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Measurement of Temperature Distribution Stability Using a Data Logger with 9 Channels Based on the Type K Thermocouple Sensor

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ABSTRACT A temperature measurement in sterilization is needed to find out whether the temperature setting has been reached, because if the tool is operated continuously it will have an impact on the performance of the tool. Data logger is a tool used to record time and temperature by recording. The purpose of this research was to develop technological advances with remote or automated systems that can monitor changes in temperature rise and fall. Therefore, the contribution of this research is making the users easily monitor the temperature distribution using the Internet of Things. This study used 9 types of K-type thermocouple sensors as temperature gauges which were placed at 9 specified points. In this case, the thermocouple was connected to the MAX6675 module for conversion which initially detected the temperature into digital form data. Meanwhile, the data processing used the Arduino Mega 2560 system and the Arduino programming software processor. HC-05 was used as a data transmission of measured results that have been read where the results were displayed on Android using the Blynk application. In this case, the data sent were in the form of Excel. This tool used a temperature comparison from the MEMMERT UN 55 incubator in the microbiology laboratory. The error value of the 100°C temperature adjustment was 2.6% at a temperature of 1, while the smallest error was at temperatures 7 and 8 by 0.2% due to the far sensor location from the heater. Furthermore, the error value at the temperature of 150°C was 1.7%, where the smallest error was at temperature 5 by 0.3% and 0.5%. Meanwhile, the error value at the temperature of 200°C was 1.8%, where the smallest error was 0.5%. This research was expected to make it easier for users to simultaneously monitor temperature and simplify data processing to obtain the accuracy error value in the unit under test (UUT).

INDEX TERMS Data Logger, Thermocouple Type K, Max6675, Bluetooth, Blynk

I. INTRODUCTION

The dry heat sterilization technique using a tool similar to a cake oven is not taught in the normal delivery care training [1]. This is assumed because the device cannot provide a stable temperature or heat during the sterilization process, so it is feared that it will not provide optimal results [2][3][4]. However, there was no research evidence that explains the comparison of the effectiveness of the two methods in killing pathogenic germs. In this case, a sterilizer is a device used to sterilize medical devices to avoid bacteria adhering to the rest of the use of medical devices. The temperature of the sterilizer varies but generally is around 175°C for dry sterilizers it [5][6][7]. The temperature calibration tool works by using a thermocouple sensor that is inserted into the tool to be measured and the temperature results will be read [7][8][9]. A thermocouple is a type of temperature sensor used to detect or measure temperature through two types of metal conductors, the working principle of which is that each end of the metal conductor is combined to create a "thermoelectric" effect [10]. One type of metal contained in the thermocouple will function as a reference with a constant temperature (fixed), while the metal conductor functions as a metal conductor that detects hot temperatures. A dry sterilizer is a device used for the sterilization process or the process of killing viruses or bacteria on a material. The basic principle is heating of the dry element which is electrified so that it heats the sterilization chamber and reaches a certain temperature. The resulting temperature is further used for the sterilization process [2]. Temperature measurement on a dry sterilizer is needed to find out if the setting temperature has been reached, because if the tool is operated continuously it will have an impact on the performance of the tool. Measurements are usually carried out by recording time and temperature with a manual system, with technological advances the author developed an automatic system accompanied by recording (data logger) to find out every change in temperature increase and decrease [3].

In a previous experimental study conducted by Dwinta Mussetyarsih in 2015, data logger temperature meter was used in Autoclave. In this case, the tool only used one sensor and was only used for autoclave tools. This research was further continued by Rizky Bian Primaswara in 2016 entitled "Data logger Temperature Meter on Dry Sterilizers". This tool used two sensors and can be used on dry sterilizers. The temperature that can be measured was between 50°C – 170°C. In 2017, this tool was developed by Rifky Ridho Isnanto entitled "Data logger Temperature Meter in Autoclave". This tool used three sensors, where the temperature that can be measured was between 50°C – 135°C. Furthermore, another relevant research was carried out by Laskhanisa Varadila in 2020 entitled "Data Logger Temperature 9 Channels" using 9 temperature channels that can be measured between 50°C - 150°C.

Based on several previous studies above, same problems were found, which is the absence of a real time graphic display that can make the recording easier in a long period of time using a blynk [11][12][13] and data delivery that cannot be monitored remotely using a bluetooth HC05 [14][15]. In this case, the author has not found previous researchers who created a data logger using a graphical display in real time. Therefore, the contribution of this research was to make it easier for users to see the temperature distribution on the measuring instrument.

Based on the problems above, the author intended to make a tool entitled data logger with 9 channels on dry sterilizer which had 9 channels and there was measurement data transmission via bluetooth using the HC 05 module [16][17] which can appear on android via the blynk application in graphic [18] form and using sensors thermocouple type K as the temperature sensor and ATMEGA2560 as a data processor [19][20].

