# Non-contact Thermometer for Humans with Internal Data Storage and Voice Output Features

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Abstract: Corona virus (COVID-19) is an infectious disease caused by a new type of coronavirus. General symptoms of COVID-19 are fever, feeling tired and dry cough. A fever with a high body temperature can be achieved through non-contact measurements using infrared wavelengths. In this research, an infrared thermometer MLX90614 module will be developed with on-screen output with 2GB internal data storage. From the tests carried out, the results of the measurement error from distance of 1 cm are 0.62 $^{o}$C from range temperature 34 up to 40 $^{o}$C and each test takes an average of 1754.8 milliseconds.

## 1 INTRODUCTION

Corona virus (COVID-19) is an infectious disease caused by a new type of coronavirus. In Indonesia, the COVID-19 case first appeared in early March 2020 (BNPB, 2020). Until now, according to data from the task force to accelerate the handling of COVID-19, the global distribution of covid-19 cases has reached 213 countries with 2,475,723 confirmed cases and 169,151 deaths. whereas in Indonesia there were 7,418 confirmed positive cases, 913 total patients recovered and 635 total patients died (Kompas.com, 2020). General symptoms of COVID-19 are fever (body temperature above 38 degrees Celsius), feeling tired and dry cough. Human temperature measurement non-contact thermometer by utilizing infrared wavelengths.

Infrared technology for temperature measurement has been researched a lot, especially in of animal husbandry sector (Cugmas, Šušterič, Gorenjec, & Plavec, 2020), the industrial sector (Liu, et al., 2019), the chemical sector (Alessio, et al., 2020), as well as the health sector (Marques & Pitarma, 2019) (Ercoli, Marchionni, Scalise, Tomasini, & Carnielli, 2013) (Iven, et al., 2014) and the measurement of human body temperature using infrared cameras (Sumriddetchkajorn & Chaitavon, 2009). All of these technologies are still being developed with the addition of the latest features such as internal loger data storage (Carre & Williamson, 2018) (Pasquali, D'Alessandro, Gualtieri, & Leccese, 2017) (Guragai, Hashimoto, Oguma, & Takizawa, 2018)and external loger data storage ones equipped with internet of things (IoT) technology (Marques & Pitarma, 2019).

In this research, a temperature reading device was developed with the addition of a sound output so that the readings could be directly heard by humans who measured the temperature. Besides that, there is also an additional feature of internal data storage with a storage memory slot of up to 2 GB, the purpose of this storage is used in health service places such as health centers and hospitals. This is intended so that officers no longer need to collect data manually but automatically on this tool.

## 2 HARDWARE AND SOFTWARE DESIGN

The MLX90614 is an Infra-Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASSP are integrated in the same temperature object (TO-39) can. Its low noise amplifier, 17-bit analog to digital converter and powerful digital signal processing unit, a high resolution and accuracy of the thermometer is achieved.

The thermometer comes factory calibrated with a digital pulse width modulation and SMBus (system management bus) output. As a standard, the 10-bit PWM is configured to continuously transmit the



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measured temperature in range of 20 up to 120˚C, with an output resolution of 0.14˚C. The factory default power on reset setting is SMBus. Block diagram system of MLX90614 can be shown in Figure 1.

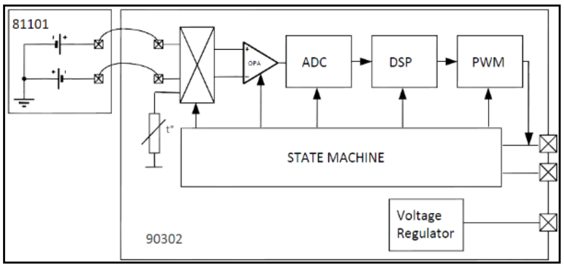


Figure 1: Block diagram system of MLX90614 (Melexis, 2019).

