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Modeling of Water Temperature in Evaporation Pot with 7 Ds18b20 Sensors based on Atmega328 Microcontroller

Pillar Satya Mahardika
Udayana University, Denpasar, Indonesia

A. A. Ngurah Gunawan
Udayana University, Denpasar, Indonesia

***Abstract*---**Making a model of the air temperature in the pan to see the difference with 7 DS18B20 sensors based on the Atmega328 microcontroller aimed at the temperature between air temperature, air surface temperature, and airbase temperature. Indonesia has a very wide ocean area and the natural resources in its sea area are not maximized. The use of a pan is a prototype of the breadth and depth of the ocean. making this model can also predict the location of fish and the growth of coral reefs. This temperature modeling is carried out in the evaporation pan with 7 sensors with 2 sensors in the air, 2 sensors on the surface of the water, and 3 sensors at the bottom of the evaporation pan to look for changes in temperature on the sensor and compare it with a mercury thermometer and then see the level of stability of the data. from the obtained graph. The DS18B20 sensor, which has an accuracy of ±0.5℃, will be more stable than the mercury thermometer owned by the Geofusuka Station Class II Sanglah Denpasar.

***Keywords*---**DS18B20 sensor, ocean temperature prototype, sensor net, sensor stability, temperature modeling.

Introduction

With the DS18B20 sensor that can be installed many at once, we can measure the temperature of an object at a certain distance. With this sensor, the microcontroller can read the data of each sensor that is installed clearly because this sensor is supported by a 1-wire with each sensor having its code. This sensor can be made resistant to extreme weather, in water, or on the ground. The DS18B20 sensor is a digital sensor that has an internal 12-bit ADC. The reading of this sensor data is very precise because it can detect the smallest change of

***Corresponding author**: Mahardika, P. S.; Email: pillarsatyamahardika@gmail.com*
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5/(212-1) = 0.0012 V/°C. In a temperature range of -10 to +85, this sensor has an accuracy of +/-0.5 degrees. This sensor works using a 1-wire (one-wire) communication protocol.

Arduino is an open-source single-board microcontroller, derived from the Wiring platform, designed to facilitate the use of electronics in various fields. The hardware has an Atmel AVR processor and the software has its programming language. Arduino uses the ATMega microcontroller released by Atmel as a base, but some individuals/companies make Arduino clones using other microcontrollers and remain compatible with Arduino at the hardware level. For flexibility, programs are loaded via the bootloader although there is an option to bypass the bootloader and use the downloader to program the microcontroller directly through the ISP port (Anita et al., 2018; Rinartha et al., 2018).

Research Method

Temperature

Temperature is a quantity that states the degree of hotness of an object and the tool used to measure temperature is a thermometer. In everyday life, people tend to use the sense of touch to measure temperature. But with the development of technology, a thermometer was created to measure temperature validly. In the 17th century, 30 types of scales confused scientists. This inspired Anders Celsius so that in 1742 he introduced the scale used as a guide for measuring temperature. This scale is named after his name, namely the Celsius scale. If the object is cooled continuously, the temperature will be cooler and the particles will stop moving, this condition is called absolute zero condition. The Celsius scale could not answer this problem, so Lord Kelvin offered a new scale called the Kelvin. The Kelvin scale starts at 273 K when water freezes and 373 K when water boils. So absolute zero equals 0 K or -273°C. In addition to these scales, there are also Reamur and Fahrenheit scales. For the Reamur scale water freezes at 0°R and boils at 80°R, while on the Fahrenheit scale water opens at 32°F and boils at 212°F (Quinn, 1990).

Thermometer

The manufacture of thermometers was first pioneered by Galileo Galilei in 1595. The tool is called a thermoscope in the form of an empty flask equipped with a long pipe with an open end. At first, it is heated so that the air in the flask expands. The open end of the pipe is then immersed in the colored liquid (Han et al., 2021; White, 1995; Lestari, 2021). When the air in the taboo shrinks, the liquid enters the tube but does not reach the flask. This is how a thermoscope works. For different temperatures, the height of the liquid column in the pipe is also different. The height of this column is used to determine the temperature. The working principle of Galileo's thermometer is based on changes in the volume of gas in the flask. But nowadays the thermometers that are often used are made of liquid materials such as mercury and alcohol. The principle used is the expansion of liquids when there is an increase in the temperature of the object. There are various types of thermometers (Sherry, 2011).