II. MATERIALS AND METHODS

This study provided 9 channels that recorded the temperature measurements using temperature sensors and MAX6675 [21][16]. As an analog to digital temperature data processor and using ATMega 2560 as the main circuit that will control all systems. Temperature data in units of degrees Celsius will be displayed on the blynk application over an HC 05 bluetooth connection. In this study, the module will be tested using a data logger comparison tool on dry sterilizer media [22].

A. DATA COLLECTION

In this study, researchers compared between the Data logger Temperature 9 Channel design module with a Dry Sterilizer (Electro-mag M6040P) and Data Logger (OM CP Oct Temp2000) which was used as a comparison with the module of the device created [23]. The study used IC ATMega 328, Fericlorit, HC–05 Bluetooth module, Thermocouple sensor, Thermometer, and MAX6675. The K-type thermocouple sensor was used as a temperature sensor. In this case, the thermocouple was connected to the MAX6675 module as a thermocouple signal conditioner [24][25]. The ATMega328 network was used as a data processor. Then, the temperature data results were displayed in the blynk app using bluetooth connection [16][26][27].

The data analysis technique in this study was to determine the accuracy of the type k thermocouple temperature sensor used in the data logger and send measurement results using bluetooth. In this case, the thermocouple measurement on the module (A) used a temperature setting of 100°C on a dry sterilizer medium with the same temperature measurement 3 times with a comparison tool (P) from the panel on the Sterilizer.

Data logger temperature of 9 channels showing on android module design can be seen in FIGURE 1. Meanwhile, the circuit minimum system are shown in FIGURE 2.

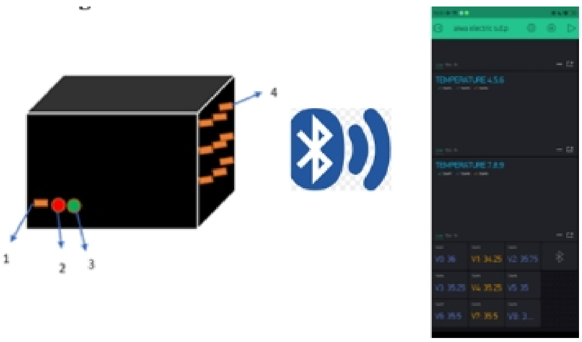

FIGURE 1. **Data Logger Temperature 9 Channels showing on Android Module Design**

FIGURE 2. **Circuit of Minimum System with 9 temperature sensor**

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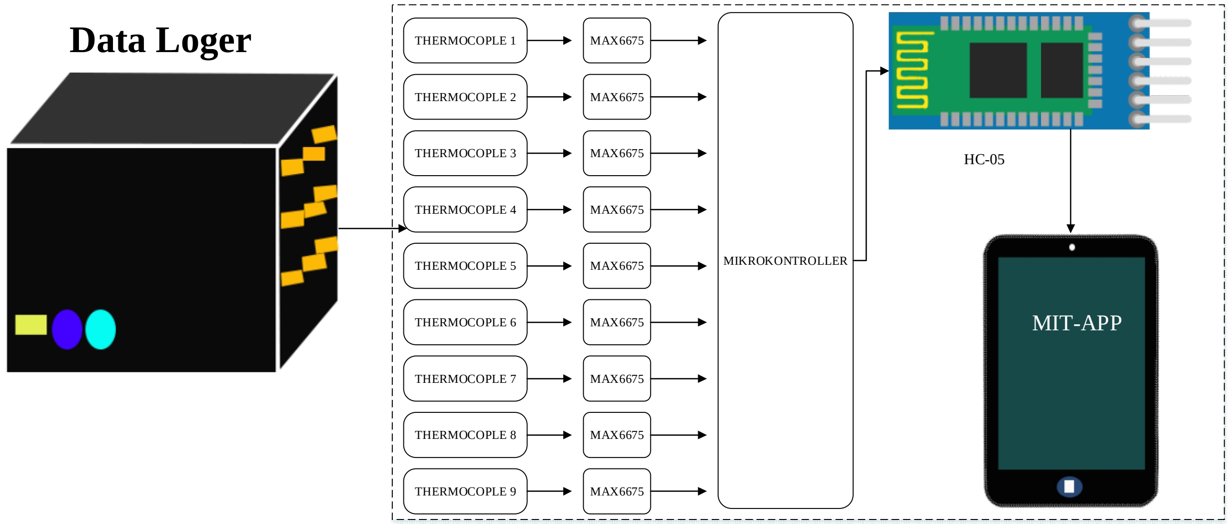


FIGURE 3. Data loger system block diagram, there are 9 thermocouple type temperature sensors as input on the MAX6675 then controlled using an ATmega 260 type microcontroller, the data is sent via bluetooth to be displayed on the android display