The operation of the MLX90614 is controlled by an internal state machine, which controls the measurements and calculations of the object and ambient temperatures and does the post-processing of the temperatures to output them through the PWM output or the SMBus compatible interface.

In single PWM output mode the settings for PWM data only are used. Based on the datasheet, the MLX90614 has a standard accuracy of + - 0.5 ºC at temperature measurements between 0 and 60 ºC.

In this paper designed a control system to checking human temperature by using infrared wavelength. Infrared waves are emitted and captured by infrared sensors. to reduce low noise, low offset amplifier with programmable gain is used for amplifying the IR sensor voltage. Max offset the input modulator and balanced input impedance is 0.5µV. after that, the signal will be changed from analog singnal to digital signal via analog to digital converter (ADC). Furthermore, the digital signal will go into DSP. signal calculations are done by the internal DSP, which produces digital outputs, linearly proportional to measured temperatures. From the DSP the signal goes to the PWM block. In this block the signal data will be storaged into EEPROM and converted into 10-bit data and ready to be sent to the main controller.

Every main controller (Arduino Nano V3) requests temperature data via i2c communication, the MLX90614 module sends digital temperature data and the controller will display the data to the 0.96" OLED display module and save the data to internal storage via SD card module and output a sound according to actual read temperature value via DF Player Module. The device supplied from power bank modules and Li-Ion batteries. Every request data always started with pushed the button. This process only takes a few seconds. So that this device can be used easily and quickly. The block diagram system can be shown in Figure 2.

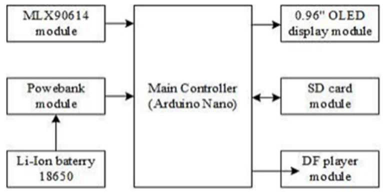


Figure 2: The block diagram system.

While the wiring diagram system can be shown in Figure 3.

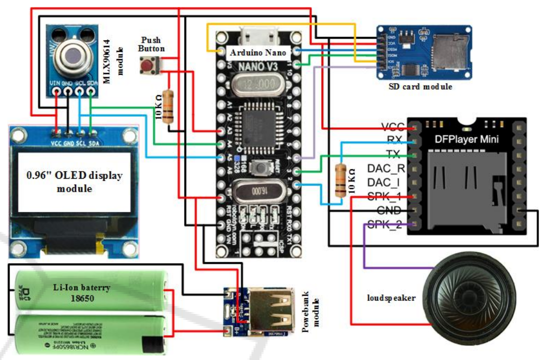


Figure 3: The wiring diagram system.

According Figure 3, it can be explained that arduino gets a supply from the Power bank module of 5 volr direct current (VDC) and supplies all components, that is: the MLX90614 module, the 0.96" OLED display module, the SD card module, and the DF Player module. The 0.96" OLED display module and the MLX90614 module using inter-integrated circuit (I2C) communication so that the SCL/SCK pins can be joined and connected to the A5 pin on the Arduino Nano and SDA pins can also be joined and connected to the A4 pins on the Arduino Nano. The difference between this modules is the i2c address. The SD card module using serial peripheral interface (SPI) communication, so that more data pins are used than I2C, that is: MOSI, MISO, SCK, and CS. The DF Player module using asynchronous serial communication so that so that there are 2 data lines used, that is: Transmitter (Tx) and Receiver (Rx).

