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Design a Vital Sign Monitor for Body Temperature (Axilla) and Oxymetry Parameters

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Abstract

In most hospitals, nurses routinely calculate and document primary vital signs for all patients 2-3 times per day to get information. Vital sign monitor is made for medical devices that can diagnose patients who need intensive care to determine patient needs. Some parameters were used oxygen saturation (SPO2), and body temperature. Therefore, the purpose of this study is to develop a vital sign monitor to record body temperature and oxygen saturation. This makes additional tasks are very important to be evaluated for medical staff and equipment manufacturers. This evaluation is needed to get the real condition of the patient. With the large number of patients who need evaluation, it is not possible to see the condition of some medical workers who work. This medical service is expected to reduce the workload of nurses with doctors and improve the quality of patient care. The great demand for these devices, mostly in intensive hospital rooms, is the basis for researching the output of data from multiple vital sensor monitor monitors to obtain accurate and precise outputs. The output of the two sensors is processed by Arduino Mega2560 and requested on a 5 inch TFT LCD in the form of body temperature and oxygen saturation. Comparison of module results with standard measuring instruments calibrated to reference this module is used for accurate and precise results. According to the assessment and reversing tool data with the dressing tool, the highest error value is 1%. With a maximum permitted permission of 5%.

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I. INTRODUCTION

Vital signs monitoring is an important nursing assessment. However, nurses seem to be doing it as part of a routine and often overlooking their significance in detecting patient deterioration [1]. In most hospitals, nurses routinely measure and document primary vital signs (e.g., pulse rate, oxygen saturation, respiratory rate, and body temperature) for all patients 2-3 times per day to assess the patient's condition. However, such measurement and documentation is a repetitive and time-consuming task for nurses [2]. They use different medical devices such as an electronic thermometer to measure body temperature and a pulse oximeter to measure heart rate and oxygen saturation. In particular, the measurement of respiratory rate is often omitted because having nurses count the chest wall movement in a busy hospital setting is not efficient [3], [4]. To reduce the workload of the nurses and improve the quality of patient care, we need equipment that can diagnose this vital organ in the human body continuously.

The patient monitoring system (PMS) is primarily implemented to have a quantitative evaluation of the crucial physiological parameters of patients during critical periods of biological functions. This system is used for measuring continuously automatically the values of the patients' important physiological parameters such as blood pressure, body temperature, ECG, EMG, heart rate, etc. [5]. Some of these parameters need to be improved for patients to the monitoring of physiological variables to evaluate treatment effects, to maintain thorough assessment of inpatients within a tertiary referral hospital 24 hours a day, early detection and treatment of post-procedural/surgical complications, early detection & treatment of the deteriorating patient emergency response system [6]. Pulse oximetry has become the standard of care in operating rooms, intensive care units (ICUs), and hospital wards in the United States and many other nations [7].

Before pulse oximetry was available, physicians relied on invasive procedures, such as arterial puncture for blood gas analysis, to identify the presence of hypoxemia. Unlike arterial blood gas analysis, pulse oximetry allows for noninvasive and continuous monitoring of arterial blood oxygen saturation. Although the pulse oximeter is easy to use, the clinician must understand the principles of pulse oximetry and must know how the equipment works to interpret the information it provides [8].

In addition to oxygen saturation in the body, human health can be identified from body temperature. Human body temperature is well established as one of the key vital signs. It is measured at regular intervals in the medical setting and often at home to try to estimate the degree of "sickness" of an individual [9]. It had been used since antiquity, in 1851, the German physician Carl Reinhold August Wunderlich obtained millions of axillary temperatures from 25,000 patients in Leipzig, thereby establishing the standard for normal human body temperature of 37˚C or 98.6 ˚F (range: 36.2–37.5˚C [97.2- 99.5 ˚F] [10]. A compilation of 27 modern studies, however [11], reported mean temperature to be uniformly lower than Wunderlich's estimate. Recently, an analysis of more than 35,000 British patients with almost 250,000 temperature measurements, found mean oral temperature to be 36.6˚C, confirming this lower value [12]. Remaining unanswered is whether the observed difference between Wunderlich's and modern averages represents true change or bias from either the method of obtaining temperature (axillary by Wunderlich vs. oral today) or the quality of thermometers and their calibration [13]. Wunderlich obtained his measurements in an era when life expectancy was 38 years and untreated chronic infections such as tuberculosis, syphilis, and periodontitis afflicted large proportions of the population). These infectious diseases and other causes of chronic inflammation may well have influenced the 'normal' body temperature of that era [10].

