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Patient Monitor for SpO_2 and Temperature Parameters

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***Abstract*-Patient monitor is an apparatus used to monitor the patient's condition in real-time, hence the patient's physiological conditions can be identified at that time. The purpose of this study is to design a patient monitor for SpO_2 and temperature parameters based on the computer with Delphi programming. In this work, the author developed the patient monitor with two parameters (SpO2 and Temperature). The workings of this tool are very simple by installing the finger sensor on the finger and the temperature sensor in the armpit area will then be detected by the two sensors that will be displayed on the PC and LCD Characters, analog data from the ADC Atmega is received by the personal computer (PC) via Bluetooth HC -05 and values per parameter are also displayed on the Character LCD. After measuring, get an error in the tool, the biggest SpO2 error of this tool is 1.02% and get the smallest error of 0.8%. And for the biggest error of Temperature of 1.02% and the smallest error of 0.8%.**

Keyword: patient monitor, finger sensor, LM35 sensor, SpO_2, temperature

I. INTRODUCTION

Patient monitors are tools used to monitor a patient's condition. This device records and displays the results of the patient's condition [1]. The monitoring process is carried out in real-time so that the patient's physiological conditions can be identified at that time. The parameters that can be displayed in patient monitors include "ECG, Respiration Rate, Blood Pressure or Non-Invasive Blood Pressure (NIBP), oxygen levels in SpO2 blood, Temperature, and in addition to Invasive Blood Pressure (IBP).

This study designed a tool that is able to monitor the patient's condition including ECG, BPM, Respiration Rate, Body Temperature, SpO2. SpO2 using photodiode as an optical sensor to capture light from an Infrared LED. The signal produced by the photodiode is a natural signal from the body with a small frequency that mixes with noise. While to monitor body temperature using the LM35 sensor.

To the knowledge of researchers, the level of monitoring of physiological parameters in patients treated is still not maximal. Nurses are still monitoring patients with direct contact, this is feared to cause high rates of transmission of the disease to nurses [2]. This makes handling patients less effective. Therefore the author wants to design a module "PATIENT MONITOR WITH TWO DISPLAYS (SpO2 and Temperature)"

In a previous study this tool had been made by Raden Duta Ikrar Abadi (2016) entitled "Monitoring Heart Rate, Respiration Rate equipped with a Temperature Sensor to a Personal Computer using Bluetooth)". Which is capable of displaying BPM values, Respiration Rate, and Body Temperature, then developed by Muhammad Alimul Husni (2017) entitled "Patient Monitor PC Display (SpO2 and BPM)" which adds SpO2 and ECG. However, this tool still does not have the appearance and parameters that we will make, namely with the Character LCD display and adding Respiration Rate and Temperature parameters.

Based on the identification of the above problems, the objective of this paper is to design a patient monitor with two-parameter (SpO2 and Temperature). this is a refinement of the design that has been made by the previous study.

II. MATERIALS AND METHODS

A. Experimental Setup

This study used ten normal subjects with the criteria the ages ranged between 22 and 27 years old and the weight is between 45 to 50 kg. The subjects were randomly sampled and the data collection is repeated 5 times.

1) Materials and Tool

This study uses a finger sensor to detect oxygen saturation and LM35 for detecting body temperature. monitoring for signals with numbers in Delphi and monitoring for numbers on character LCDs.

2) Experiment

In this study, a comparator for oxygen saturation using pulse oximetry and body temperature using a digital thermometer

B. The Diagram Block

The installed finger sensor will detect oxygen levels in the blood (SpO2). To get the value and signal from the finger sensor leads, it will then be processed in the photoplethysmograph sequence. The output of the

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photoplethysmograph circuit will be filtered to eliminate noise signals and interference will then be converted into digital data by the ADC from Atmega328. Besides the Atmega 328P microcontroller also functions to regulate serial communication with a personal computer (PC). Digital data from the 328P ADmega ADC is received by a personal computer (PC) via the HC-05 Bluetooth module. Furthermore, the data is processed with the Delphi program and then displayed on the monitor in graphical form and on the tool is also available a character LCD to display the values of all parameters.