The component part of the tool consists of a minimal system consisting of ATmega328p as a processor of all systems on the tool module, max6675 circuit, HC05 module, Battery, and Charger Module. Max6675 was formed from a cold-junction compound whose output was digitization of the K-type thermocouple signal. The output data has a 12-bit resolution and supports microcontroller SPI communication in general. The data can be read by converting the result of a 12-bit reading of the data. The Bluetooth module (BT) used, in this case, is the HC-05. This Bluetooth module was used to transmit the results of the data that has been processed to the blynk application. For communication between the Arduino board and the Bluetooth module, two pins were required, namely Tx (transmitting sensor temperature data) and Rx (receiving information between the microcontroller and the blynk application).

FIGURE 3 shows a block diagram processing. When the power on / off is in the on position, the entire circuit obtained voltage from the battery. The sensor was then detect the temperature and enter the ATMega 2560 Microcontroller IC for processing the data. The read temperature data were then sent via the HC-05 Bluetooth module and displayed via Android.

Furthermore, FIGURE 4 presents a flow chart in processing. When program started, the input and output of the microcontroller were initialized through the HC-05. Sensor took temperature readings and temperature data were then recorded every 5 minutes and then the data were transferred via a bluetooth connection (HC- 05) to be displayed on android. It started with initialization for bluetooth connection (HC-05) on the device which was connected to android or not. The measured results were displayed on Android using the Blynk application which displays 9 measurement results.

B. DATA ANALYSIS

Researchers tested the accuracy of the loadcell sensor against

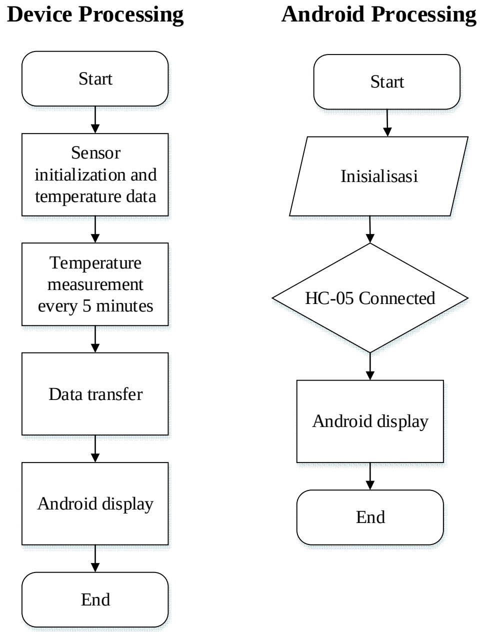


FIGURE 4. The Flowchart of the Temperature Data Logger 9 Channel design. There are two flowchart diagrams consisting of process devices and process androids

the standard by conducting tests 3 times on each measured value. Researchers used 10 values in the testing process. Based on these values, the average value, error value and also the standard deviation of each value that has been measured in this accuracy test were found. In this case, the average of the measurements can be obtained using the following equations (1):

$$X = \frac{X1+X2+\cdots+X}{n} \quad (1)$$

Where X indicates the average value for n-measurement, X1 indicates the first measurement, X2 shows the second measurement, and Xn indicates the n measurement. Then, the standard deviation (stdev) value indicates the degree of data group variation or standard size deviation from the average value that can be determined using equation (2):

$$s_i = \sqrt{\frac{\sum_{i=1}^{n}(X - X)^2}{n-1}} \quad (2)$$

Where xi indicates the amount of the desired values, x indicates the average of the measurement results, n shows the number of measurements. The % Error shows the error of the system. The lower value Error is the difference between the mean of each data. Error value is an error value that can be searched with equations (3):

$$E\ \% = \frac{D\ s_i\ -a}{D\ s_i}\ x\ 100\% \quad (3)$$

III. RESULT

TABLE 1 is a table of measurement results for a 9-channel thermocouple mounted on an Electro-mag M6040P with temperature settings of 100°C, 150°C, and 200°C on dry sterilizer media with the same temperature measurement 5 times with a comparison tool of OM CP Oct Temp2000 from the panel on the Sterilizer.

TABLE 1.
Testing the reliability of the 9 channel thermocouple T1, T2, T3, T4, T5, T6, T7, T8, and T9 at temperature settings of 100 °C, 150 °C, and 200 °C on a dry sterilizer.