Individual body temperature depends on age, exertion, infection, sex, and the place of the body at which the measurement is made. However, each method has disadvantages when performing the measurements. .e thermometers can break if bitten when doing the oral measurement, the rectum could be injured when doing rectal measurements, and the thermometer may need to be left in a place for a long time to obtain an accurate measurement. [14]. Kinds of method measuring temperature body are Rectal measurements, oral measurements, and axillary measurements are the well-known methods for human body temperature measurements [15]. Modern devices for measuring axillary temperature may have changed the range of body temperature that is recognized as normal [16]. "Normal body temperature" was defined as the axillary temperature measured using a mercury thermometer (approximately 37.0 °C) [11]. This monitoring medical device has been made by Teguh, 2016, with the title Fingertip Pulse Oximeter Using PC Interface. This tool interface is preferred on devices with a flexible interface using a PC. Can reduce the portable side of the device. The research was carried out again with the development of IoT technology with the title "IoT-based Pulse Oximeter (SPO2) Design" by Septia Khairunisa in 2018. This study shows the SPO2 percentage value with the IoT system. The weakness of this study is that there is only one parameter, namely SPO2, and there is a delivery delay so that the data transmitted is not real-time.

Based on the results of the identification of the chronological problems above and take notice of the results of the evaluation through analysis on the previous tool, the author wants to design a patient monitor device with parameters (monitoring SPO2 values and temperature using the LCD touchscreen and real-time data monitoring).

II. MATERIALS AND METHODS

A. Experimental Setup

This study used six subjects aged between 20 and 28 years. Subjects were taken randomly, and data collection was repeated five times.

B. Materials and Device

This study uses the MAX30100 Sensor to monitor oxygen saturation in the blood (SpO2) and the LM35 Sensor to monitor the temperature body.[17] 2 resistors are used MAX30100 to pull up before entering the microcontroller. Arduino Mega2560 microcontroller was used to process the data read by the sensor MAX30100. Nextion 5.5-inch TFT LCD as a display for displaying the value Spo2 and Body temperature and using the 2300 mAH batteries as a power supply. Thermometer with brand Magic Star and Finger Pulse Oximetry with brand Elitech type of FOX1 was used as a means of comparison.

C. Experiment

In this study, researchers measured the value of spo2 and body temperature from respondents who were randomly selected, and the results were compared with standard.

D. The Diagram Block

When the power button is pressed, all circuits will have a voltage, including the Sensor, if the Sensor has a voltage indicating the Sensor is ready or standby. Place your index finger on the max30100 Sensor to get the value of oxygen saturation and place the LM35 Sensor on the axillary point of the body to get the value of body temperature. After that, the Sensor will start working and start processing data with analog data and then processed by Arduino Mega2560 for data processing. The data that has been identified will be processed from analog data to digital data. Initialization is needed to process data in the form of oxygen saturation percentages and body temperature in numbers.

All digital data results will be output or displayed on a 5.5 inch TFT LCD screen with oxygen saturation in the form of percentages per minute and body temperature in the form of figures continuously (**Fig. 1**).

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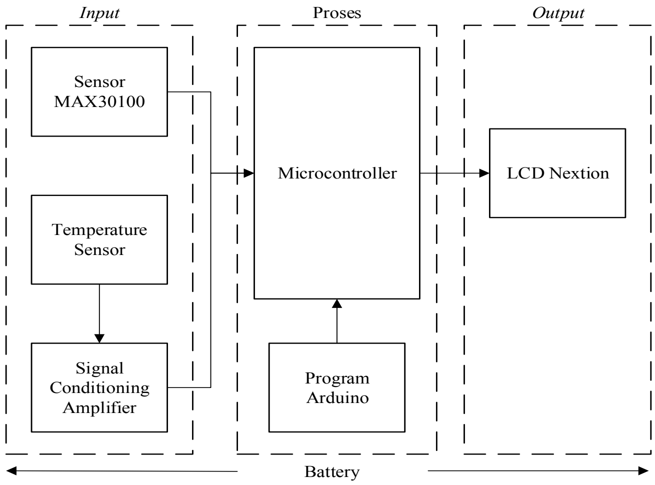

Fig 1. The diagram block of the Pulse Oximetry and Temperature Body

E. The Flowchart SPO2

The flowchart of the proposed method is shown in **Fig. 2**. The initial command will initialize the session. Place the index finger on the Sensor.