LM35 temperature sensor that has been installed in the armpit area of the patient will detect the patient's body temperature The result of reading the LM35 temperature sensor will be processed with a PSA circuit so that the sensor output to Atmega 328 is in the range of 0-5V and received by personal computer (PC) via Bluetooth module HC-05.

Furthermore, the data is processed with the Delphi program and then displayed on the monitor in the form of values and on the tool is also available a character LCD to display the values of all parameters. The lm35 sensor specification is input 5-30 V every 1-degree increase is 10 Mv

The spo2 value is obtained from the ratio calculation obtained from the output of the photoplethysmograph circuit. there are 4 outputs from the circuit, namely AC RED, AC IR, DC RED, DC IR

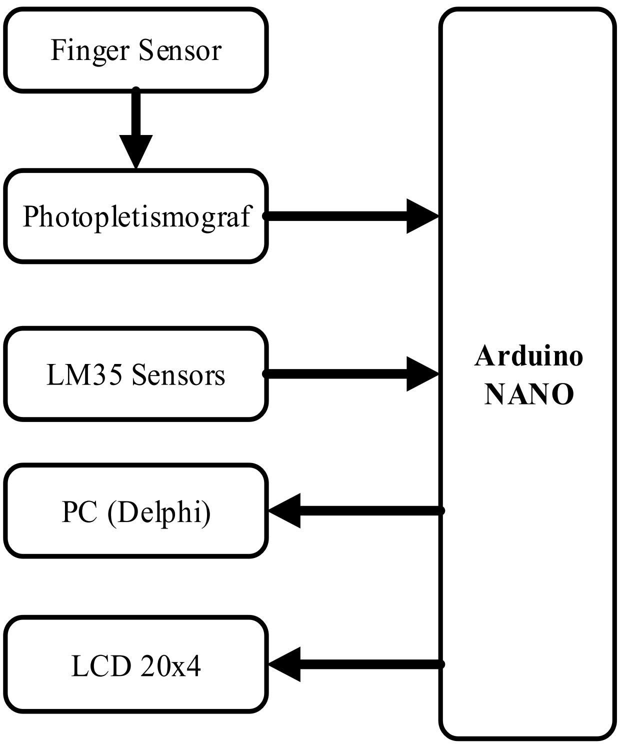

Fig. 1. The diagram block of the SpO_2 and Temperature

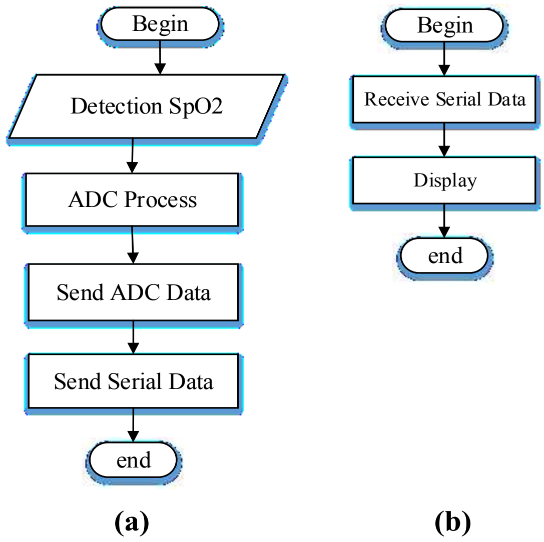

Fig. 2. The Flowchart of the SpO_2. (a) transmitter, (b) receiver

C. The Flowchart

In this Transmitter flow diagram, a compilation of tools turned on finger sensors will activate oxygen saturation levels in the patient's blood, then the updated signal will be received by the ADC microcontroller, after which it will be sent to the serial port using Bluetooth. On the Receiver flow diagram, then received then with the Delphi application programmed calculation of SpO2 and will be counted to the display, after it is finished.

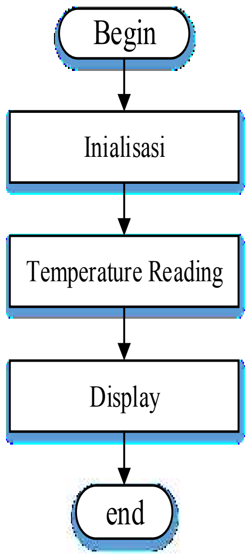

Fig. 3. The Flowchart of the Temperature

D. The Flowchart

When the device is turned on, the temperature sensor will detect the body temperature in the patient, then the detected

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temperature value will be processed by the microcontroller to be displayed on the display.