	Channel	Mean Display Android (°C)	*Error %*
Measurement Result Temperature 100 °C	T1	103	3.7
	T2	102	1.5
	T3	100	0.0
	T4	101	0.7
	T5	102	2.2
	T6	103	3.0
	T7	104	3.7
	T8	104	4.4
	T9	102	1.5
Measurement Result Temperature 150 °C	T1	153	3.0
	T2	154	3.7
	T3	153	2.9
	T4	153	3.0
	T5	152	2.2
	T6	151	0.7
	T7	153	3.0
	T8	154	3.7
	T9	151	0.7
Measurement Result Temperature 200 °C	T1	201	0.7
	T2	202	1.5
	T3	204	3.7
	T4	200	0.0
	T5	202	1.5
	T6	204	3.7
	T7	202	1.5
	T8	202	1.5
	T9	201	0.7

Based on the TABLE 1, it is explained that at the temperature settings of 100°C, 150°C, and 200°C, the type K thermocouple used in this study read quite stable and the error value was still at the threshold value of 5% of the error value [28]. At 100°C, the highest error was 3.7% which was at T1, while the lowest error was 0% at T3. Furthermore, at 150°C, the highest error was at T2 and T8 at 3.7% and the lowest error was at T9, which was 1.5 %. Meanwhile, at the temperature setting of 200°C, the highest error was at T3 and T6 with an error value of 3.7% and the lowest error value at T4 was 0%. FIGURE 5 is a graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 100°C and FIGURE 6 is a graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 150°C.

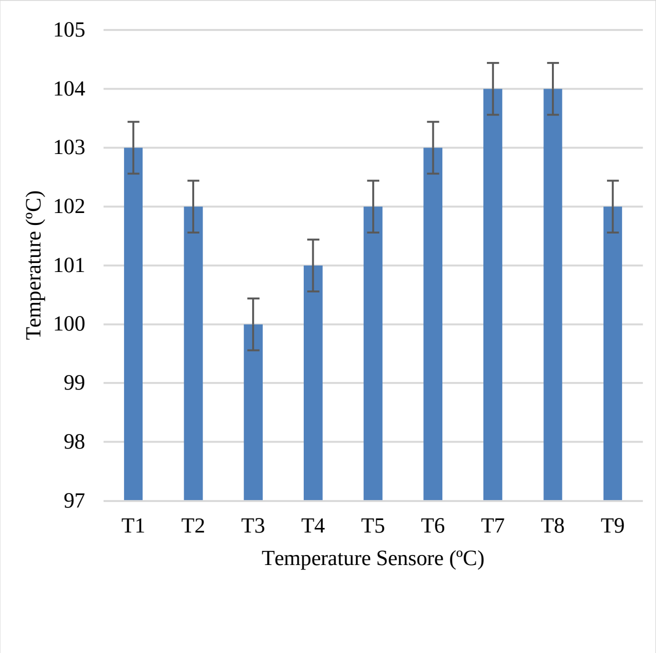


FIGURE 5. **Graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 100°C.**

From the FIGURE 5, it is explained that the highest temperature reading for a type K thermocouple with a temperature setting of 150 ^{0}C is at a temperature of 103 ^{0}C at the measuring point T1 with an error value of 3.7% and the lowest reading is at a temperature of 100 ^{0}C at the measuring point T3 with an error value by 0%.

temperature reading for a type K thermocouple with a temperature setting of 200 ^{0}C is at a temperature of 204 ^{0}C at the measuring point T3 and T6 with an error value of 3.7%, while the lowest reading is at a temperature of 201 ^{0}C at the measuring point T1 and T9 with an error value by 0.7 %.

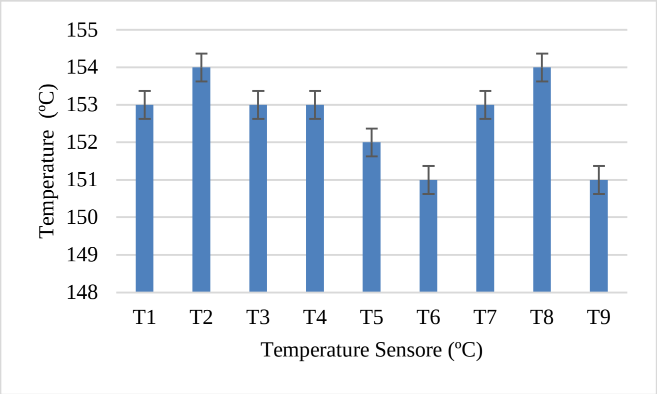


FIGURE 6. Graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 150°C.

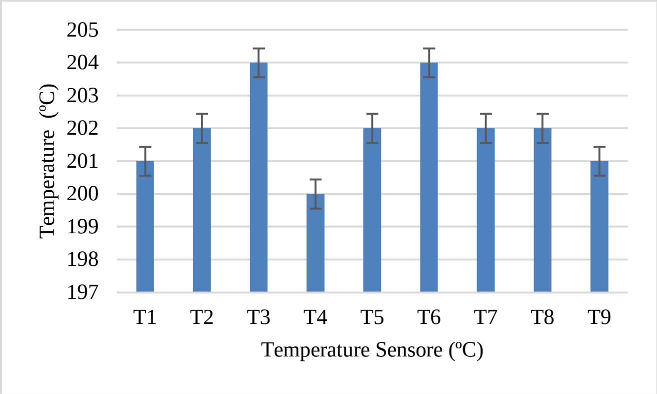


FIGURE 7. Graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 200°C.