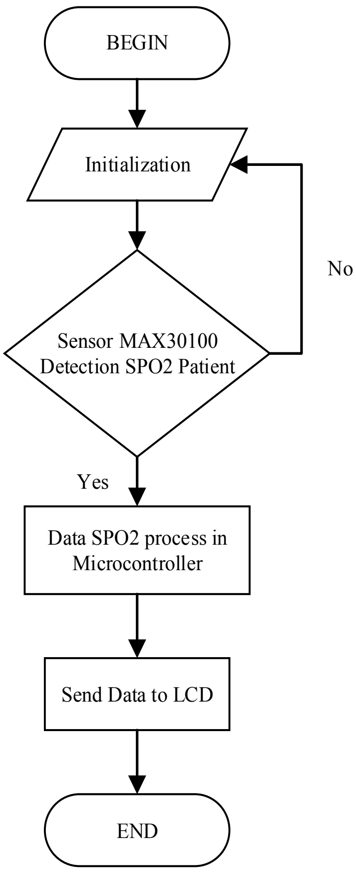

Fig 2. The Flowchart SPO2 of the Arduino Program

Then after completing the initialization process, the MAX30100 Sensor reads oxygen saturation in the blood and then passes it on to the microcontroller Arduino Mega2560 for processing (**Fig. 4**). Data that has been managed as a percentage will be sent and displayed on the LCD. In order to finish the measurement process, the on/off the button must be pressed to the off position, and then the measurement process will end.

F. The Flowchart Temperature Body

The flowchart of the proposed method, as shown in **Fig. 3**. The initial command will initialize the Sensor. Put LM35 Sensor in the axilla point of the body. Then after completing the initialization process, the temperature sensor reads the temperature value in the patient and then forwarded to the Arduino Mega2560 microcontroller for processing. The data that has been set will be approved and approved on the LCD. In order to activate the measurement process, the on/off button must be pressed to the off position, and then the measurement process will end.

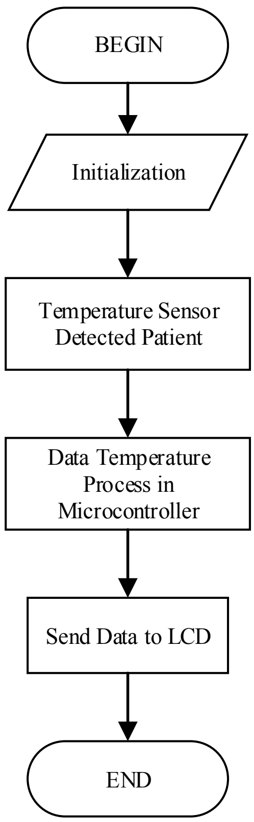

Fig 3. The Flowchart Temperature Body of the Arduino Program

G. Circuit

1) Circuit of microcontroller

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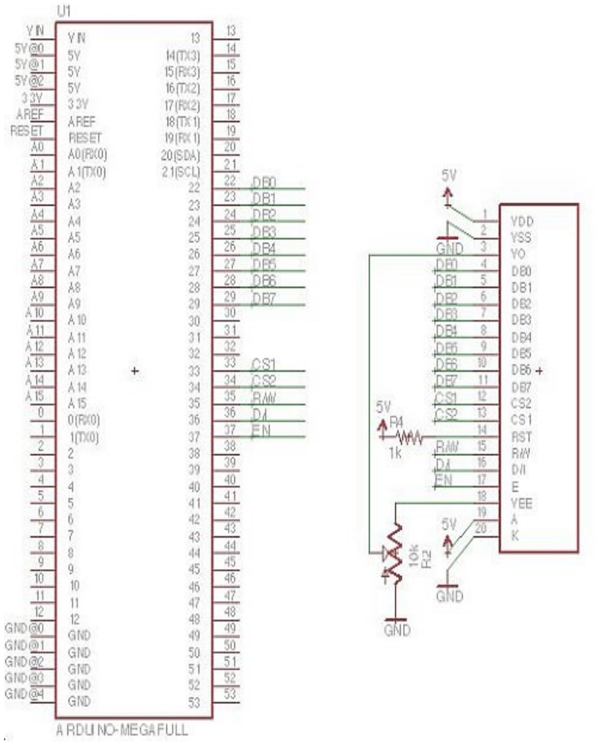

Fig 4. Circuit of microcontroller

2) *MAX3100*

The MAX30100 Sensor has a digital value output (**Fig. 5**). The value released is the ADC value that has been processed by the MAX30102 Sensor itself, which is then processed by the microcontroller. Before entering the microcontroller, the value of the Sensor is given a pull-up resistor.

