

Incubator Analyzer Using Bluetooth Android Display (Humidity & Air Flow)

Vina Nadhirotul Azkiyah[#], Syaifudin, Dyah Titisari

Department of Electromedical Engineering PoltekkesKemenkes, Surabaya

Jl. Pucang Jajar Timur No. 10, Surabaya, 60245, Indonesia

[#]vinnadhiroh98@gmail.com, Nyong74@yahoo.com, ti2_sari@yahoo.com

Abstract— Incubator Analyzer is a calibrator used to calibrate incubator temperature, mattress temperature, noise, humidity and airflow so that conditions in the baby incubator environment remain stable and within normal limits. The purpose of this study is to develop a system for sending data to android and data storage. "Incubator Analyzer Using Bluetooth Appear Android" has four parameters for measuring temperature, noise, humidity, and water flow. Using the Atmega328 microcontroller as a data processor, and the output results will be displayed on the LCD display and equipped with data transmission via bluetooth HC-05 displayed to Android with data storage. The moisture parameter detects humidity quite well where the biggest error is obtained at 1.28% DHT-22, the Ultrasound Sensor HC SR-04 can detect Air Flow with an error of 311.66% as measured by a comparison device. Incubator Design This analyzer is made portable to calibrate baby incubator tools.

Keywords—Incubator Analyzer; Kelembaban; Air Flow; Android

I. INTRODUCTION

An incubator analyzer is a device designed and built to verify the operation and environmental conditions of a baby incubator that can record parameters such as air flow, noise, temperature, and relative humidity [1]. The baby incubator serves to provide protection to babies born prematurely by providing a stable temperature so that the baby's body heat is maintained [2]. To verify all parameters in a baby incubator, a tool calibration is necessary. The definition of calibration is an activity to determine the conventional truth of the appointment of measuring instruments and measuring materials by comparing it to the standard size traced (traceable) to the National or International standard [3]. The Incubator Analyzer uses 4 parameters, one of which is measurement of humidity and air flow. In its measurement these parameters require a stable condition to produce a measure according to its standard [4]. While the Incubator Analyzer tool that was previously made by the final assignment by Imro'ah Dyah Sulistya and Laily Kurniati (in 2018), the air flow sensor is still not in accordance with the specified target and there is no data storage. This condition causes the operator to not be able to see the previous measurement data and the air flow sensor has not reached the expected [5].

The previous Incubator Analyzer has been made by Herlina Candra Putri and Rohmantus Sholihah (in 2006) with 3 parameters (temperature, noise, humidity) that appear together in one display. The tool according to the author's observation is still less effective because it is not portable and there are no air flow parameters. Then developed by Aljaziroh Jannatul Maghfiroh and Ghafur Slamet (in 2014) with portable systems. This tool still has drawbacks, where the noise sensor cannot detect a range of 30 dB - 44 dB (which reads a 45 dB range - 60 dB) and there are no air flow parameters. Furthermore, it was developed by Ahmad Syaifudin and Denny Prasetyo (in

2015) with the addition of air flow sensor, battery and 4x20 LCD display parameters, but the air flow sensor cannot reach a range of 0.7 m / s (which reads range 0 - 1.2 m / s). The per-parameter measurement process must be alternated because it only uses one display [6]. This condition causes the readable value to be less linear. Then it was redeveloped by Vina Alfi Majidah and Helen Reynilda Ericka (in 2016) with the addition of sending data via bluetooth which was displayed via Personal Computer. This is considered to be less efficient because when the calibration process is carried out in a different room, the calibration officer must also move the Personal Computer which is a unit of the Incubator Analyzer. The latest one was developed by Imro'ah Dyah Sulistya and Laily Kurniati (in 2018) this tool has been portable using the Android display, but there are still shortcomings namely there is no data storage so the operator cannot see the results of previous measurements. The error value obtained in measuring the water flow sensor is still quite large when compared to the Incubator Analyzer II at the Surabaya Polytechnic Laboratory.

Based on the results of the identification of the chronological problem above, the author wants to perfect the sensor module whose results are less linear and develop the Incubator Analyzer tool equipped with data transmission via bluetooth which is displayed on android with data storage.

