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Accuracy of DHT11 Temperature and Humidity Sensor in Egg Incubator

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ABSTRACT

Temperature and humidity are two parameters that need to be considered in hatching eggs. The research results showed that the difference in egg temperature in the incubator gave a significant difference in fertility, mortality, and hatchability. One of the most widely used temperature and humidity sensors is the DHT11 sensor. The objective of this research is to determine the accuracy of the DHT11 sensor in measuring temperature and humidity. This study uses the UT333 sensor as a reference for measuring temperature and humidity. The temperature measurement test is done with the DHT11 and UT333 sensors measuring the temperature at the same place and time, and then the difference is calculated as an error value. Humidity testing is done by the DHT11 and UT333 sensors measuring humidity at the same time and place and using a humidifier to provide variations in humidity levels. The difference in humidity between DHT11 and UT333 was then calculated as an error. Each temperature and humidity test was repeated 25 times. Based on all the tests, it was found that the DHT11 sensor has an average error value of 3.16% or an accuracy of 96.84% for temperature measurements and an average error of 7.07% or an accuracy of 92.93% for humidity measurements. The average success value for temperature and humidity testing is 94.89%.

1. Introduction

Temperature and humidity are two parameters that are widely used in research. Usually, temperature and humidity parameters are used in research related to smart home, smart farming, animal husbandry, weather-related research and so on. During the pandemic, temperature is also used as one of the initial screenings for COVID-19 [1].

In the field of animal husbandry, temperature, and humidity can be used as parameters for hatching eggs, considering that temperature and humidity are two parameters that really need to be considered in hatching eggs [2]. The research results showed that the difference in egg temperature in the incubator gave a significant difference in fertility, mortality, and hatchability [3].

Based on these facts, the researcher considers it important to know the accuracy of the temperature and humidity sensors that will be used in the egg incubator. The egg incubator is planned to have several features such as automatic temperature and humidity range control, remote and monitoring features based on IoT (Internet of Things), also temperature and humidity data storage. However, in this article, the research only focuses on measuring the accuracy of the DHT11 temperature and humidity sensor.

The temperature and humidity sensor used in this research is DHT-11. Measurement of DHT-11 accuracy is done by comparing the results of temperature and humidity measurements of DHT-11 with

UT333 sensors that are used as references. Each temperature and humidity measurement test is repeated 25 times.

Temperature and humidity parameters are used in many research fields, such as smart home or special spaces, smart farming, animal husbandry, weather-related research, and so on. During the pandemic, temperature is also used as an initial screening parameter for COVID-19 [1].

One of the uses of DHT-11 for smart homes or other special rooms is for door security and early detection of fires. The system uses a limit switch to detect if someone opens the door, the MQ-2 sensor to detect a gas leak, the DHT-11 sensor to detect a significant increase in temperature which is an indication of a fire, and the use of the VC0706 camera as a visual observation tool. The system is proven to be able to send security notifications well [4]. Another function of the DHT-11 sensor is to monitor the data center room temperature [5].

DHT-11 sensors are also widely used in smart farming, for example for the automatic watering of plants in greenhouses [6]. DHT11 sensor for monitoring chili plants with the Fuzzy Logic method for data processing [7]. The use of the DHT-11 sensor on tomato watering system with parameters of soil moisture, air, and environmental temperature using the Fuzzy Logic method [8]. DHT-11 sensor for measuring temperature, which is combined with soil pH and soil moisture parameters in an automatic tomato plant treatment system [9].

In the livestock sector, DHT-11 is commonly used in egg incubators. For example, the use of the DHT-11 sensor in the egg incubator temperature control and monitoring system with the ESP8266 microcontroller [10]. Use of DHT-11 sensor with Arduino Uno R3 microcontroller for egg incubator [11], [12], [13]. Another research combined DHT11 (temperature and humidity) with lighting settings in egg incubation systems [14].