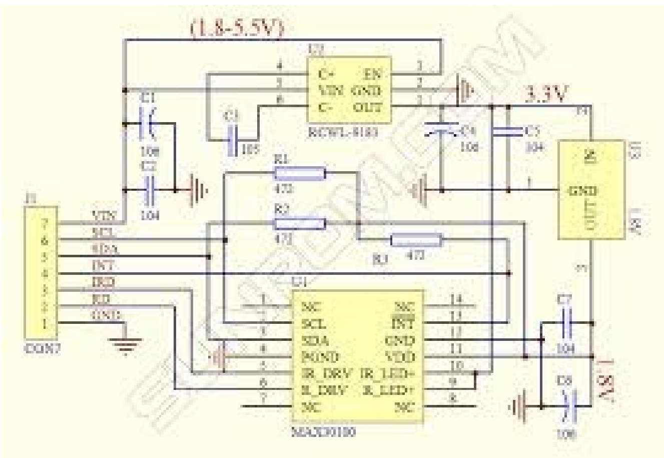

Fig 5. Circuit of MAX30100

3) *Filtering for LM35*

The output of the LM35 will go into two 150K resistors, which are paralleled to form a 75K resistor and fed with a 1uF capacitor is a recommended RC-Series circuit from the LM35 datasheet. While the 1K5 resistor and 1nF capacitor form a passive Low Pass filter circuit with a frequency of 1 kHz. With this circuit, it is proven that the output voltage of this circuit is much more stable than the output voltage of the basic circuit above. Thus the accuracy and precision of measurements can be improved. Opamp output voltage can be directly fed to the ADC circuit and then the data is further processed by a microcontroller. (Fig.6)

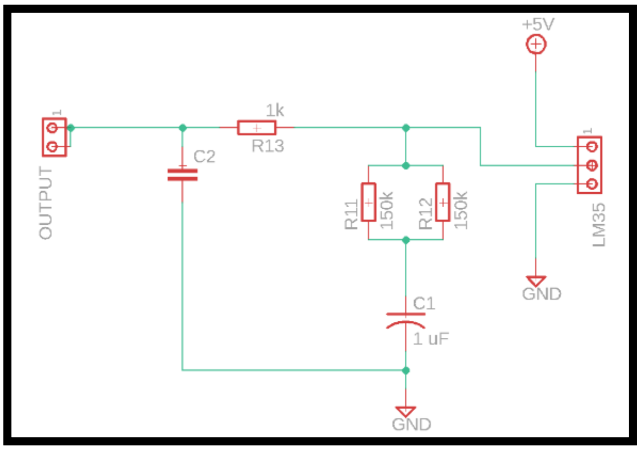

Fig 6. Circuit of PSA LM35 Body Temperature

III. RESULTS

In this study, the Oximetry was tested by comparing it with a standard measuring instrument. The results show (**Fig. 7 and Fig. 8**) that the value of the oximetry and body temperature with the value of a standard measuring instrument is feasible to use.