Arduino Nano programming made with the Arduino IDE's Software. In this programming, it is done through 2 step, that is: the first step is initialization and the second step is making the main program. The initialization step by including the MLX90614 library, OLED display library, SD card library and DF Player library into the Arduino IDE's Software. The main programming step is requesting temperature data from MLX90614 started with pushed the button switch, displaying actual temperaure to OLED display, saving temperatur value to internal SD card and sounding voice via DF player module. The initialization step can be shown below this.

```
#include <Wire.h>
#include <Adafruit_MLX90614.h>
#include <SPI.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <SD.h>
#include "SoftwareSerial.h"
#include "DFRobotDFPlayerMini.h"
File myFile;
#define OLED_RESET 4
Adafruit_SSD1306 display(OLED_RESET);
#define NUMFLAKES 10
#define XPOS 0
#define YPOS 1
#define DELTAY 2
#if (SSD1306_LCDHEIGHT !=32)
#error ("Height incorrect, please fix
Adafruit_SSD1306.h!");
#endif
Adafruit_MLX90614 mlx = Adafruit_MLX90614();
static const uint8_t PIN_MP3_TX = 2; // to
module's RX
static const uint8_t PIN_MP3_RX = 3; // to
module's TX
SoftwareSerial softwareSerial(PIN_MP3_RX,
PIN_MP3_TX);
DFRobotDFPlayerMini player;
int counter=0;
float suhu,suhutotal,rerata_suhu;
void setup() {
  Serial.begin(9600);
  softwareSerial.begin(9600);
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  mlx.begin();
  while (!Serial) {
    ;
  }
  Serial.print("Initializing SD card...");
  if (!SD.begin(4)) {
    Serial.println("initialization
failed!");
    return;
  }
  Serial.println("initialization done.");
  myFile = SD.open("Suhu.txt", FILE_WRITE);
  display.clearDisplay();
}
```

The main program can be shown below this.

```
void loop() {
  int tombol_on=digitalRead(A3);
  if(tombol_on==HIGH){
  display.clearDisplay();
  ambil_data_suhu();
  text_suhu();
  tulis_data_suhu();
  keluarkan_suara_suhu();
  }
  else {
  tampil_tekan_tombol();
  Serial.println("Tekan Tombol Start");
  }
}
```

# 3 RESULTS OF EXPERIMENT

In this research, will do some testing, that is: comparison of MLX90614 module with contactless infrared thermometer testing, internal data storage time testing, and DF player module timing testing.

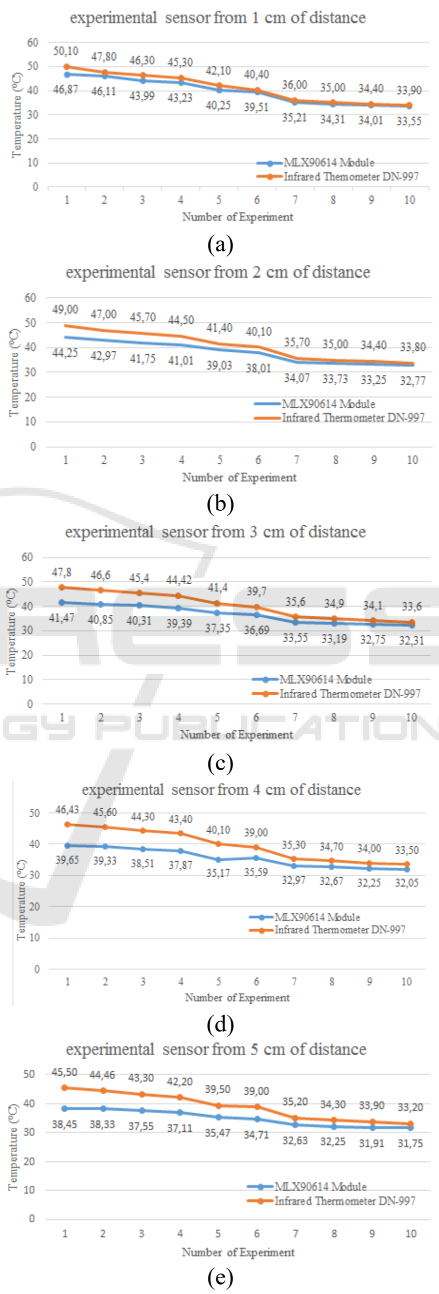


Figure 4: Graph comparison of the MLX90614 module and the DN-997 infrared thermometer output.

