Creative Thinking in The Development of DHT11 Plug-and-Play Temperature Sensor System

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Abstract – The emergence of IEEE 1451 is proof that plug-and-play can solve compatibility problems experienced by a variety of different sensors when accessing communication. The plug-and-play system makes it easy for users to innovate, add, remove or replace sensors. The convenience offered by the plug-and-play system requires researchers to be able to think creatively from the aspect of flexibility to implement plug-and-play which is integrated with the DHT11 temperature sensor so that the sensor can be directly connected to the interface. This study shows a plug-and-play process developed by a scanning process to find connected PORTs without having to do configuration, showing a comparison of the DHT11 error value with a comparator that reaches 0.628% in temperature values and 0.428% in humidity values. This study also shows 120 monitoring data of temperature and humidity values for one month obtained from the interface that has been made.

Keywords: Creative Thinking, Plug-and-play, DHT11.

I. INTRODUCTION

Communication is the most important part to establish relationships that are interrelated with one another. Communication does not only occur between humans and humans but is also experienced by computers. Computers can communicate with each other to exchange information. Computers use serial communication to communicate with other devices and are usually connected by USB (Universal Serial Bus). The new generation of ATMEL microcontrollers provides opportunities for users to be more capable of developing various kinds of communication systems to a higher and more complex level [1]. Communication protocols have been widely used by researchers to build systems that can connect one system to another at a lower cost, such as a smart city [2]. This new feature can support communication so that it can be implemented using a variety of IC (Integrated Circuit) that are already widely available in the market such as 1553B, RS-422, RS232, and so on [3]. Each type of IC used has a different configuration. The configuration process will cause problems when many devices are connected to become multi-channel [4].

Plug-and-play systems offer integration features from various sensors such as digital sensors and digital sensors that are directly connected to the processing unit, a communication unit, and an interface unit. The interface must know what parameters will be displayed. The plug-and-play system overcomes the problems involved in connection and configuration. Various articles that discuss the application of digital and analog sensors with plug-and-play systems are increasingly appearing because of the many benefits offered by these systems [5]. The emergence of IEEE 1451 is proof that plug-and-play can solve compatibility problems experienced by a variety of different sensors when accessing communication. The plug-and-play system makes it easy for users to innovate, add, remove or replace sensors [6] [7] [8].

The convenience offered by the plug-and-play system requires researchers to be able to think creatively. Creative thinking is a metacognitive process that involves a combination of individual knowledge and action evaluation to produce a creation [9]. According to Redifer, Creative thinking is the ability to generate useful new responses. Like other complex thinking processes, creative thinking draws on high-level cognitive resources [10]. Creative thinking involves a series of processes such as acquiring information and even skills, transforming knowledge into new forms, and verifying products against internal and external standards. Creative thinking consists of several aspects, one of which is flexibility [11] [12] [13]. The aspect of flexibility is the skill to change an approach to an existing problem [14]. According to Kenett, the flexibility of theorized thinking plays an important role in the ability of highly creative individuals to generate new and innovative ideas. [15]. Alex argues that the aspect of flexibility is important for human progress to understand the requirements of creativity [16]. From the explanation described above, it can be concluded that flexibility and innovation are needed to get as many solutions as possible in dealing with problems. connected to a computer without having to configure it first.

II. METHODS

The method used in this research is experimental research. This research begins with a literature study on plug-and-play systems and continues with a search for literature on creative thinking in terms of flexibility and innovation. The flexibility aspect is used in creating a plug-and-play system that is implemented with the DHT11 temperature sensor. Innovative aspects are used to provide innovation in developing a plug-and-play system so that it is directly connected to an interface that is made to display information on temperature and humidity values obtained from DHT11 without having to configure the PORT first. Tests in this study were divided into 4 parts, the first test was carried out on the DHT11 sensor which was compared with an analog thermometer and humidity meter. The second test was conducted to test the plug-and-play system without having to configure the PORT. The third test was carried out to measure the temperature value displayed by the interface that was created twice a day at 7 AM and 7 PM in one month. The fourth test is carried out to test the humidity value displayed by the interface that is made. The time for taking humidity data is the same as the time for taking data on temperature values. The location of research was carried out in the telematics laboratory at Surabaya State University building A8. So the total data obtained from the third and fourth tests are as many as 120 data consisting of 60 temperature values for a month and 60 humidity values for one month.