II. MATERIAL AND METHODE

A. Experimental Setup

This study uses the Fluke Biomedical Brand II Incubator Analyzer as a comparison tool and performs data collection as much as 6 times the measurement during the interval of one hour for each parameter.

1) Materials and Tool

This study uses a DHT-22 sensor to detect humidity and temperature sensors ultrasound HC SR-04 to detect air flow or alira air in the baby incubator. Components used include Atmega 328 as a microcontroller, LCD 2x40 and Android as a display, and bluetooth module HC-05 for sending data from microcontrollers to android.

2) Experiment

In this study measurements were taken on the DHT-22 sensor output and ultrasound sensor HC SR-04 to see how much output the amplitude was using an oscilloscope. Next, the researchers conducted a comparison of humidity and water flow testing with the Incubator Analyzer II with a temperature setting of 340C and 360C in the baby incubator.

B. The Diagram Block

First pressing the on button, then the battery will supply voltage throughout the circuit so that the temperature sensors 1, 2, 3, 4, 5, the sensor temperature of the mattress, air flow, humidity, and noise will be active and do the reading. The humidity sensor will convert the humidity in the room into digital data that is forwarded and managed by ATMEGA328 into moisture data. The ultrasound sensor will convert water flow into digital data that is forwarded and managed by ATMEGA328 into water flow data. Humidity and water flow data will be displayed on the 4x20 character LCD and sent using Bluetooth HC-05 to be displayed on Android. When the start button found on Android is pressed, the results of reading all sensors will be displayed on the Android display and will automatically perform the storage process on the Android internal memory. If you will take the next measurement, press the reset button to start the process of reading data from the beginning.

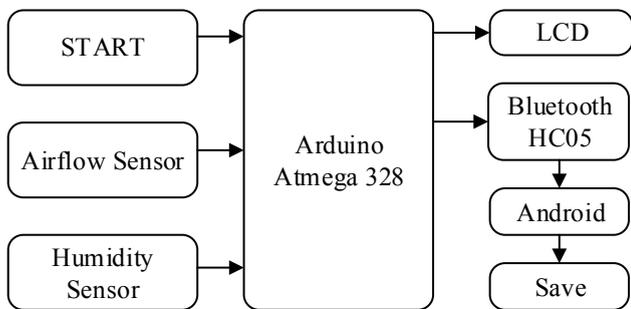


Fig. 1. The diagram block of the Incubator Analyzer

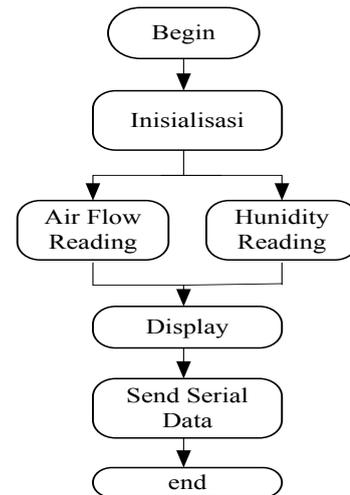


Fig. 2. The Flowchart of the Arduino Program

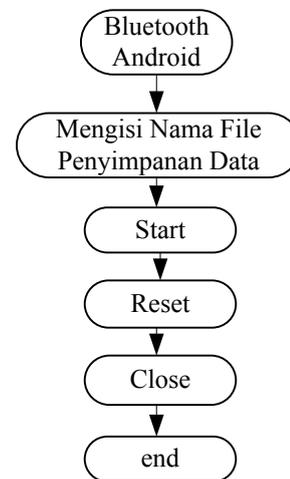


Fig. 3. The Flowchart of the Android Program

C. Flowchart

In the above flow diagram after initialization, the sensor will begin reading and then be processed and converted to ATMEGA328, then the results of processing will be displayed on the 4x20 lcd then sent via bluetooth in the form of numbers to android and will be displayed on the android display and automatically store data.