1) Preamplifier

The amplifier circuit and the second filter function for amplitude amplifiers and use the same filter. The noise signal looks thinner because it uses filters with the same cut-off frequency so the filter presses better.

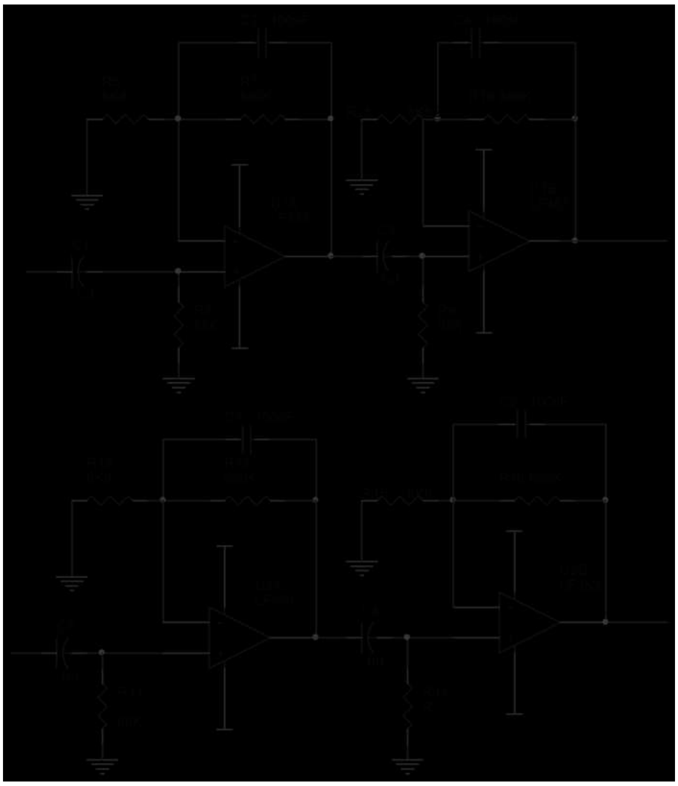

Fig. 4. Instrumentation amplifier

2) Astable

The astable circuit functions to provide a frequency of 868.8 Hz in the driver circuit for the infrared and red lamp. The transistor driver can work when it gets a voltage above 0.7 v for an NPN type transistor and works below 0.7v for a PNP type transistor

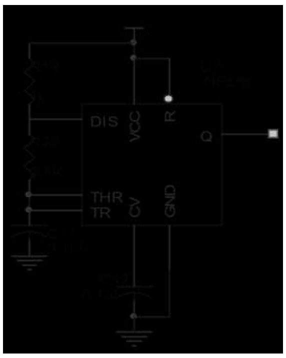

Fig. 5. Astable

3) Driver Transistor

The infrared lamp driver circuit and the red lamp function to give 1/0 logic to the infrared light and red lamp. The transistor driver can work when it gets a voltage above 0.7 v for an NPN type transistor and works below 0.7v for a PNP type transistor

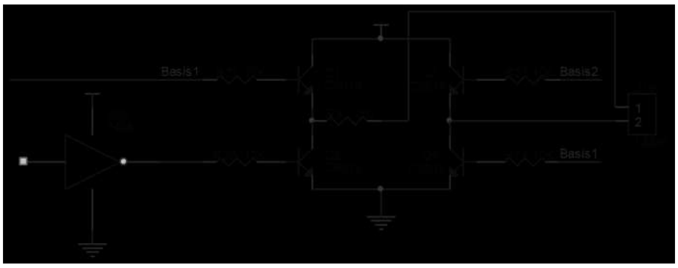

Fig. 6. Driver Transistor.