TABLE 2
Testing ANOVA 9 channel with setting temperature 100°C, 150°C and 200°C consist of Two Table namely Description and Anova

DESCRIPTION

Group	*Count*	*Sum*	*Mean*	*Variance*	*SS*	*Std Err*	*Lower*	*Upper*
Temp 100 °C (Error (%))	9	20.7	2.3	2.245	17.96	0.437398	1.397255	3.202745
Temp 150 °C (Error (%))	9	22.9	2.544444	1.292778	10.34222	0.437398	1.6417	3.447189
Temp 200 °C (Error (%))	9	14.8	1.644444	1.627778	13.02222	0.437398	0.7417	2.547189

ANOVA

Sources	*SS*	*df*	*MS*	*F*	*P value*	*F crit*	*RMSSE*	*Omega Sq*
Between Groups	3.899	2	1.949259	1.132071	**0.338982**	3.402826	0.354663	0.009688
Within Groups	41.32	24	1.721852					
Total	45.22	26	1.739345					

Based on the FIGURE 6, it is explained that the highest temperature reading for a type K thermocouple with a temperature setting of 150 ^{0}C is at a temperature of 154 ^{0}C at the measuring point T8 with an error value of 3.7%, while the lowest reading is at a temperature of 151 ^{0}C at the measuring point T6 and T9 with an error value by 0, 7 %.

FIGURE 7 is a graph that shows the stability of thermocouple readings on 9 temperature point channels with temperature settings of 200 °C.

Based on the graphic above FIGURE 7, the highest

To find out the value of accuracy and the difference test, a statistical analysis of the Test ANOVA was carried out with a standard P-Value of more than 0.05. The statistical test results using the setting temperatures of 100°C, 150°C, and 200°C are shown in TABLE 2.

Based on TABLE 2 Description, there were 3 groups involved in the statistical calculation, including thetemperature of 100°C, 150°C, and 200°C. Each of temperature calculated the error on 9 channel data loger, which further obtained the standard error from the temperature of 100°C, 150°C, and

200°C by 0.437398. Furthermore, the statistical test using ANOVA obtained P Value of 0.338982 and RMSSE value of 0.354663.

IV. DISCUSSION

Based on the results of research conducted by the authors of this study, the aim was to create a data logger that can be used for temperature monitoring in a dry sterilizer. The results of measurements using a MEMMERT in 30 dry sterilizer and a comparison of Data Logger with a measurement time of 60 minutes at certain temperature settings, when the temperature is set high, the temperature will be faster at the beginning. Meanwhile, if the setting temperature is not too high, the sterilization is slow for the heating. After each measurement, the data were sent directly to the registered email of the blynk application in csv form and then saved to excel.

Based on the results of measurement of each temperature, the error value obtained was still at the threshold value. In this case, at 100°C, the highest error was 3.7% at T1 and the lowest error was 0% at T3. Meanwhile, at 150°C, the highest error was at T2 and T8 by 3.7% and the lowest error was at T9 by 1.5 %. Furthermore, at the temperature setting of 200°C. the highest error was at T3 and T6 with an error value of 3.7% and the lowest error value at T4 was 0%. Furthermore, the statistical analysis conducted through Anova test, obtained P Value of 0.338982, indicating that there was no significant difference since the p value obtained is more than 0.05.

In the previous research conducted by G.S. Nhivekar, R.R.Mudholker the making of data logger was also carried out using sms delivery system which obtained average value of 0.60 ^{0}C ± 0.50 ^{0}C and sensor error of ±0.250 ^{0}C [1].

This module was designed using monitoring via Bluetooth which can monitor the temperature distribution displayed on the blynk platform on Android. Therefore, this research can contribute to users of the tool to monitor the temperature distribution of the dry sterilizer easier. Meanwhilem the weakness of this research is the use of blynk since we need to have token before using it.

V. CONCLUSION

In this study, the authors designed a 9 channel Bluetooth data transfer logger module on a dry sterilizer which is used as a suggestion for monitoring the temperature of a dry sterilizer. Overall, it can be concluded that the circuit that has been made can be used to retrieve data. The use of the HC-05 module is because bluetooth can connect to android. On the Android, there are 9 measurement results using the Blynk application. At the temperature setting of 100°C, 150°C, and 200°C, the type K thermocouple used in this study reads quite stable and the error value is still at the threshold value of 5% of the error value. At 100°C, the highest error was 3.7% at T1 and the lowest error was 0% at T3. Meanwhile, at 150°C the highest error was at T2 and T8 at 3.7% and the lowest error was at T9 by 1.5 % and at the temperature setting of 200°C the highest error was at T3 and T6 with an error value of 3.7% and the lowest error value at T4 was 0%. Furthermore, the statistical test analysis through Anova test obtained P Value of 0.338982, indicating that there was no significant difference since the p value obtained was more than 0.05.