2. Method

The incubator in this research consisted of DHT-11 sensor, NodeMCU microcontroller, actuator, and Telegram BOT. DHT-11 sensor is used to measure temperature and humidity. Then the temperature and humidity data will be checked by the NodeMCU. If the temperature and humidity values are appropriate then the system does nothing, on the contrary, if the temperature and humidity are not appropriate then the system will activate the actuator to normalize the temperature and humidity. Then the status, temperature, and humidity data is displayed on the LCD and sent to the Telegram BOT at the same time.

However, this study only focuses on measuring the accuracy of the DHT-11 sensor. The purpose of measuring the accuracy of the DHT-11 sensor is to see if DHT-11 is good enough to be used in detecting temperature and humidity in the incubator.

The temperature measurement test is done by observing the DHT-11 sensor data and comparing it with the UT333 sensor as a reference for the same time and place of temperature measurement. Then the temperature data of the DHT-11 sensor and the UT333 sensor were compared. The test was repeated 25 times.

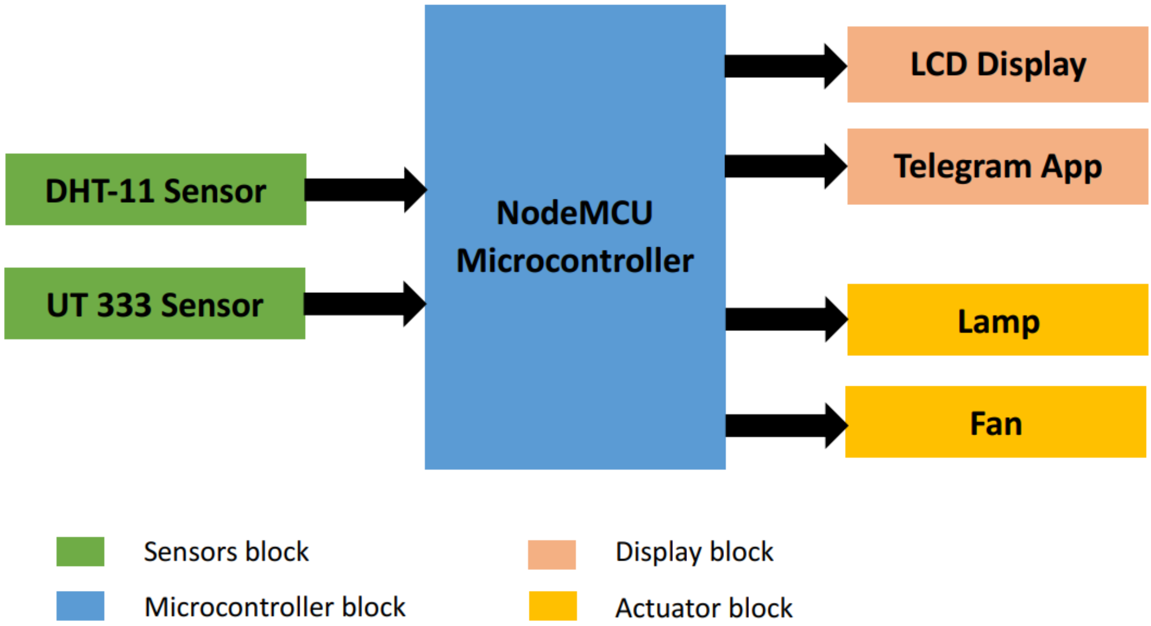

Figure 1. Block diagram system

While the humidity measurement test is done by turning on the humidifier, then the DHT-11 sensor and UT333 sensor measure humidity at the same time and place. Then the humidity data of the DHT-11 sensor and the UT333 sensor were compared. The test was repeated 25 times.

The error value of the DHT-11 temperature and humidity data is measured by comparing it with the UT333 temperature and humidity sensor data which is used as a reference. The following is a formula for calculating temperature and humidity data errors on the DHT11:

$$Error = \frac{|a-b|}{b} \; x \; 100\% \qquad (1)$$

With :
a = DHT-11 sensor data
b = UT333 sensor data

3. Result and Discussion

We did two kinds of testing in this research, these are temperature testing and humidity testing. Temperature testing is done utilizing DHT-11 and UT333 to measure the temperature of the incubator at the same time. Then the temperature data from SHT11 and UT333 as a reference are compared to determine the error value. The test is repeated 25 times.