D. Circuit Analog

An important part of this development is the analog circuits that illustrate in Fig. 4 (block of moisture), Fig. 5 (air flow block), which is used to process the work of the incubator analyzer. Therefore it will be ready for digital processing using Arduino.

1) Humidity

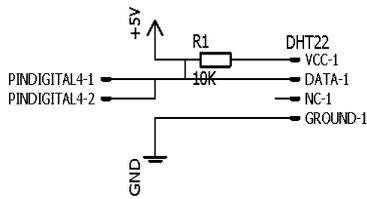


Fig. 4. DHT-22

The DHT-22 module specification requires a + 5V DC voltage to the ground. There is a resistor installed parallel to the output of the DHT-22 sensor. This resistor functions as a pull up voltage output data produced by the sensor so that it can be read maximally by Arduino. The output pin of the module will be connected to the pin (PD4).

2) Air Flow

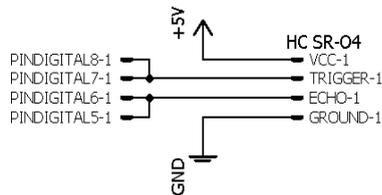


Fig. 5. HC SR-04

The ultrasonic module specification HC SR-04 requires a + 5V DC voltage to the ground. The output pin of the module will be connected to pins (PD5) and PD6 for trigger foot output, while PD7 and PD8 for foot echo output .

3) Mikrokontroller

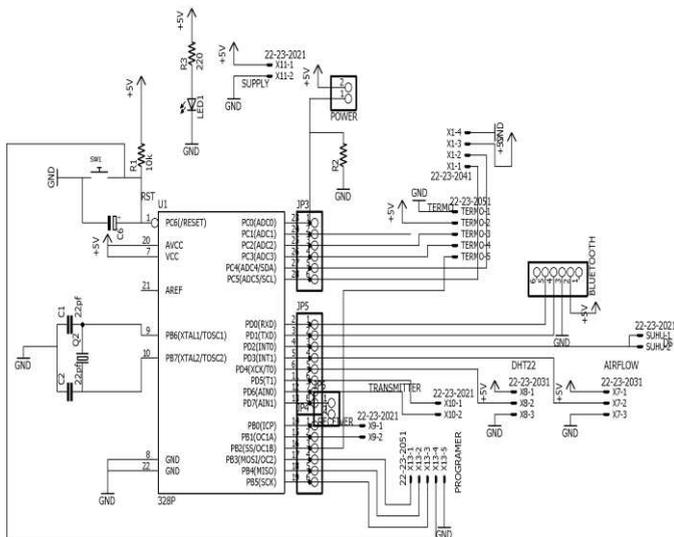


Fig. 6. Mikrokontroller

The microcontroller circuit shown in fig.6 is used for processing data from the output of each sensor. And it is used for programming and sending data with Bluetooth.

4) Bluetooth Module

The Bluetooth module used in this tool is HC-05. This Bluetooth module is used to transmit data from the sensor readings to android. The Bluetooth module is connected to the Microcontroller by connecting the Microcontroller TX pin to the RX Bluetooth pin and vice versa, the Microcontroller RX pin to the Bluetooth TX pin.

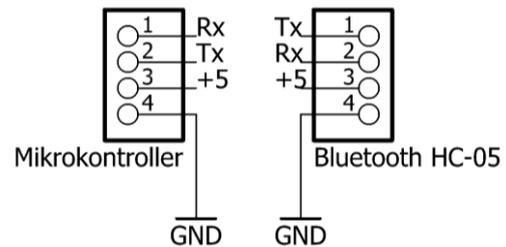


Fig. 7. Bluetooth Connection

III. RESULTS

In this study a trial was carried out on the device directly at the baby incubator with the Incubator Analyzer II (Fluke Biomedical) as a comparison tool. The researcher also took measurements using the thermohygrometer as another means of comparison.



Fig. 8. Design

1) The Modul Design

Photographs of digital parts of this tool are shown in Fig. 9. The digital part consists of a microcontroller consisting of Atmega328 as a system regulator, crystal 16,000 MHz which functions as an external clock to perform microcontroller functions. In the digital section there are also DHT-22 sensor modules, ultrasound sensors, and Bluetooth HC-05 which are used to send data from the microcontroller to Android.