The author further suggests to use an application other than Blynk in the future research, because this application requires use to have a token before it can be used since each account should have the token.

REFFERENCES

[1] G. Nhivekar and R. Mudholker, "Data logger and remote monitoring system for multiple parameter measurement applications," *J. Electr. Electron. Eng.*, vol. 4, no. 1, pp. 139–142, 2011.

[2] M. Rofi'i and D. Titisari, "Calibration waterbath 9 (channel)," *Jeemi*, vol. 1, no. 1, pp. 1–6, 2019, doi: 10.1234/jeeemi.v1i1.9xx.

[3] S. Badhiye, S. S. Badhiye, P. N. Chatur, and B. V Wakode, "Data Logger System: A Survey," *Int. J. Comput. Technol. Electron. Eng.*, no. January 2011, p. 2011, 2011.

[4] M. B. Waghmare and P. N. Chatur, "Temperature and Humidity Analysis using Data Logger of Data Acquisition System: An Approach," *Int. J. Emerg. Technol. Adv. Eng.*, vol. 2, no. 1, pp. 102–106, 2012.

[5] C. D. Okwudibe and B. O. Akinloye, "Design and simulation of temperature data logger," *Am. J. Eng. Res.*, no. 6, pp. 14–19, 2017.

[6] V. Essien, C. A. Bolu, J. Azeta, I. P. Okokpujie, O. Kilanko, and S. A. Afolalu, "Application of Data Logger for Monitoring Indoor and Outdoor Temperature of Buildings: A Review," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1107, no. 1, p. 012181, 2021, doi: 10.1088/1757-899x/1107/1/012181.

[7] A. Kumar, I. P. Singh, and S. K. Sud, "Design and development of multi-channel data logger for built environment," *Proc. Int. MultiConference Eng. Comput. Sci. 2010, IMECS 2010*, vol. II, pp. 993–998, 2010.

[8] M. Noriega *et al.*, "Thermocouples calibration and analysis of the influence of the length of the sensor coating," *J. Phys. Conf. Ser.*, vol. 582, no. 1, 2015, doi: 10.1088/1742-6596/582/1/012029.

[9] L. Zhanqiang and Z. Shijun, "Development of a thermocouple sensor using tool coating and its substrate to measure metal turning temperatures," *Int. J. Mater. Prod. Technol.*, vol. 46, no. 1, pp. 71–80, 2013, doi: 10.1504/IJMPT.2013.052791.

[10] A. D. Korawan, "Rancang Bangun Data Logger Temperatur," *J. Electron. Electromed. Eng. Med. Informatics*, vol. 12, no. 2, pp. 12–14, 2018.

[11] M. H. Bin Zohari and M. F. Bin Johari, "Weather monitoring system using blynk application," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 1, pp. 1315–1319, 2019, doi: 10.35940/ijitee.L3666.119119.

[12] F. Hidayanti*, "Implementation of Blynk Internet of Things Platform for Benzene Gas Monitoring System on Density Laboratory," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 4, pp. 1090–1094, 2020, doi: 10.35940/ijitee.d1563.029420.

[13] K. P., "A Sensor based IoT Monitoring System for Electrical Devices using Blynk framework," *J. Electron. Informatics*, vol. 2, no. 3, pp. 182–187, 2020, doi: 10.36548/jei.2020.3.005.

[14] ITead Studio, "HC - 05 - Bluetooth to Serial Port Module (Datasheet)," *Datasheet*, vol. 2, p. 1, 2010.

[15] S. Sadi and S. Mulyati, "TEMPERATURE MONITORING USING HC-05 MODULE BASED ON ANDROID," *J. Tek.*, vol. 8, Mar. 2019, doi: 10.31000/jt.v8i2.1623.

[16] Rizkiyatussani, Her Gumiwang Ariswati, and Syaifudin, "Five Channel Temperature Calibrator Using Thermocouple Sensors Equipped With Data Storage," *J. Electron. Electromed. Eng. Med. Informatics*, vol. 1, no. 1, pp. 1–5, 2019, doi: 10.35882/jeeemi.v1i1.1.

[17] E. Rəduca *et al.*, "Web server with ATMEGA 2560 microcontroller," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 106, no. 1, 2016, doi: 10.1088/1757-899X/106/1/012018.

