversion

Based on the relative humidity signal output SRH from the sensor module, the relative humidity RH is obtained by the following formula (result in %RH), no matter which resolution is chosen:

$$RH = -6 + 125 \cdot \frac{S_{RH}}{2^{16}} \qquad Eq.1$$

Temperature Conversion

The temperature T is calculated by inserting temperature signal output ST into the following formula (result in °C), no matter which resolution is chosen:

$$T = -46.85 + 175.72 \cdot \frac{S_T}{2^{16}} \qquad Eq.2$$

3. Results and Discussion

Table 2 shows the data collected for 7 continuous days on temperature and humidity values on the surrounding soil, topsoil, and bottom soil. To illustrate these values in line graphs, the data is divided into temperature and humidity for 7 days, as shown in Figure 5. Based on the table data and line graphs, the output shows differences in the time taken for temperature and humidity sensors located in three different locations. The graphs are divided into 14 sections, with two graphs for each day, representing temperature and humidity line graphs.

Table 2: Results of the temperature and humidity value for 7 days based on the three locations

	Time	10am						12pm						3pm					
	Sensor	Srdng		Top		Bottom		Srdng		Top		Bottom		Srdng		Top		Bottom	
Days	Value	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H	T
DAY 1		68.0	29.8	90.9	28.7	96.7	28.1	62.0	32.8	90.5	31.6	96.0	29.6	77.0	28.9	91.8	28.8	97.5	28.5
Day 2		59.3	29.4	89.2	29.0	96.9	28.8	61.9	33.0	89.4	32.8	95.2	30.1	55.0	33.8	92.7	31.5	99.0	30.1
Day 3		60.0	29.6	90.2	28.3	97.0	28.2	60.3	34.5	85.6	33.3	93.3	32.2	63.2	32.7	86.3	32.1	98.7	31.8
DAY 4		60.2	29.3	89.5	29.0	97.0	27.8	62.8	32.1	88.7	32.0	95.0	30.4	60.5	33.5	82.1	33.2	97.8	31.3
DAY 5		60.1	29.8	89.9	28.6	97.2	27.4	63.1	31.6	89.0	31.6	96.8	29.9	61.2	33.2	82.2	33.1	98.9	28.9
DAY 6		60.0	29.3	90.1	27.6	98.1	27.1	60.7	34.2	88.6	32.6	95.7	31.8	64.8	31.8	82.8	32.9	97.9	29.2
DAY 7		63.0	29.5	90.3	27.5	97.9	27.0	64.2	32.9	90.2	31.9	95.0	30.1	73.0	30.2	92.1	30.2	93.2	31.6

Referring to the graph, the correlation between the temperature and humidity values versus time and location can be easily seen. It is clear that the surrounding temperature and humidity values are always slightly higher than those of the topsoil, while the bottom soil has the lowest temperature and humidity values. At 12 pm, the three sensors record the highest temperature values. Moreover, as the graphs show, when the temperature values are high, the humidity is low, which applies to all three sensors.

It can be said that due to the composition of peat soil, the bottom soil temperature is always cooler compared to the surrounding and topsoil values. However, as the bottom soil is able to trap heat, it heats up faster than the surrounding and topsoil values when monitored at night. In this work, as the experiment was conducted for only 7 days, the primary factor of heat, which depends on the weather on that day, can be predicted. It can be observed that during the rainy season in December, sometimes it only rains for a while, but the temperature and humidity readings change from the sensors at the three locations. Figure 5 illustrates the data in line graph. The data is divided into temperature and humidity for 7 days.