III. RESULT AND DISCUSSION

DHT11 is a sensor that is often used in monitoring temperature and humidity values. This sensor has a working voltage of 3 to 5 volts. DHT11 has a maximum current of 2.5 mA. It has 3 pins connected to VCC which is connected to 5 volts of Arduino Uno, a ground pin which is connected to the ground pin of Arduino Uno, and a data pin which is connected to pin 2 of Arduino Uno to provide temperature and humidity information to the microcontroller. To better understand the circuit used in this study, the authors made the DHT11 temperature and humidity sensor wiring with Arduino UNO which can be seen in Figure 1.

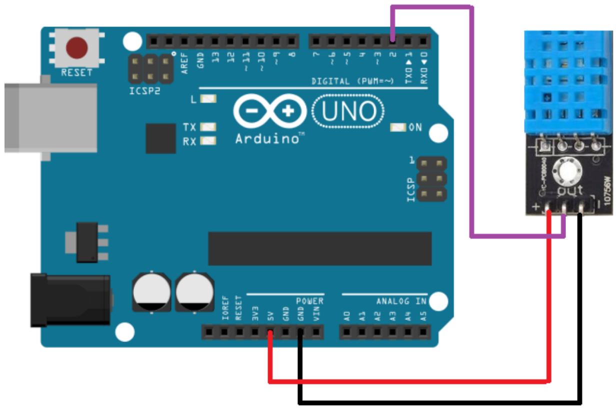

Figure 1. Wiring DHT11 with Arduino Uno

After doing the wiring, the next step is to make a program to integrate the sensors so that they work as expected. The program used to carry out the integration is the Arduino IDE program which can be seen in Figure 2.

Figure 2. Arduino IDE

The first test in this research focuses on comparing the temperature and humidity values in DHT11 with an analog thermometer and humidity meter. The physical form of the DHT11 comparator can be seen in Figure 3. The test was carried out 30 times for data collection which can be seen in Table 1.

Figure 3. The physical form of an Analog Thermometer and Humidity meter

Table 1. Comparison of DHT11 and Analog Sensors

No.	DHT11		Analog Thermometer and Humidity meter	
	Temperature	**Humidity**	**Temperature**	**Humidity**
1	26 °C	51 %	26 °C	50 %
2	27 °C	55 %	27 °C	55 %
3	26 °C	54 %	27 °C	54 %
4	25 °C	53 %	26 °C	54 %
5	26 °C	52 %	27 °C	53 %
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
29	38 °C	52 %	38 °C	52 %
30	32 °C	51 %	31 °C	51 %