[18] T. Juwariyah, S. Prayitno, L. Krisnawati, and S. Sulasminingsih, "Design of IoT-Based Home Fire Detection System Equipped with a Data Logger," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1125, no. 1, p. 012079, 2021, doi: 10.1088/1757-899x/1125/1/012079.

[19] N. N. Mahzan *et al.*, "A Design of Smart IoT-Based Using Arduino," *J. Phys. Conf. Ser.*, vol. 1529, no. 2, pp. 1–9, 2020, doi: 10.1088/1742-6596/1529/2/022045.

[20] Y. PRABOWO, G. PURWANTO, and A. H. NUDIN, “Prototype of Feeding Control System, Automatic Harvest Using Blynk Application Based on Arduino Uno R3 Microcontroller and Nodemcu,” *Iccd*, vol. 3, no. 1, pp. 452–456, 2021, doi: 10.33068/iccd.vol3.iss1.399.

[21] R. Septiana, I. Roihan, and R. A. Koestoer, “Testing a calibration method for temperature sensors in different working fluids,” *J. Adv. Res. Fluid Mech. Therm. Sci.*, vol. 68, no. 2, pp. 84–93, 2020, doi: 10.37934/ARFMTS.68.2.8493.

[22] Y. Kusumawardani, E. Dian Setioningsih, and D. Titisari, “Water Bath Calibration Device with Data Storage Using Six Thermocouple Sensor,” *J. Electron. Electromed. Eng. Med. Informatics*, vol. 2, no. 2, pp. 40–47, Jul. 2020, doi: 10.35882/jeeemi.v2i2.2.

[23] M. Safitri, A. Pranaditya, B. Handoko, and S. Anggoro, “Design and implementation of automatic autoclave temperature and pressure data recording system,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1088, no. 1, p. 012081, 2021, doi: 10.1088/1757-899x/1088/1/012081.

[24] R. M. PARK, “Thermocouple Fundamentals,” *Wire*, pp. 12–26, 1821.

[25] Syarifatul Ainiyah, D. H. Andayani, A. Pundji, and M. Shaib, “Development of Incubator Analyzer Based on Computer with Temperature And Humidity Parameters,” *J. Electron. Electromed. Eng. Med. Informatics*, vol. 2, no. 2, pp. 48–57, Jul. 2020, doi: 10.35882/jeeemi.v2i2.3.

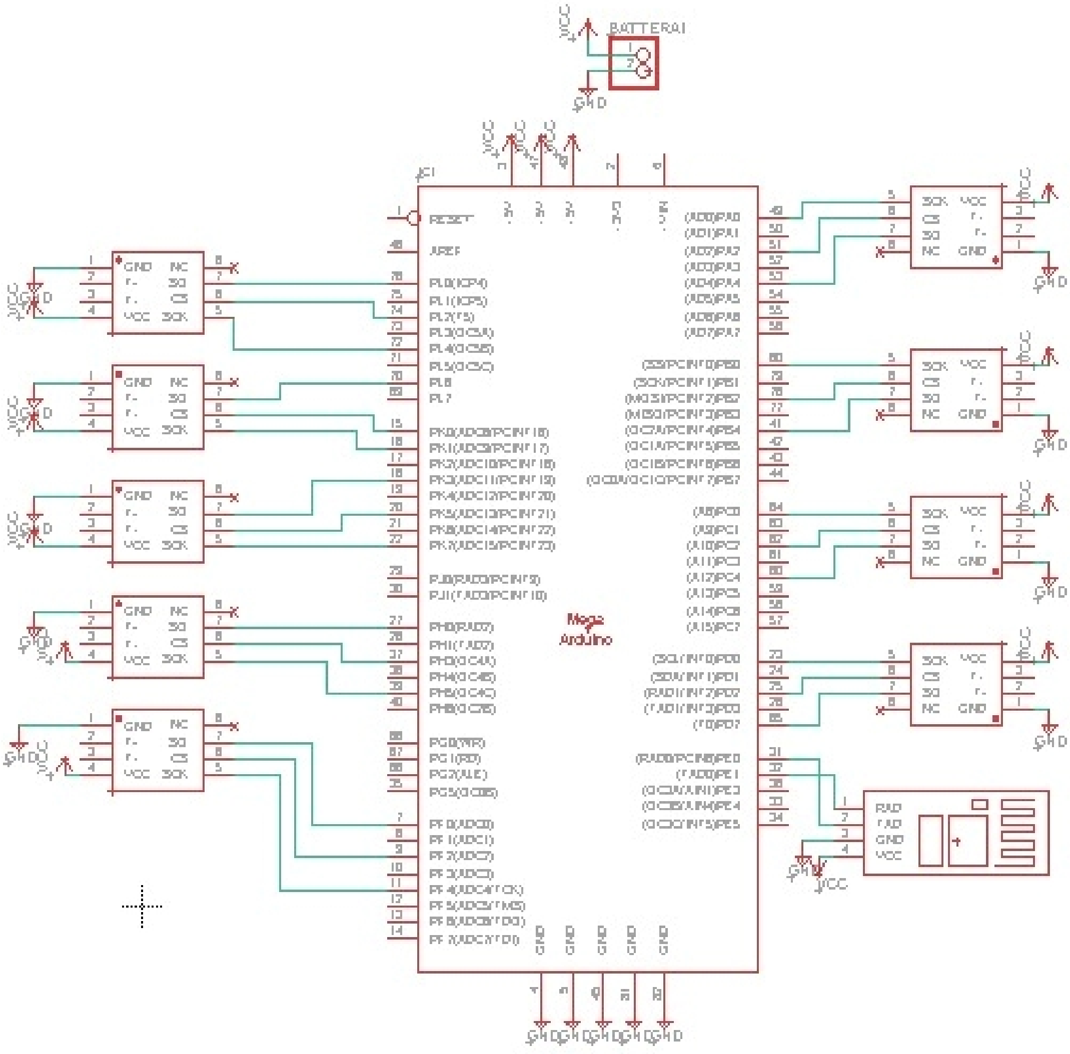
[26] O. R. Yunita, D. Titisari, and T. Hamzah, “Kalibrator Suhu dengan Thermocouple Dilengkapi dengan Tampilan Grafik,” *J. Teknokes*, vol. 13, no. 1, pp. 32–42, 2020, doi: 10.35882/teknokes.v13i1.5.