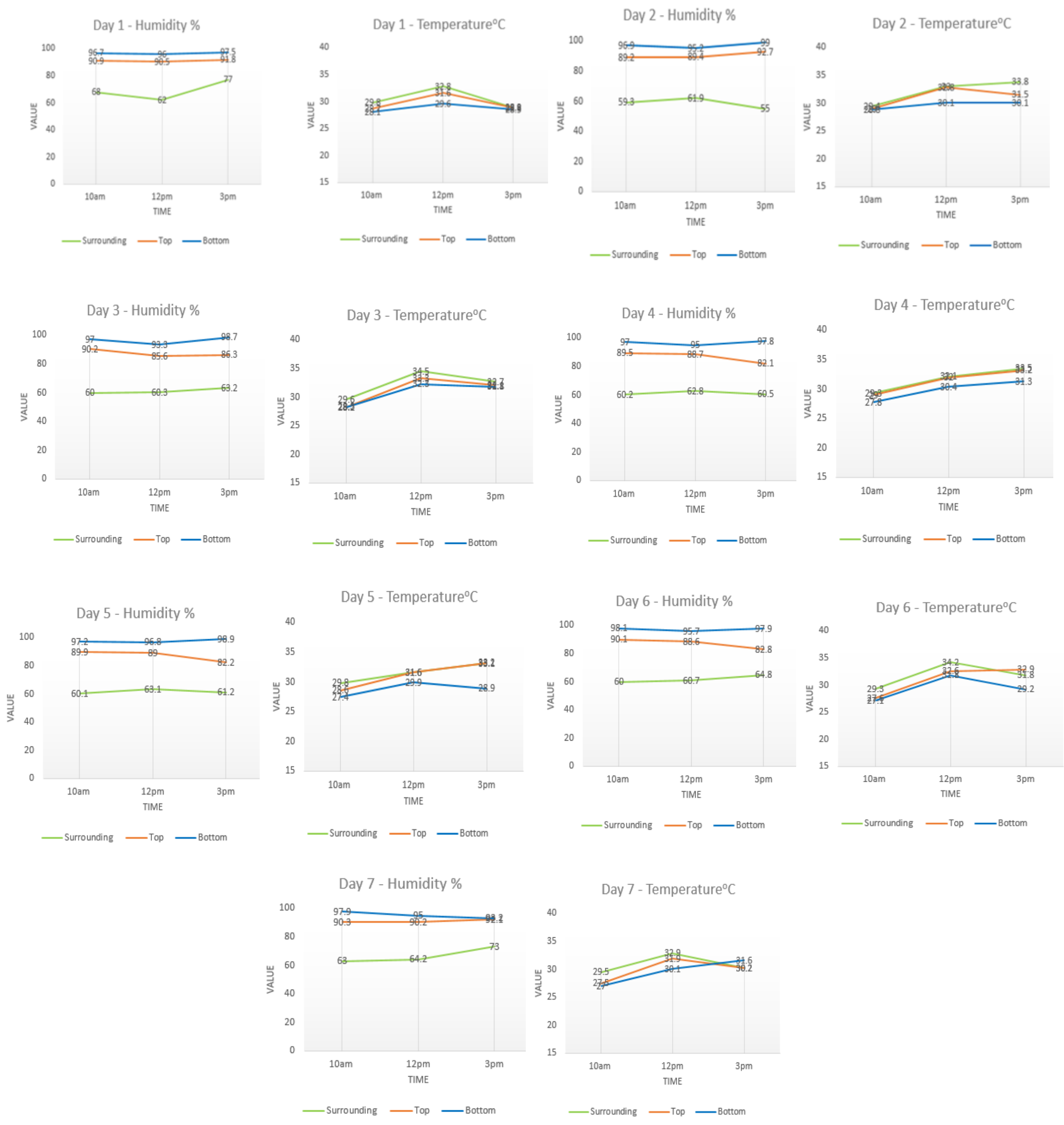

Figure 5: Line graph of the temperature and humidity value for 7 days

4. Conclusion

The proposed IoT-based system for real-time monitoring of peat soil has been successfully created and analyzed. The sensors can detect the parameters from the surrounding soil, top soil, and bottom soil values, and then transmit the data via the ESP32 module. Overall, this work required suitable hardware for monitoring soil conditions, followed by the installation process of the ESP32 with appropriate code using Arduino IDE, and the installation process of the temperature and humidity sensor and OLED display. Based on the collected data, the results for the three locations were illustrated through line graphs. It can be concluded that peat soil has unique properties that allow it to absorb and maintain heat for a period of time. Tropical peat soil on the surface is more prone to high temperatures, resulting in a higher degree of decomposition/humification [4]. Therefore, this peat soil monitoring system is necessary to prevent fires and reduce potential losses to the community in that area.

Acknowledgement

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References

[1] Jabatan Alam Sekitar, Kementerian Tenaga, Sains, Tecknologi, Alam Sekitar & Perubahan Iklim, “Program Mencegah Kebakaran Tanah Gambut untuk Mengatasi Masalah Jerebu di Malaysia”, (MESTECC) (2019)

[2] Silvia Liberata Ullo and G R Sinha , “Advances in Smart Environment monitoring Systems Using IoT and Sensors” May 2020, 20(11):3113, doi:10.3390/s20113113

[3] Evizal Abdul Kadir, Sharul Kamal Abdul Rahim, Sri Listia Rosa, “Multi-Sensor System for Land and Forest Fire Detection Application in Peatland Area,” Indonesian Journal of Electrical Engineering and Informatics (IJEEI), vol. 7, no.4, 2019, doi: 10.5249/ijeei.v7i4.1604

[4] Azlan Shah Nerwan Shah, Khairul Azlan Mustapha and Roslan Hashim,”Characterization and Impact of Peat Fires on Stabilization of Tropical Lowland Peats in Banting, Selangor, Malaysia,” Sains Malaysiana 49(3)(2020): 471-481, http://dx.doi.org/10.17576/jsm-2020-4903-02