DS18B20

The DS18B20 sensor is a digital sensor that has an internal 12-bit ADC. The reading of this sensor data is very precise because it can sense the smallest changes of 5/(212-1) = 0.0012 Volts/°C. In a temperature range of -10 to +85 degrees Celsius, this sensor has an accuracy of +/-0.5 degrees. This sensor works using a 1-wire (one-wire) communication protocol (Benedict, 1991).

This sensor can be installed in parallel using only 1 data cable (one wire) and of course, using the “oneWire.h” library. So that in 1 control more than 1 sensor can be used in order to reduce the level of error reading by comparing the differences between the sensors and taking the average. Sensor specifications obtained from the datasheet:

- Interface to the microcontroller only uses 1 wire
- Working voltage in the range of 3.0 to 5.5Vdc
- The measurement range starts from -55°C to 125°C while if it is converted to Fahrenheit it starts from the range of 67°F to 257°F
- Measurement accuracy is ±0.5°C with measurement conditions ranging from -10°C to 85°C
- Zero standby power required
- Can be applied to industrial systems, to be a thermometer, to any sensitive thermal system

Figure 1. DS18B20 temperature sensor

Arduino

Arduino is an open-source single-board microcontroller, derived from the Wiring platform, designed to facilitate the use of electronics in various fields. The hardware has an Atmel AVR processor and the software has its own programming language (Suarsana et al., 2018). Arduino uses the ATMega microcontroller family released by Atmel as a base, but some individuals/companies make Arduino clones using other microcontrollers and remain compatible with Arduino at the hardware level. For flexibility, programs are loaded through the bootloader although there is an option to bypass the bootloader and use the downloader to program the microcontroller directly through the ISP port (Mirayanti et al., 2018).

Currently, the development team is Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, David Mellis, and Nicholas Zambetti. They strive for 4 things in this Arduino, namely:

- Affordable price
- Can be run on various operating systems, Windows, Linux, Max, and so on.
- Simple, with a programming language that is easy for laypeople to learn, not just for technical people.
- Open Source, hardware, and software.

Liquid Crystal Display (LCD)

LCD is a type of display media that uses liquid crystals as the main display. LCDs have been used in various fields, such as electronic devices such as televisions, calculators, or computer screens. In this post, the LCD application used is a dot-matrix LCD with a character count of 2 x 16. The LCD functions as a viewer which will later be used to display the working status of the tool. The features presented in this LCD are (Firdausi, 2018):

- Consists of 16 characters and 2 lines.
- Has 192 stored characters.
- There is a programmable character generator.
- Addressable with 4-bit and 8-bit modes.
- Equipped with backlight

Figure 2. LCD

The research location and the set of tools are located at BMKG Sanglah, Tarakan Island, Denpasar, Bali. At BMKG, this sanglah has an evaporation pan that can be used as material for research. Because the evaporation pan is placed in an open area, the temperature of the water in the evaporation pan will change more quickly. Time for research and manufacture of tools starts on July 20 to August 30, 2017.

Research block diagram

The block diagram for the design of the tool. An underwater temperature modeling system with 7 ds18B20 sensors based on the Atmega328 microcontroller is shown in Figure 3.

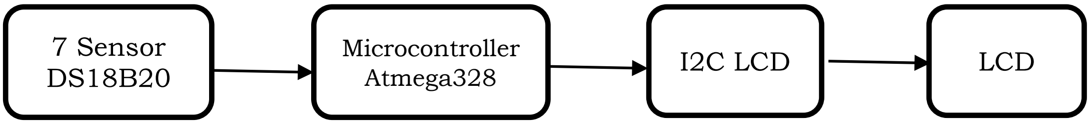

Figure 3. Tool design block diagram

The signal response flow shown in Figure 3 starts from 7 DS18B20 sensors which convert the input signal in the form of temperature into an analog signal in the form of voltage. With the 1-wire in the DS18B20 sensor, the Arduino Uno microcontroller can distinguish the data sent from each DS18B20 sensor. The Arduino Uno microcontroller which already contains an Analog-Digital Converter (ADC) converts analog signals into digital data. The digital data obtained is then processed by the Arduino Uno microcontroller and forwarded to the I2C LCD module. The LCD I2C module sends data to the LCD which will display the temperature data. The data displayed on the LCD shows the measured temperature results (Hsu, 2003; Fernandes et al., 2021; Jackman, 2020).