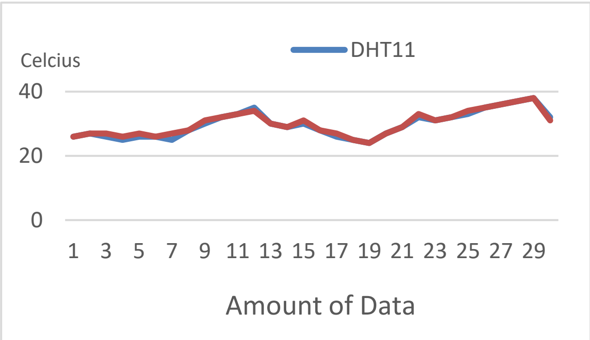

Figure 4. Graph of DHT11 temperature with an analog sensor

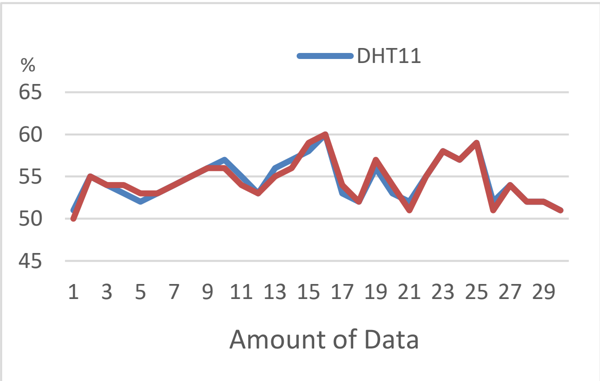

Figure 5. Graph of DHT11 humidity with an analog sensor

After obtaining comparative data, the next step is to find the error value of DHT11 with a comparison sensor. Finding the error value can use the formula in equation 1 and equation 2.

$$Absolute\ error = (Xmeasured - Xactually) \quad (1)$$

$$Percent\ of\ error = \frac{Absolute\ error}{Xsebenarnya} x\ 100\% \quad (2)$$

$$Mean\ of\ error = \frac{\sum Xi}{N} \quad (3)$$

Information:

Xmeasured = Value read by DHT11

Xactually = Value read by the comparison sensor

Xi = Represent data 1st, 2nd, 3rd, . . ., 30

N = Amount of data

Table 2. Error-values

No.	Temperature	Humidity
1	0 %	0.02 %
2	0 %	0 %
3	0.02 %	0 %
4	0.02 %	0.02 %
5	0.02 %	0.02 %
.	.	.
.	.	.
.	.	.
29	0 %	0 %
30	0.02 %	0 %
Mean of Error	0.628 %	0.428 %

From the total calculations that have been carried out and those that have been listed in Table 2, it is found that the total DHT11 error value for the analog sensor is 0.628% for the temperature value and 0.428% for the humidity value.

The second test was carried out to test a plug-and-play system that is capable of direct communication with the interface without any configuration. The plug-and-play system used in this study can be seen in Figure 6.

Figure 6. Plug-and-play system

The Plug-and-play system in this study starts from the DHT11 sensor which is connected to the Arduino Uno microcontroller. Arduino uno then utilizes serial communication to connect with a PC or laptop. The PORT detection process automatically starts by describing the PORT from address 0. The interface will continue to carry out the scanning process until the address is found. If address 0 cannot be connected, the program will counter with each iteration of the address number added to 1 so that no address is missed. If the detected address is following the scanning process, the counter will stop working and will not perform the PORT scanning process again. After the PORT has been connected, the interface will compare the ID data values sent by Arduino to prepare to receive data and display data on the interface. The data sent by Arduino to the interface consists of 4 data bits with the first-bit being ID, the second-bit being temperature, the third-bit being humidity, and the fourth bit being the end of sending which can be seen in Figure 7.