A. Results of microcontroller circuit design

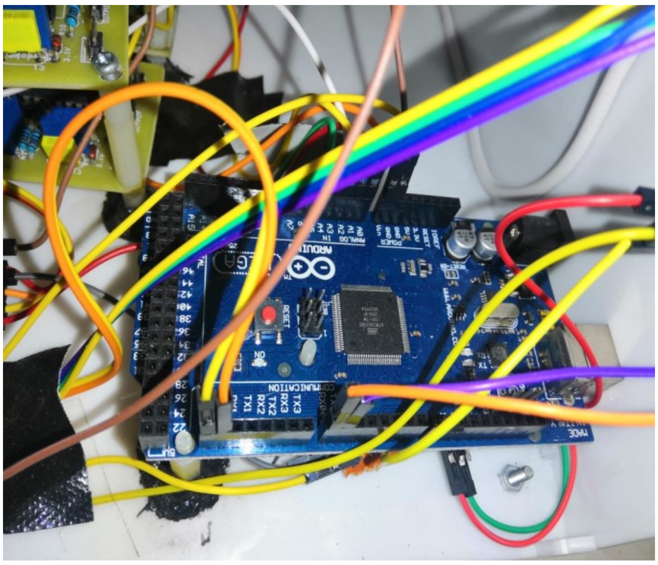

Fig 7. Results of microcontroller circuit design

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B. PSA LM35 circuit design

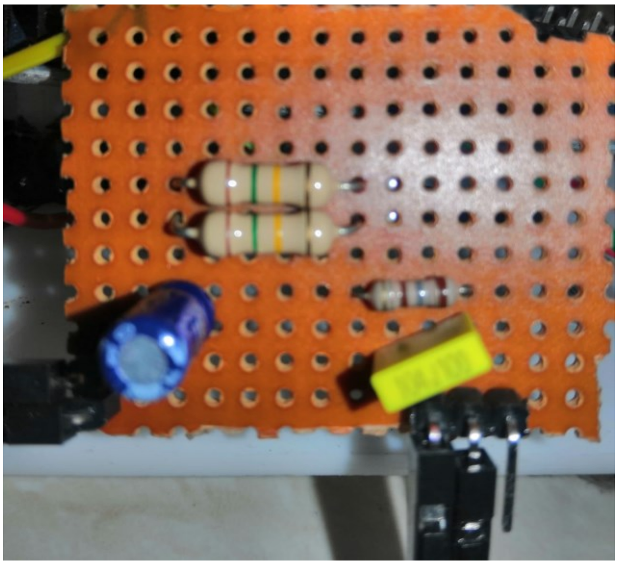

Fig 8. Pull-up Resistor

Pseudo Code: Reading SPO2 and Temperature Body

```
LOOP:
  jumlahperulanganbaca=jumlahperulanganbaca+1;
  suhu=analogRead(Suhu);
  suhu=suhu*2.56;
  suhu=suhu/10.23;
  suhutotal=suhutotal+suhu;
  IF (jumlahperulanganbaca==20) THEN
   suhuakhir= suhutotal/20;
   suhufinal=suhuakhir+4;
   jumlahperulanganbaca=0;
   suhutotal=0;
  ENDIF
  CALL pox.update();
  IF (millis() - tsLastReport > PERIOD_MS THEN
    PRINT Humidity
    PRINTSERIAL HeartRate());
    PRINT Oxigen
    PRINTSERIAL SpO2
    tsLastReport = millis();
  ENDIF
ENDLOOP
```

The above program is used to get the values of temperature and oxygen saturation. In order to get a stable temperature value, the signal conditioning circuit and the program listing above are needed, while for oxygen saturation, the program listing is adjusted to the Arduino Mega256 library.

C. Program initialization

```
INIT:
 Serial.begin(9600);
 delay(500);
 Serial.print("baud=115200");
 Serial.write(0xff);
 Serial.write(0xff);
 Serial.write(0xff);
 Serial.end();
 Serial.begin(115200);
 LOOP:
  FOR  thisReading = 0 and thisReading < numReadings
   thisReading++
   ENDFOR
   readings[thisReading] = 0;
;
  IF (!pox.begin())
    Serial.println("FAILED");
    FOR(;;)
      ENDFOR
  ENDIF
  IFELSE
   Serial.println("SUCCESS");
  ENDIFELSE
```

The above program is a program for TFT LCD and Sensor inisiaisasi MAX30102 to be able to communicate with the microcontroller. TFT LCD with 9600 baudrate and Sensor using a baudrate 115200. Then activate the library from max30100 before use.

Pseudo Code: Display Functions

```
IF (millis()-Report>waktukirim) THEN
 Serial.print("n1.val=");
 Serial.print(suhufinal);
 Serial.write(0xff);
 Serial.write(0xff);
 Serial.write(0xff);

 Serial.print("n2.val=");
 Serial.print(spo2);
 Serial.write(0xff);                         /
 Serial.write(0xff);
 Serial.write(0xff);

 Report = millis ();
ENDIF
```

The above program is a command to display the data or value already processed by the previous program then communicated with TFT LCD that is data Spo2 with a temperature body. **Fig. 7,** and **Fig. 8**. show responses of subject to SPO2 and temperature body, respectively. **Table I** and **Table II** show the measurement error for ten subjects for SPO2 and Body Temperature, respectively. (Fig.9) and (Fig.10).