Placement of the sensor in the evaporation pot

The placement of the sensor is carried out in an evaporation pan which is placed in an open area belonging to the BMKG. 2 sensors are placed in the open air above the evaporation pan, 2 sensors are placed floating in the evaporation pan and 3 sensors are placed at the bottom of the evaporation pan as shown in Figure 4. The placement of the sensor as shown in Figure 4. can see a very significant temperature difference. During the morning until noon, the sensor that is placed in the air rises faster than the sensor that floats and is at the bottom of the water. During the day until the afternoon, the temperature obtained by the sensor placed in the air decreases faster than the temperature sensor that floats and is on the bottom of the water. In the afternoon the temperature sensor at the bottom of the water is hotter than the sensor in the air and the sensor that floats (Tucker, 1993; Qing et al., 2006; Omer, 2015).

In placing the sensor as shown in Figure 4, it can also be seen clearly that the presence of heat capacity is evident from the difference in air temperature which causes the water temperature to rise. when the air temperature drops, the water temperature will retain its heat longer and slowly the water temperature will decrease.

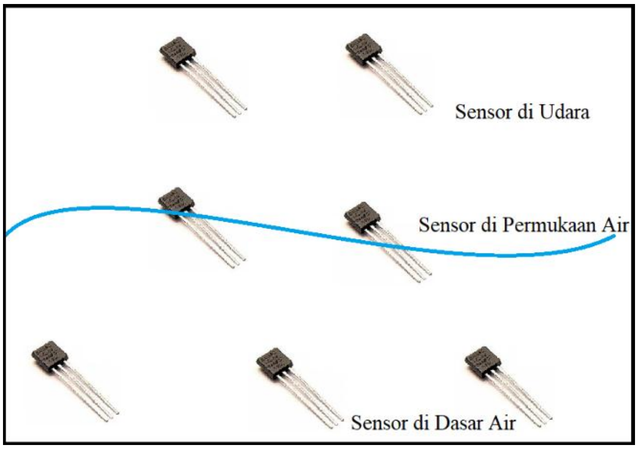

Figure 4. Placement of the sensor in the evaporation pan

Results and Discussion

This study used data collection methods. The data used is rainfall data on the radar in the West Denpasar area in 2018, in the form of data on the time of the incident and the duration of the event (weather). Some of the software used is Telegram which is to get weather early warning data which is disseminated by the MKG Regional III Denpasar Center, then the Microsoft Excel application is used to manage radar and GSMaP data to be matched to get accuracy results from the data according to which the unit is clearly stated. used in each quantity, either SI or CGS units. The following is a research flow chart including the following:

The modeling system uses a DS18B20 sensor with a model made to measure temperature with water in the evaporation pan at BMKG Sanglah. The sensors are placed 2 directly above the surface of the water, 2 floating on the water, and 3 at the bottom of the evaporation pan. The data received by this sensor is compared with a floating thermometer and a water thermometer very close to the same. The author conducted data collection for 7 days from 07.00 to 18.00.

Not only using the DS18B20 sensor, but the author also uses an Arduino microcontroller from the ATmel manufacturer. This Arduino microcontroller is very small and simple in its form compared to homemade microcontrollers. For this Arduino microcontroller, it uses Atmega328. Arduino also has its own programming language which is very easy to understand. Arduino has many microcontroller models, one of which the author uses is Arduino UNO (Atmega328). With the DS18B20 sensor, Arduino can read the code from each sensor with the help of a program that has been created and entered. The presence of an LCD that is installed makes it very easy to see the temperature that has been read by the Arduino from the DS18B20 sensor. The data displayed on the LCD is the temperature of each sensor that has been installed from sensor 1 to sensor 7 (Thu et al., 2013; Abbasi & Younis, 2007).