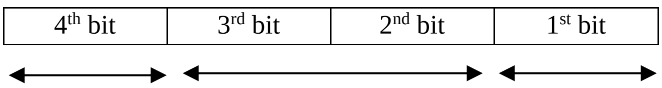

Figure 7. 4-bits data

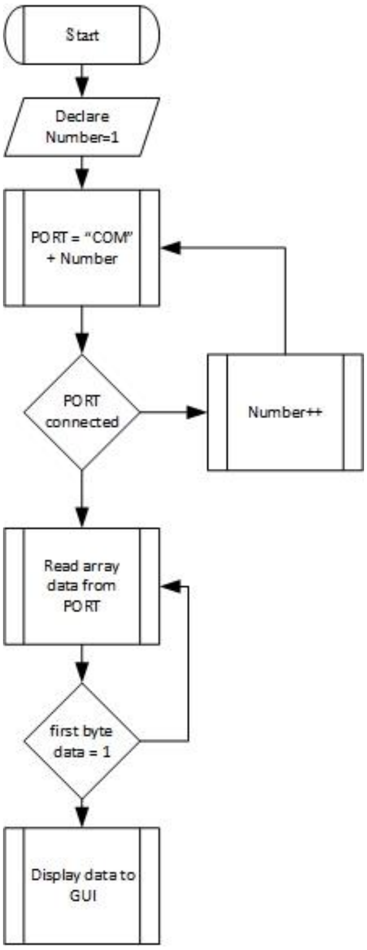

Figure 8. Flowchart graphical user interface

Figure 8 is a system flowchart in the interface that is used to perform PORT scanning automatically to support the Plug-and-play system, while Figure 9 is a system flowchart from Arduino uno and the DHT11 temperature sensor.

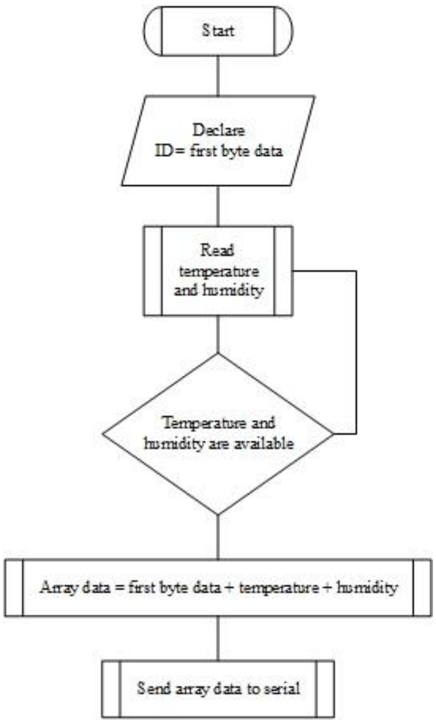

Figure 9. Arduino Uno system flowchart

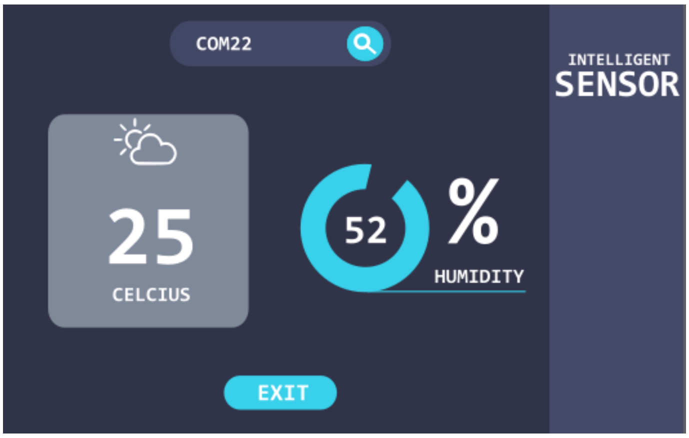

Figure 10. The graphical user interface is connected

Figure 10 is the display shown when the PORT has been found and connected to the GUI that has been created. The writing COM22 in the image shows that the detected PORT is COM22. The first time the software is opened, the program will immediately scan the PORT starting from COM1 to COM22. After a successful connection automatically, the software will retrieve the data sent from COM22. The data will be converted and the results will be displayed on the GUI that has been created. If the software is only opened without a connected PORT, the software cannot be used automatically and will force the user to close the software as shown in Figure 11.

Figure 11. Graphical user interface when no port is connected

There is no COM in the image above, this is because there is no PORT that the software can read, the COM information will be replaced by the words "Looking PORT" and the words "Unhandled exception has occurred in your application." . .". This pop-up will force the user to want or not to close the GUI. To be able to reconnect, the user must close the interface first, and connect the Arduino Uno to a PC or laptop, followed by reopening the interface that was created. This is done so that the first time Arduino is connected to the laptop, the interface immediately scans the PORT from COM 0 to the appropriate COM.

The third test begins by monitoring the DHT11 temperature value which is displayed through the interface that has been made. Monitoring was carried out for one month. Every day temperature and humidity data will be recorded every 7 AM and 7 PM so that

4 data are obtained in a day, namely 2 temperature data and 2 humidity data. The data obtained is then recorded and can be made into a graph in Table 3 and Figure 12.