4) Summing Amplifier

The circuit for LM35 consists of resistors and capacitors which serve to stabilize the value of the LM35 output voltage. The lm35 sensor specification is input 5-30 V every 1-degree increase is 10 mV

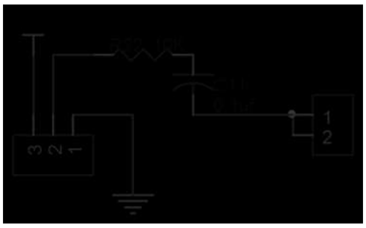

Fig. 7. LM35

5) Filter LPF

In this circuit a low pass filter is used with a cut-off frequency of 0.8 Hz to discard the AC signal and pass the DC signal. This circuit produces DC output IR and DC RED.

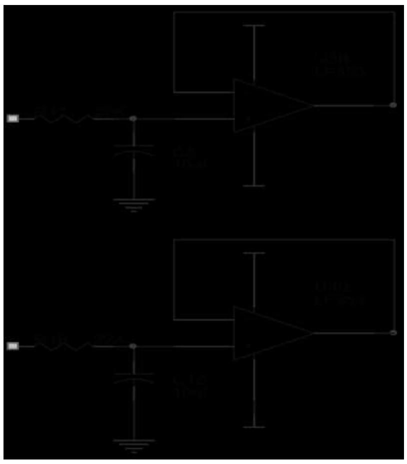

Fig. 8. Filter LPF

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III. RESULTS

1) *The Design*

Fig. 9. Design

2) *SpO₂ circuit*

In this circuit using a power supply + 12, -12, + 5, -5, the ground there are HPF and LPF filters in the circuit. with an HPF filter of 2.3 Hz and an LPF filter of 0.8 Hz.

The transistor driver can work when it gets a voltage above 0.7 v for an NPN type transistor and works below 0.7v for a PNP type transistor

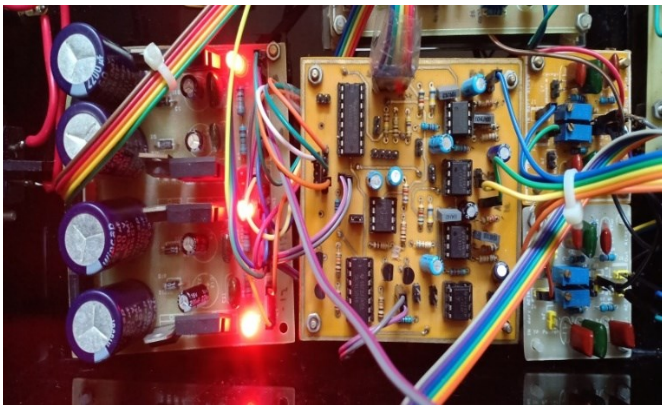

Fig. 10. SpO_2 circuit

3) *The Listing Program for Arduino SpO₂ and Temperature*

In this paper, the software was divided into two sections which are for Arduino and Delphi programming. The listing program for Arduino as shown in the Listing Program 1. Which consisted of the program to send the data to the computer

Listing program 1. Program to send the SpO_2 and temperature data to a computer

```
void loop()
{
unsigned long currentMillis = millis();
suhu=0;
for (int i=0;i<100;i++)
{
suhu=suhu+(analogRead(A6)*0.0048875855327468
23069403714565);
}
 suhuasli= (suhu/100*100);
if (currentMillis - previousMillis >= interval)
{
Serial.print('m');
Serial.print(suhuasli);
Serial.print('n');
previousMillis = currentMillis;
}
if (maksimumACredlamp < ACredlamp)
{
maksimumACredlamp = ACredlamp;
}
if (maksimumACinfrared < ACinfrared)
{
maksimumACinfrared = ACinfrared;
}
else
{
maksimumACinfrared=maksimumACinfrared;
holdACinfrared = (maksimumACinfrared * 0.4);
}
if (ACinfrared > holdACinfrared)
{
if (logika == 0)
{
counteran++;
nodetak = 0;
}
logika = 1;
}
else
{
 logika = 0;
}
if (counteran == 5)
{
if (DCredlamp == 0)
{
bagi1 = 0;
}
else
{
bagi1 = (float) maksimumACredlamp / DCredlamp;
}
if (DCinfrared == 0)
{
bagi2 = 0;
}
else
{
bagi2 = (float) maksimumACinfrared / DCinfrared;    }
```