From the data received, the temperature difference that the writer got from the sensor and mercury stated that the deeper the water, the longer the temperature from the outside will be stored. It will be more visible difference in temperature per depth if this tool is used in the sea or used in the ground. The author hopes that this tool can be developed again so that it can measure soil and water with a certain depth that can measure the temperature of each meter. So it is easier and more efficient in its development.

Table 1
Observation data with 7 sensors DS18b20 (℃)

DAY	**DATE**	**HOURS**	TOOL WITH 7 (SEVEN) SENSORS						
			OUTSIDE OF THE WATER		FLOATING ON WATER		AT THE BASE OF THE WATER		
			SENSOR 1	*SENSOR 2*	*SENSOR 3*	*SENSOR 4*	*SENSOR 5*	*SENSOR 6*	*SENSOR 7*
WEDNESDAY	16/08/2017	07:00	23,69	23,69	21,75	21,87	21,81	21,94	21,75
		08:00	25,56	25,62	22,06	22,25	22	22,19	21,94
		09:00	27,75	27,75	23,62	23,94	23,19	23,37	23,12
		10:00	28,81	28,62	26	26,19	25,69	25,75	25,5
		11:00	30,31	30	29,56	29,25	28,62	28,75	28,56
		12:00	31,44	30,88	31,31	31,31	31,5	31,75	31,44
		13:00	32,94	33	34	34,06	34,13	34,44	34,13
		14:00	33,5	33,5	36	35,75	35,13	35,5	35,13
		15:00	34,5	34,63	35,31	35,31	35,5	35,88	35,44
		16:00	32	31,62	34,19	33,94	34,19	34,25	34,13
		17:00	28,81	28,75	31	31,23	32,2	31,92	32,15
		18:00	27,06	26,94	30	29,87	29,87	30,01	29,81
THURSDAY	17/08/2017	07:00	21,94	21,81	21,25	21,25	21,31	21,44	21,25
		08:00	24,57	24,12	21,56	21,84	21,5	21,5	21,37
		09:00	27,19	27,25	23,75	23,51	22,37	22,31	22,19
		10:00	28,37	28,14	25,64	25,81	24,94	24,94	24,81
		11:00	30,27	30,31	27,87	28,3	27,81	27,87	27,64
		12:00	32,31	32,31	30,12	30,19	30,25	30,44	30,31
		13:00	33,34	33,37	32,63	32,94	32,63	33	32,68
		14:00	33,58	33,56	34,5	34,48	34,5	35	34,81
		15:00	33,75	33,44	34,69	34,56	35	35,19	35
		16:00	31,31	30,94	33,81	33,88	33,94	34,16	33,8
		17:00	27,81	27,75	31,75	31,81	31,63	31,87	31,62
		18:00	27,06	26,94	30	29,87	29,87	30,01	29,81