Fig. 9. The Digital part of the Incubator Analyzer

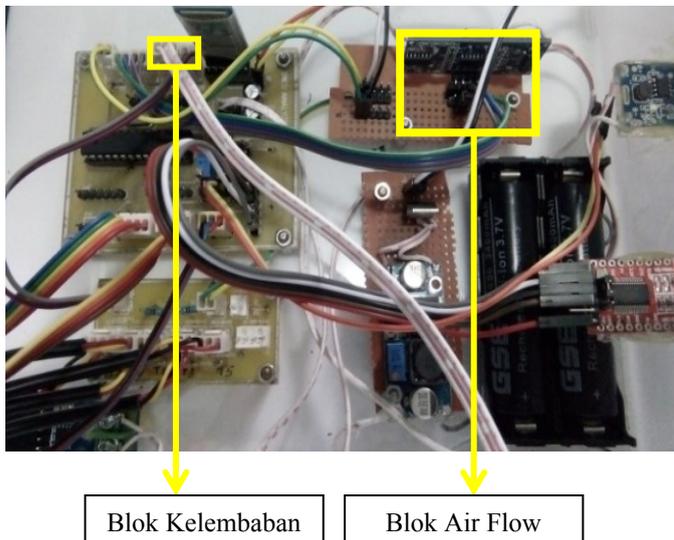


Fig. 10. Design

2) *The Listing Program for Arduino*

Arduino program listing consists of a humidity sensor program shown in program listing 1, a program for water flow sensors shown in program listing 2, and a program to send data to android shown in program listing 3.

Listing program 1. Program to display the Humidity

```
#include "DHT.h"
#define DHTPIN 4
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);
float hum;
float temp;
```

```
hum = dht.readHumidity();
temp = dht.readTemperature();
lcd.setCursor(0,0);
lcd.print("Humidity : ");
lcd.print(hum);
lcd.print("%RH");
int data2=hum;
int data=hum*100;
```

Listing Program 2. Program to display the Air Flow

```
#include <NewPing.h>
#define SONAR_NUM 2
#define MAX_DISTANCE 50
NewPing sonar[SONAR_NUM] = {
  NewPing(7, 6, MAX_DISTANCE),
  NewPing(8, 5, MAX_DISTANCE)
}
float AirSpeed;

float pingSensor1=sonar[0].ping_median(6);
float pingSensor2=sonar[1].ping_median(6);
float error=100-(pingSensor2/pingSensor1)*100;
float AirSpeed=(0.3/2)*((pingSensor1/1000000-
pingSensor2/1000000)/(pingSensor1/1000000*pingSensor2
/1000000));
lcd.backlight ();
lcd.setCursor (0, 2 );
lcd.print(" Air Flow =");
lcd.print(AirSpeed);
lcd.print ("m/s");
int data4=AirSpeed;
data4=AirSpeed*100;
```

Listing Program 3. Program to send data to a android

```
Serial.print("i");
Serial.println(hum);

Serial.print("g");
Serial.println(abs(AirSpeed));
```

3) *Listing Program untuk Aplikasi Android*

In this study to make an android application using Mit App Inventor. Programming to make this android application consists of a bluetooth module connection program with an android application shown in fig. 11, the program receives moisture data as shown in Fig. 12, the program receives the air flow data shown in fig. 13, the data storage program to memory internal shown in Fig. 14, the storage time program shown in fig.15, the start button program shown in fig.16, the reset button program shown in fig.17 close button program shown in fig.18.

```

when Screen1 Initialize
do
  if not BluetoothClient1 Enabled
  then
    call Notifier1 ShowAlert
    notice "Bluetooth Belum aktif"

to disconnection
do
  call BluetoothClient1 Disconnect
  set Connect Text to "Connect"

when ListPicker1 BeforePicking
do
  set ListPicker1 Elements to BluetoothClient1 AddressesAndNames

when Connect Click
do
  if BluetoothClient1 isConnected
  then
    call disconnection
  else
    call ListPicker1 Open
    set Clock1 TimerEnabled to false

when ListPicker1 AfterPicking
do
  if call BluetoothClient1 Connect
  address ListPicker1 Selection
  then
    call BluetoothClient1 SendText
    text "1"
    call Notifier1 ShowAlert
    notice "Terhubung Ke Bluetooth"
    set Connect Text to "Disconnect"
  else
    call Notifier1 ShowAlert
    notice "Tidak Dapat Terhubung Ke Bluetooth"
    set Clock1 TimerEnabled to false
    
```