Table 1. Result of temperature testing

Testing	Temperature (*C)		Error (%)
	DHT-11	UT333	
1	27.6	29.4	6.12
2	30.2	28.9	4.50
3	28.5	29	1.72
4	28.1	29	3.10
5	28.1	29.3	4.10
6	28	29.6	5.41
7	29.3	30	2.33
8	29.3	29.8	1.68
9	31.3	31	0.97

10	31.3	31.3	0.00
11	32.1	31.7	1.26
12	31.8	31.8	0.00
13	32.3	31.5	2.54
14	32.3	31.6	2.22
15	31.3	31.5	0.63
16	30.8	30.5	0.98
17	35.2	31.8	10.69
18	33.3	32.4	2.78
19	33.3	32.3	3.10
20	33.8	31.7	6.62
21	33.3	32.5	2.46
22	32.8	32.3	1.55
23	33.3	31	7.42
24	32.4	30.3	6.93
25	31.3	31.3	0.00
Average Error			3.16

The results of the temperature measurement test using the DHT-11 sensor are shown in Table 1. In Table 1 of the temperature test, UT333 sensor data is used as a reference value. Table 1 shows that the error percentage value varies from the smallest, namely 0% in the 10th, 12th, and 25th tests to the largest reaching 10.69% in the 17th test. Overall from 25 tests, the average error is 3.16%, in other words, the accuracy reaches 96.84%.

Humidity testing was done by DHT-11 and UT333 used to measure the humidity of the incubator at the same time, with the incubator installed with a humidifier to provide humidity variations. Then we calculated the error value of DHT-11data with the UT333 data as a reference. The test was repeated 25 times.

Table 2. Result of humidity testing

Testing	Humidity		%Error
	DHT-11	UT333	
1	88	86	2.33
2	80	86	6.98
3	80	84.5	5.33
4	80	82.1	2.56
5	83	83.4	0.48
6	87	79.1	9.99
7	84	89.4	6.04
8	85	88.9	4.39
9	83	81.7	1.59
10	75	80.1	6.37
11	76	78.3	2.94
12	77	76.7	0.39
13	76	84.2	9.74
14	75	81.1	7.52
15	78	82.9	5.91
16	79	89.6	11.83
17	66	82.8	20.29
18	73	80.9	9.77
19	72	81.5	11.66
20	72	82.4	12.62
21	70	74.4	5.91
22	73	78.4	6.89
23	71	84	15.48
24	69	75.4	8.49
25	71	72	1.39
Average Error			7.07

The results of the humidity test for the DHT-11 sensor are shown in Table 2. In Table 2 of the humidity test, UT333 sensor data is used as a reference value. Table 2 shows that the error percentage value varies from the smallest, namely 0.48% on the 5th test to the largest reaching 20.29% on the 17th test. Overall from 25 tests, the average error is 7.07%, in other words, the accuracy reaches 93.93%.

For the whole test, both temperature and humidity, the percentage of average error is 5.11%, in other words, the accuracy reaches 94.89%.

4. Conclusion

Based on all the tests that have been done for the temperature and humidity parameters, several things can be concluded. First, the DHT-11 sensor works quite well in measuring temperature, it is proven when compared to the UT333 sensor the average error value is only 3.16%, in other words, the accuracy value is 96.94%. The DHT-11 sensor is also proven to be quite good at measuring humidity, as evidenced by its reading results when compared to the UT333 sensor, the average error is only 7.07%%, in other words, the accuracy value is 92.93%. This shows that the DHT-11 sensor is quite good for measuring temperature and humidity values with an average error value of only 5.11%, or the accuracy value is 94.89%.

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