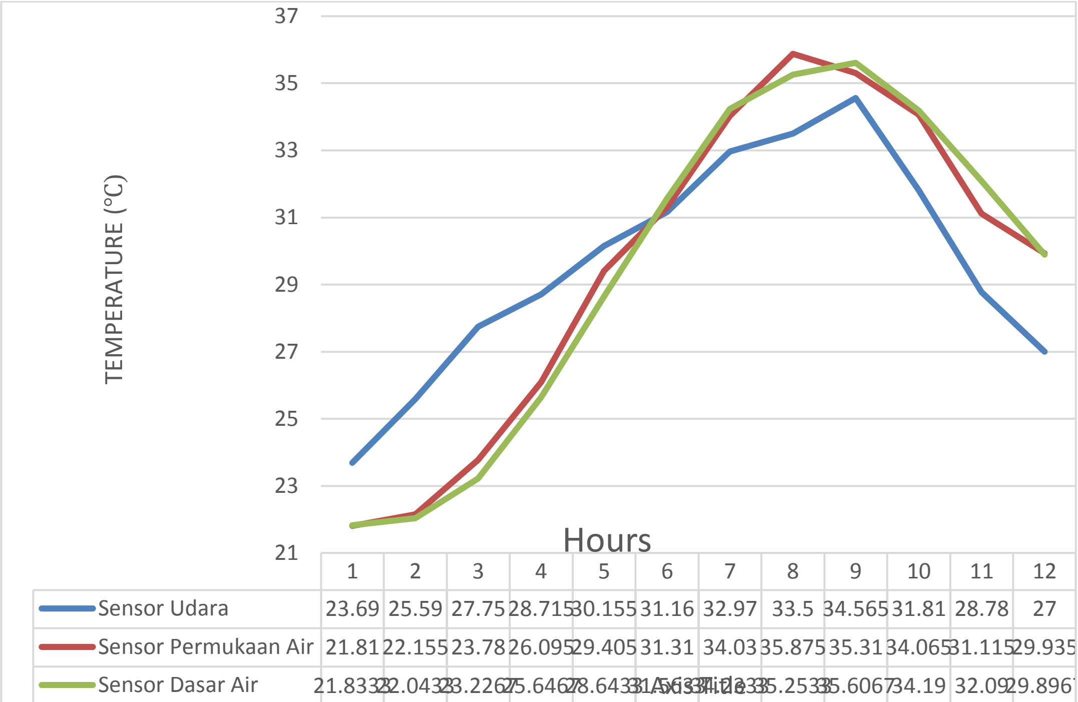

Figure 5. Censorship Wednesday graph

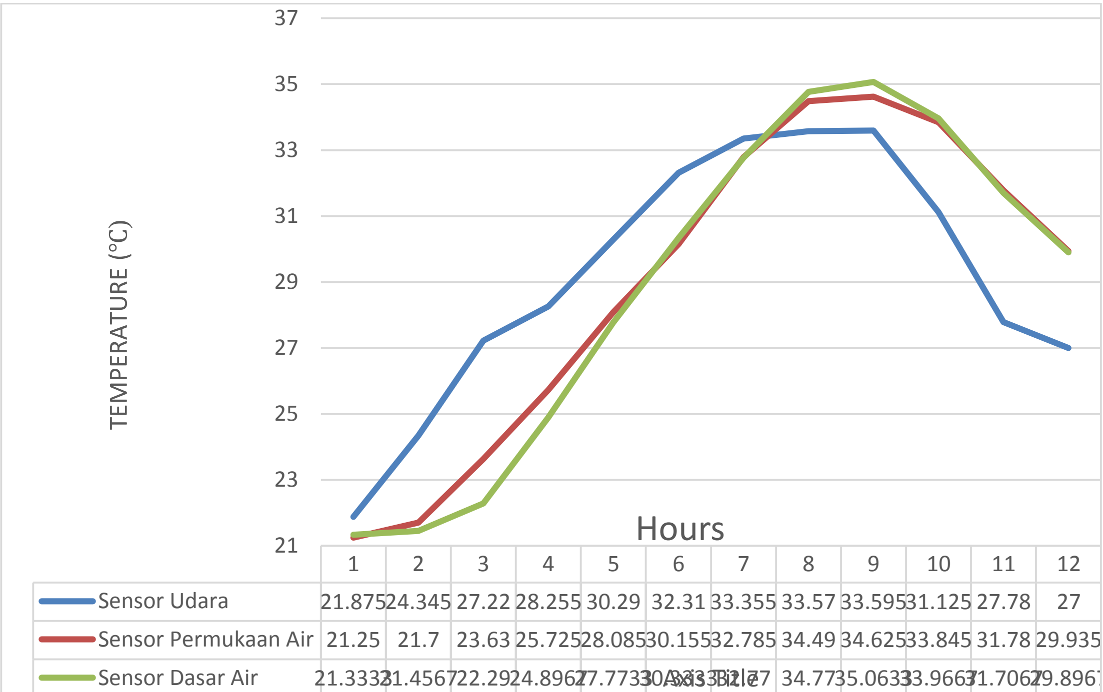

Figure 6. Censorship Thursday graph

Conclusion

The conclusions are as follows:

- The modeling obtained from the 7 DS18B20 sensors to see the temperature difference obtained is by placing 2 sensors in the air, 2 sensors on the surface of the water, and 3 sensors placed on the bottom of the water, you will see the difference in temperature due to the heat capacity of the water (Sahoo et al., 2009; LeBlanc et al., 1997).
- From the data and graphs that have been obtained, it proves that the data graph using the sensor is more stable than the mercury thermometer, although it is not much different, the mercury thermometer graph is sharper than the data taken by the sensor because the data read by the sensor is two digits behind the comma.

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