Fig. 11. Program Module Bluetooth Connection

The block (Fig.11) is a program to open a list of names and bluetooth addresses that will be selected as data connections. The selected Bluetooth must have been paired with a cellphone. The block also explains the status of the Bluetooth connection to Android. After selecting a Bluetooth name and address, the Bluetooth module will be connected to Android. When the Bluetooth module is connected to the Android application, it will read connected and if the Bluetooth connection with the Android application is disconnected, the text will return with the word disconnect.

```

when Clock1 Timer
do
  if BluetoothClient1 isConnected
  then
    initialize local dataadc to call BluetoothClient1 ReceiveText
    numberOfBytes 1
    in
    if starts at text get dataadc = "i"
    piece "i"
    then
      set dataadc to segment text get dataadc
      start 2
      length length get dataadc - 1
      set NilaiHum Text to get dataadc
    
```

Fig. 12. Program received the data Humidity

On the block (fig.12) uses letter codes to separate the data received from the minimum system serial communication. If the time is running and if Bluetooth is connected then read the data in real time with the code "i" for the humidity sensor.

```

else if starts at text get dataadc = "g"
piece "g"
then
  set dataadc to segment text get dataadc
  start 2
  length length get dataadc - 1
  set NilaiFlow Text to get dataadc
  
```

Fig. 13. Program received the data Air Flow

The above command is a program for receiving data that has been sent via bluetooth HC-05 which is then read in real time with the code "g" for the air flow sensor which will be displayed in the column in the application that matches the code.

```

initialize global save to ""
when savedata Timer
do
  call File1 AppendToFile
  text
  join
  NilaiT1 Text
  NilaiT2 Text
  NilaiT3 Text
  NilaiT4 Text
  NilaiT5 Text
  NilaiTM Text
  Noise Text
  NilaiNoise Text
  Hum Text
  NilaiHum Text
  Air Flow Text
  NilaiAirFlow Text
  "n"
  fileName get global save
  
```

Fig. 14. Program save memory

The above command is a program listing that functions to process the storage format of the data that appears in txt and will be stored automatically in the android internal memory. Where the save data timer stores data on all T1 sensors to Air Flow sensors in one second for one hour..

```

when clk_perjam Timer
do
  set savedata TimerEnabled to false
  set clk_perjam TimerEnabled to false
  
```

Fig. 15. Program Untuk Mengatur Lamanya Waktu Penyimpanan

Where the clock_perjam timer works for one hour and will automatically stop after the setting time is fulfilled. It is marked by the false command for the savedata and clk_perjam timers, which will break the data storage process. When the storage process is complete, the data reading in real time will continue and will stop when pressing the "reset" button.

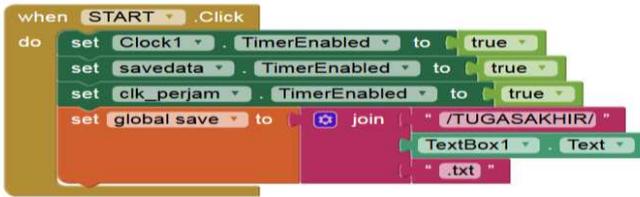


Fig. 16. Start Button Program

The above command to activate the start button. Where clock 1 functions as a timer in reading data. A savedata timer to give commands to save data to android internal memory. The clk_perjam timer works for a one-hour storage deadline. If "START" is pressed then all timers will be active and start the reading and storage process. Storage of data results in txt format.