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```
if (bagi2 == 1)
{
spo2 = spo2;
}
else
{
ratio = (float) bagi1 / bagi2;
spo2 = 110 - (25 * ratio);
}
maksimumACredlamp = 0;
maksimumACinfrared = 0;
}
tampilkan++;
cekdetak++;
}
if (DCinfrared == 0)
{
spo2 = 0;
}
Serial.print('e');
Serial.print(ACinfrared);
Serial.print('f');
Serial.print('k');
Serial.print(spo2);
Serial.print('l');
}
```

4) The Listing Program for Delphi SpO_2 and Temperature

In this study, the Delphi application is enabled to receive data from Arduino

Delphi's application in this study serves to monitor the patient's condition remotely. there are a signal display and the patient's body temperature value

Listing Program 3. Program to display the SpO_2 and Temperature.

```
//================SPO2==============/
procedure TForm1.ComDataPacket3Packet(Sender: TObject;
const Str: String);
Var
tegangan:double;
E,dataRAW:Integer;
begin
Val(Str,dataRAW,E);
tegangan:=dataRAW*0.0048875855327468230694037145651;
Label19.Caption:=floattostr(tegangan);
Memo3.Lines.Add(Label19.Caption);
Chart3.Series[0].AddXY(xval2,tegangan);
if
Chart3.Series[0].MaxXValue >
Chart3.BottomAxis.Maximum then begin
Chart3.Series[0].Clear;
xval2:=0;
//Memo3.Lines.Clear();
end;
xval2:=xval2+0.0261;
end;
//=========SPO2========//

procedure TForm1.ComDataPacket6Packet(Sender : TObject;
const Str: String);
begin
Label3.Caption:=Str;
end;
//=========SUHU=========//
procedure TForm1.ComDataPacket7Packet(Sender : TObject;
const Str: String);
begin

//==========ACIR============//
procedure TForm1.ComDataPacket10Packet(Sender :
TObject; const Str: String);
begin
Label21.Caption:=Str;
end;