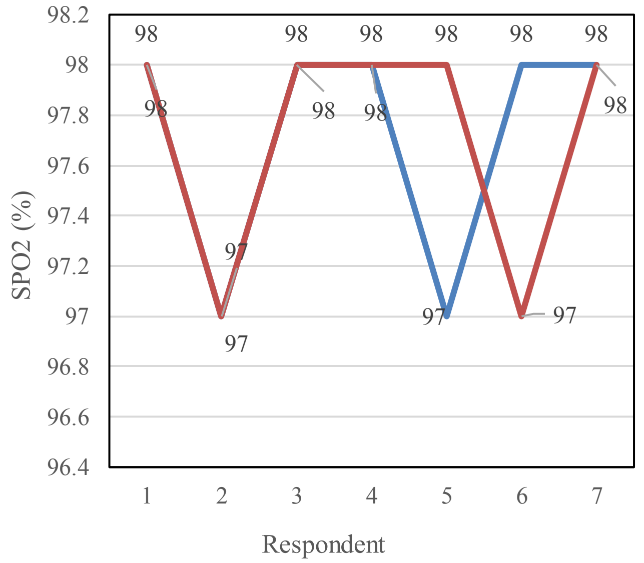

Fig 9. The result of the reading between the calibrator (red line) with the design (SPO2) (blue line)

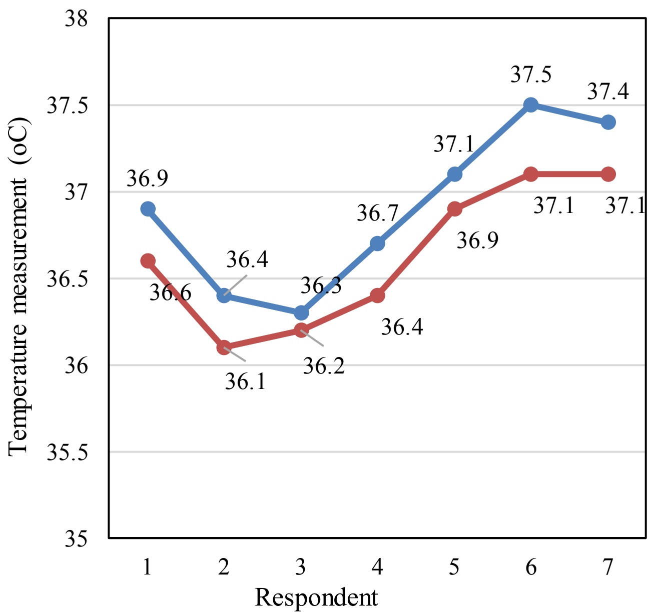

Fig 10. The result of the reading between the calibrator (red line) with the design (blue line) (Temperature Body)

D. *The Error of SPO2 (Beats Per Minutes)*

TABLE I. THE ERROR OF MEASUREMENT FOR THE SPO2 PARAMETER BETWEEN THE DESIGN AND STANDARD UNIT (PULSE OXIMETRY).

No	Subject	Error (%)
1	P1	0
2	P2	0
3	P3	0
4	P4	- 0,01
5	P5	0,01
6	P6	0

E. *The Error of BPM (Beats Per Minutes)*

TABLE II. THE ERROR OF MEASUREMENT FOR THE TEMPERATURE BODY PARAMETER BETWEEN THE DESIGN AND STANDARD UNIT (BODY TEMPERATURE).

No	Subject	Error (%)
1	P1	0,01
2	P2	- 0,002
3	P3	- 0,005
4	P4	- 0,01
5	P5	0,002
6	P6	- 0,002

IV. DISCUSSION

In this study, the researchers measured the value of SpO2 and heart rate from 6 randomly selected adult respondents, and the results were compared with standard measuring instruments. The temperature body parameter produces an error value of 0.01%, and for beat per minute parameters (SPO2) produces an error value of 0.01%. From the measurement results, this device can work well and is suitable for use. But as for the weakness of this module, that is when measuring if there is a finger movement that will cause a large error value.

V. CONCLUSION

After making a Portable Pulse Oximetry and Body temperature module that uses the MAX30100 and LM35 Sensor with a microcontroller using Arduino Mega2560 displayed on a TFT LCD. It can be generally concluded that the Portable Pulse Oximetry module can be used as an appropriate medical device.

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