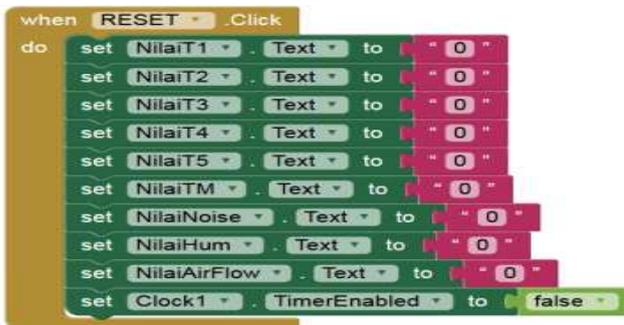


Fig. 17. Reset Button Program

The above command to activate the reset button. When the reset button is pressed then clock 1 performs its function to disconnect Bluetooth connections which results in all data displayed in the measurement column will be erased and on Android will appear the number 0. If "START" is pressed then re-read the data from the beginning



Fig. 18. Close Button Program

The above command for the close button. When the close button is pressed, the application will be closed, the HC-05 bluetooth connection will be disconnected automatically and the data reading will stop.

4) *The Error of Humidity value*

Results of measurement of humidity with 2 kinds of temperature settings compared with the Incubator Analyzer II. The error value is shown in Table I.

TABLE I. THE ERROR OF MEASUREMENT FOR HUMIDITY PARAMETER BETWEEN STANDARD UNIT (INCUBATOR ANALYZER II).

Temperature Setting	Error (%)
34°C	1.2865
36°C	0.8362
Rata - rata Error	1.0613

Based on the results of measurements using the Incubator Analyzer II as a comparison tool the results were different / there was a difference in value. The biggest error value is 1.2865% and the average error value from the measurement results is 1.0613%.

5) *The Error of Air Flow value*

The results of measurement of water flow with 2 kinds of temperature settings compared to the Incubator Analyzer II. The error value is shown in Table II.

TABLE II. THE ERROR OF MEASUREMENT FOR AIR FLOW PARAMETER BETWEEN STANDARD UNIT (INCUBATOR ANALYZER II).

Temperature Setting	Error (%)
34°C	311.666
36°C	69.0721
Rata - rata Error	190.369

Based on the results of measurements using the Incubator Analyzer II as a comparison tool the results were different / there was a difference in value. The biggest error value is 311,666% and the resulting average value of error from the measurement results is 190,369%.

IV. DISCUSSION

Moisture and water flow measurements were carried out directly at the baby incubator and compared with the Incubator Analyzer II. The average error value obtained from humidity measurements between modules and Incubator Analyzer II is 1.06% and the average error obtained from the measurement of water flow between modules and digital thermometer is 190.36%.

V. CONCLUSION

Based on the results of the discussion and the purpose of making the module it can be concluded that this module can display the values of the two parameters that have been processed with the Arduino program whose results are displayed on the LCD 4x20 and on the Android application. Android applications that have been made can also work well to display data that has been received from a microcontroller via Bluetooth.

REFERENCES

- [1] C. F. Ginting and K. Brahmana, "Suhu Dan Kelembaban Berbasis Mikrokontroler ATmega8535."
- [2] A. S. Utomo *et al.*, "Monitoring Baby Incubator Sentral Dengan Komunikasi," vol. 9, no. 1, pp. 225–230, 2018.
- [3] S. N. Indonesia and B. S. Nasional, "Peralatan elektromedik – Bagian 2-19: Persyaratan khusus untuk keselamatan dasar dan kinerja esensial inkubator infant," 2014.
- [4] R. Tarulescu, U. T. Brasov, S. Tarulescu, and U. T. Brasov, "The Influence Of Wind Speed And Direction Over The Ultrasonic The Influence Of Wind Speed And Direction Over," no. April 2015, 2014.
- [5] U. M. Arief, "Pengujian Sensor Ultrasonik PING untuk Pengukuran Level Ketinggian dan Volume Air," vol. 9, no. 2, 2011.
- [6] S. Komparatif and A. Avr, "Perbandingan Akurasi Pengukuran Suhu dan Kelembaban Antara Sensor DHT11 dan DHT22."