//===============SPO2==========//
kelainan2:=strtofloat(Label3.Caption);
if kelainan2<90 then
begin
Label13.Caption:= 'Hypoxia';
end;
if kelainan2>100 then
begin
Label13.Caption:= 'Unit Error';
end;
if (kelainan2>=90) and (kelainan2<=100) then
begin
Label13.Caption:= 'Normal';
end;
//============SUHU========//
kelainan3:=strtofloat(Label4.Caption);
if kelainan3<32 then
begin
Label14.Caption:= 'HypoThermia';
end;
if kelainan3>37 then
begin
Label14.Caption:= 'HyperThermia';
end;
if (kelainan3>=32) and (kelainan3<=37) then
begin
Label14.Caption:= 'Normal';
end;
end;
end;
```

5) The second output amplifier and filter from the 14 foot demultiplexer

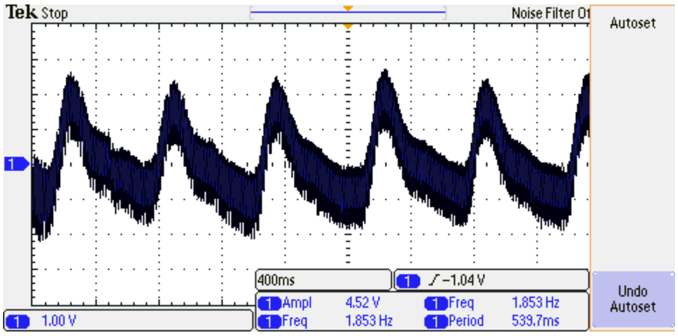

Fig. 11. Output filter ACRED

This is the measurement result on the output amplifier and the second filter from the 14-foot demultiplexer with a frequency of 1.853 Hz, amplitude of 4.52 V

6) The second output amplifier and filter from the 13-foot demultiplexer

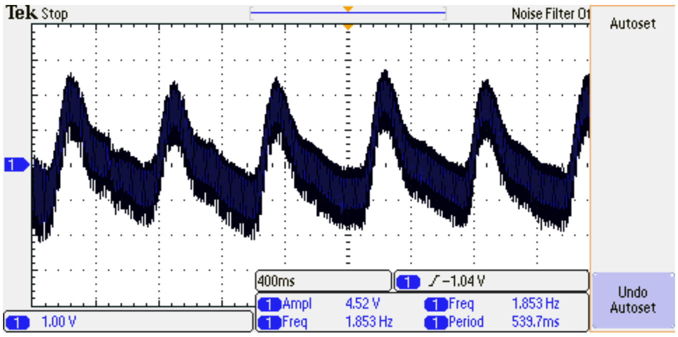

Fig. 12. Output filter ACIR

This is the measurement result at the output amplifier and the second filter from the 13-foot demultiplexer with a frequency of 1.853 Hz, an amplitude of 4.52 V

7) Output Astable

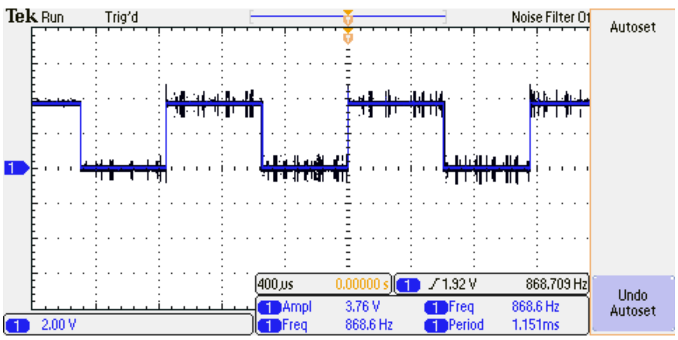

Fig. 13. Output astable

The result above is the output of an astable circuit that is active alternately with logic 1 (+ 5V) and 0 (GND)

8) output Transistor

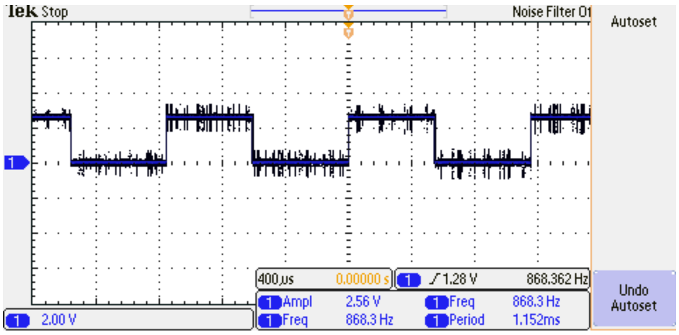

Fig. 14. Output transistor

This is the output after going through the transistor driver measured on connector J16 foot 1.

IV. Discussion

The Spo2 design and temperature were examined and fully tested in this study. Based on the measurement of output, the spo2 signal generated when using the input from the patient shows the correct pattern. Each spo2 record for each subject shows a different amplitude. This makes sense because each subject has different heart characteristics. the biggest error rate of spo2 and the temperature between the design and the comparator is 0.0609% for spo2 and 4.918% for temperature.

V. Conclusion

This study shows the development of Holter to monitor spo2 signals and the temperature of the subject in real-time. The study was built on an Arduino microcontroller and several analog circuits and Bluetooth transmitters to connect to a computer unit. The disadvantage of this study is that there is still an unstable value if there is movement from the patient.

References

[1] A. H. Noviyanto, "Perancangan Keamanan Data Pada Data Hasil Monitoring Pasien,", Jurnal Penelitian, Vol. 18, No. 1 pp. 38–42, 2014.

[2] Riki Ristanto, "Hubungan Respiratory Rate (RR) dan Oxygen Saturation (SpO2) Pada Klien Cedera Kepala,", Jurnal Kesehatan Hesti Wira Sakti, Vol 4, No. 5, 2017.

[3] Yoga Alif Kurnia Utama, "Perbandingan Kualitas Antar Sensor Suhu dengan Menggunakan Arduino Pro Mini," *e-Jurnal NARODROID*, vol. 2, no. 2. pp. 145–150, 2016.

[4] Wahyu Dwi Perdamaian, 2018. *Monitoring Photopletismograf PPG Berbasis Arduino tampil Personal Computer PC,* Tugas Akhir tidak diterbitkan, Prodi D-3 Teknik Elektromedik Poltekkes Kemenkes Surabaya, Surabaya