Table 3. Temperature monitoring for 1 month

Test	Serial Monitor	GUI	Date	Time
1	26°C	26°C	15-11-2022	7 AM
2	27°C	27°C	15-11-2022	7 PM
3	27°C	27°C	16-11-2022	7 AM
4	27°C	27°C	16-11-2022	7 PM
5	26°C	26°C	17-11-2022	7 AM
.	.	.	.	.
.	.	.	.	.
29	25°C	25°C	15-12-2022	7 AM
30	27°C	27°C	15-12-2022	7 PM

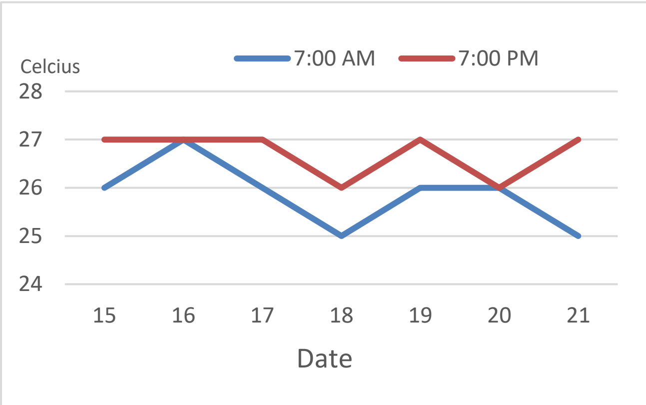

Figure 12. Temperature comparison for 1 month

Table 4. Humidity monitoring for 1 month

Test	Serial Monitor	GUI	Date	Time
1	65%	65%	15-11-2022	7 AM
2	66%	66%	15-11-2022	7 PM
3	68%	68%	16-11-2022	7 AM
4	67%	67%	16-11-2022	7 PM
5	67%	67%	17-11-2022	7 AM
.	.	.	.	.
.	.	.	.	.
29	68%	68%	15-12-2022	7 AM
30	66%	66%	15-12-2022	7 PM

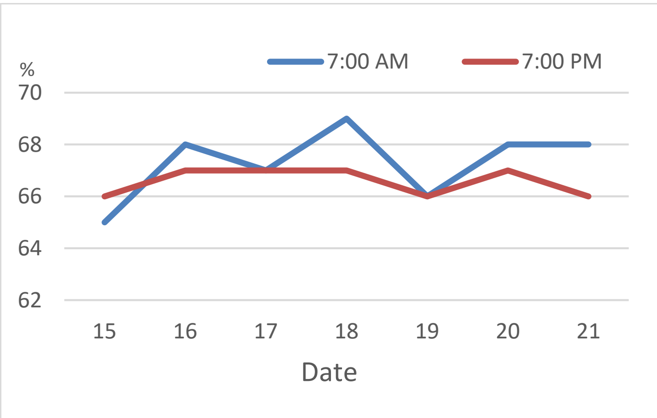

Figure 13. Humidity comparison for 1 month

IV. CONCLUSION

Creative thinking in terms of flexibility and innovation is important for every individual to apply previously acquired knowledge and experience so that they can produce various solutions to a problem that is being faced [17][18]. In this research, flexibility, and innovation succeeded in providing solutions and developing a plug-and-play system in the aspect of flexibility that supports the plug-and-play system to be a flexible feature and can be used on any computer because this feature already has an automatic PORT scanning system without the need for configuration. first on the DHT11 temperature and humidity sensor. Figure 10 shows that the communication process directly with the interface can be carried out directly without the need for configuration. This study also shows the results of processing DHT11 temperature and humidity values which have an error value of 0.628% on the temperature value and 0.428% on the humidity value. Not only that, but this study also provides temperature and humidity monitoring data from interfaces made for a full month in Table 3 and Table 4.

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