[27] A. Z. Febriyanti, P. C. Nugraha, and Syaifudin, “Temperature calibrator using thermocouple based on microcontroller,” *Ijeemi*, vol. 2, no. 1, pp. 13–20, 2020, doi: 10.35882/ijeeemi.v2i1.3.

[28] W. Widhiada, T. G. T. Nindhia, I. N. Gantara, I. N. Budarsa, and I. N. Suarndwipa, “Temperature stability and humidity on infant incubator based on fuzzy logic control,” *ACM Int. Conf. Proceeding Ser.*, no. April, pp. 155–159, 2019, doi: 10.1145/3330482.3330527.

ATTACHMENT 1

Schematic :



ATTACHMENT 2

LISTING PROGRAM

```
#define BLYNK_USE_DIRECT_CONNECT

// You could use a spare Hardware Serial on boards that have it (like Mega)
#include <SoftwareSerial.h>
SoftwareSerial DebugSerial(0, 1); // RX, TX
#define BLYNK_PRINT DebugSerial
#include <BlynkSimpleSerialBLE.h>
// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
Char auth[] = "UUxJmXAd4fktOmqm2gPFaZ4VsZo8nZY3";
#include "max6675.h"
MAX6675 thermocouple1(13, 12, 11);//SCK,CS,SO
MAX6675 thermocouple2(10, 9, 8);
MAX6675 thermocouple3(4, 3, 2);
MAX6675 thermocouple4(7, 6, 5);
MAX6675 thermocouple5(22, 24, 26);
MAX6675 thermocouple6(28, 30, 32);
MAX6675 thermocouple7(34, 36, 38);
MAX6675 thermocouple8(40, 42, 44);
MAX6675 thermocouple9(46, 48, 50);
Float suhu1,suhu2,suhu3,suhu4,suhu5,suhu6,suhu7,suhu8,
suhu9;
void setup()
{DebugSerial.begin(9600);
  Serial.begin(9600);
  Blynk.begin(Serial, auth);}
void loop()
{suhu1 =  thermocouple1.readCelsius()-5 ;
  suhu2 =  thermocouple2.readCelsius()-5 ;
  suhu3 =  thermocouple3.readCelsius()-4 ;
  suhu4 =  thermocouple4.readCelsius()-8 ;
  suhu5 =  thermocouple5.readCelsius()-6 ;
  suhu6 =  thermocouple6.readCelsius()-6 ;
  suhu7 =  thermocouple7.readCelsius()-6 ;
  suhu8 =  thermocouple8.readCelsius()-4 ;
  suhu9 =  thermocouple9.readCelsius()-8 ;
  Blynk.run();
  Blynk.virtualWrite(V1, suhu1);
  Blynk.virtualWrite(V2, suhu2);
  Blynk.virtualWrite(V3, suhu3);
  Blynk.virtualWrite(V4, suhu4);
  Blynk.virtualWrite(V5, suhu5);
  Blynk.virtualWrite(V6, suhu6);
  Blynk.virtualWrite(V7, suhu7);
  Blynk.virtualWrite(V8, suhu8);
  Blynk.virtualWrite(V9, suhu9);
  delay(2500);}
```