*A. Result of MLX90614 Module*

In this tests, testing is done by comparing the data output of the MLX90614 module with the contactless infrared thermometer Model: DN997. The test is carried out at a distance of 1 cm up to 5 cm. The purpose of measuring this distance is to determine the accuracy of the MLX90614 module at a certain distance. After a combination of measurement distances is carried out against the measurement results, it is known that the ideal distance for measuring human temperature is known. The test results of MLX90614 can be seen in Figure 4.

For distance of the sensor from the object (a) 1 cm, (b) 2 cm, (c) 3cm, (d) 4 cm, and (e) 5 cm

Based on Figure 4, it can be concluded that the most accurate measurement results are obtained at a measurement distance of 1 cm with an average measurement difference of 0.62 ºC. Whereas for a distance of 2 cm the average difference is 1.43 ºC, at a distance of 3 cm the average difference is 1.88 ºC, at a distance of 4 cm the average difference is 2.19 ºC, and at a distance of 5 cm the average difference is 2.47 ºC.

*B. Result of SD Card Module*

The first step in testing the SD Card module is to format the memory and ensure that the type is system fat32. Then the SD Card is inserted into the SD Card module and readings are carried out from the Arduino program. if the reading is successful, the SD Card module is ready for use.

In this tests, time is calculated starting from the reading of the MLX90614 module sensor up to the command to write the sensor reading data to the SD card module. The test was carried out 5 times. The results of SD Card module can be shown in table 1.

Table 1: Result of SD card module.

| No. | Data sensor | Write data | Time | Captions |
|---|---|---|---|---|
| 1 | 31.25 ºC | 31.25 ºC | 155 ms | Success |
| 2 | 31.53 ºC | 31.53 ºC | 157 ms | Success |
| 3 | 31.13 ºC | 31.13 ºC | 153 ms | Success |
| 4 | 31.39 ºC | 31.39 ºC | 154 ms | Success |
| 5 | 31.19 ºC | 31.19 ºC | 153 ms | Success |
| Average of writing time | | | 154.4 ms | |

According to table 1, The SD card module has successfully stored temperature data with an average time of 154.4 ms.

*C. Result of DF Player Module*

The first step in testing the DF player module is to record sounds ranging from "30.00 degrees Celsius" to "40.00 degrees Celsius" sounds. Then the sound is stored on a separate memory card with an internal data storage memory. When the reading is finished, the recorded voice is called in according to the temperature measurement value that was read. for example, if the read temperature is 31.25, the resulting sound is "Thirty-one point two five".

In this tests, time is calculated starting from the reading of the MLX90614 module sensor up to the command to write the sensor reading data to the SD card module, and voice output from DF player module. The test was carried out 5 times. The results of DF player module can be shown in table 2.

Table 2: Result of DF player module.

| No. | Value | Voice output | Tie (ms) | Captions |
|---|---|---|---|---|
| 1 | 31.25 | "Tiga puluh satu koma dua lima" | 1754 | Success |
| 2 | 31.53 | "Tiga puluh satu koma lima tiga" | 1757 | Success |
| 3 | 31.13 | "Tiga puluh satu koma satu tiga" | 1754 | Success |
| 4 | 31.39 | "Tiga puluh satu koma tiga sembilan" | 1755 | Success |
| 5 | 31.19 | "Tiga puluh satu koma satu sembilan" | 1754 | Success |
| Average of voice output time | | | 1754.8 | |

According to table 2, DF player module successfully emits the same sound as the temperature sensor reading value with an average time of 1754.8 ms.

## 4 CONCLUSIONS

The results of testing MLX90614, It known that, the farther the sensor distance from the object, the greater the reading error. The smallest error is obtained on measurements with a distance of 1 cm to the object with an average error of 0.62 oC for temperature measurement from 33 oC up to 40 oC. While in the test module SD Card and the module DF Player did very well, with an average time of 154.4 ms storage, and execution time module DF Player of 1754.8 ms.

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