Bed Measuring Estimate Blood Volume and Cardiac Output With TFT Display Equipped With Data Storage (SpO_2 and BPM)

Ahmad Zaky Ma'arif#, Priyambada Cahya Nugraha, Andjar Pudji
Department of Electromedical Engineering Poltekkes Kemenkes, Surabaya
Jl. Pucang Jajar Timur No. 10, Surabaya, 60245, Indonesia
Email: #zaky926@gmail.com, priyambadacn@gmail.com, andjar.pudji@gmail.com
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Abstract

BED for measuring EBV and CO are the tools used to monitor the condition of preoperative patients. The Estimation Blood Volume (EBV) is a calculation to determine the approximate volume of blood in the human body and CO is the amount of blood volume pumped by the heart per minute the calculation of EBV used uses weight, height and gender. CO calculations utilize BPM multiplied by standard Stroke Volume. In this section the author discusses oxygen saturation in the blood using different wavelengths of red LED light and infrared captured by the photodiode. The author also discusses BPM to monitor minute heart rates. The design of this measuring instrument uses MAX30100 sensor, Arduino Mega , Arduino Nano and TFT LCD. Data from the MAX30100 sensor enters the Arduino minimum system, then is processed to produce a percentage of SpO_2 values which are then displayed on the TFT LCD. In the module, the data displayed can be stored and displayed again so that patient data can be traced. Testing is done by comparing the module with a standard measuring instrument that produces the biggest error of 2.80% on BPM and 0.95% on SpO_2.

Corresponding Author:
Priyambada Cahya Nugraha
Department of Electromedical Engineering
Poltekkes Kemenkes, Surabaya
Jl. Pucang East Jajar No. 10, Surabaya, 60245, Indonesia
Email: priyambadacn@gmail.com

I. INTRODUCTION

SpO_2 and BPM instrument is a tool used to measure the percentage of oxygen saturation and minute heart rate in patients. Pulse Oximetry is a non-invasive method for monitoring oxygen saturation (SpO2) from hemoglobin. At present, pulse oximetry devices are widely used in health services that include intensive care, rehabilitation rooms, and monitoring anesthesia patients

Previous SpO2 and BPM gauges have been made with the title "Fingertip Pulse Oximeter PC Display [1] in this study the author uses a PC as a data display so that it is less practical and difficult to carry when used in patients.

Estimated Blood Volume (EBV) is used to determine the approximate amount of blood volume in the human body. To determine the approximate amount of blood volume in the human body, the calculation of EBV uses weight and multiplied by the standard blood volume based on the age of the patient . That way both nurses or doctors can classify bleeding that occurs in patients before undergoing surgery.

Cardiac Output (CO) is the amount of blood released by the amount of blood released by the left ventricle into the aorta every minute. Calculation of CO is used to avoid hypovolemic disorders, which affect oxygen delivery in the body and involve heart function, so doctors or nurses can determine the appropriate treatment according to the patient's condition [2]. Cardiac output also affects anxiety and stress levels in preoperative patients [3].

EBV and CO calculators with reclining positions have previously been made with the title "Bed Counting Blood Volume and Cardiac Output Estimates in Preoperative Patients" [4] but there are still shortcomings namely there is no data storage. Then further developed with the title "EBV and CO measuring devices with TFT LCD display" [5] in this study the tools are equipped with supporting facilities with SpO2 parameters and height but there are still shortcomings namely the design of the tool can only be used in a standing position. If the tool is used in total paralyzed patients who cannot stand or sit, then when the measurement process becomes less comfortable and has not been equipped with data storage so that patient data cannot be traced.

From the above problems, the author would like to develop "BED EBV MEASURING AND TFT-LOADED MEASURES COMPLETED WITH DATA STORAGE (SpO2 and BPM)"

II. Materials and Methods

A. Experimental Setup

This study used twenty normal subjects with the criteria the ages above 18 years old. The subjects were randomly sampled and the data collection is repeated for 3 times

1) Materials and Tool

This study uses the module MAX30100, atmega 328 and atmega 2560 as microcontroller,.

2) Experiment

In this study, researchers measured output data in each patient and compared these results with comparison

B. The Diagram Block

The MAX30100 module is used to obtain SpO2 and BPM results. The output from the sensor is then processed using Arduino to produce a signal processing conversion of the SpO2 value in the form of% and BPM in the form of a minute heart rate. The results of processing signals in the form of SpO2 and BPM will be displayed by the TFT LCD. The TFT LCD will display with a save and load option. Save is used to store patient examination data, load is used to display the results of patient data.

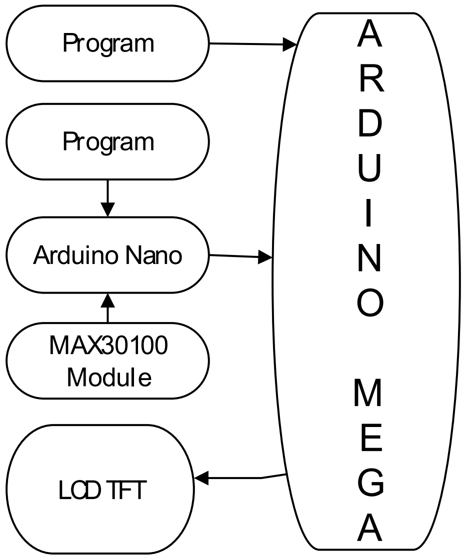

Fig. 1. The Diagram Block

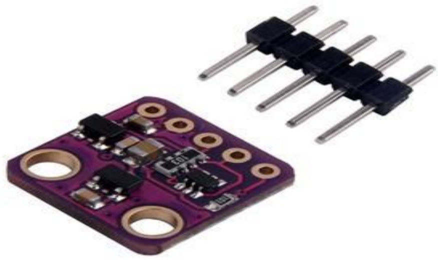

Fig. 2. MAX30100 Module

MAX30100 is an integrated module pulse oximetry and heart-rate. This module is a combination of 2 LEDs, photodetectors, optics, and low-noise signal processing to detect pulse oximetry and heart-rate.

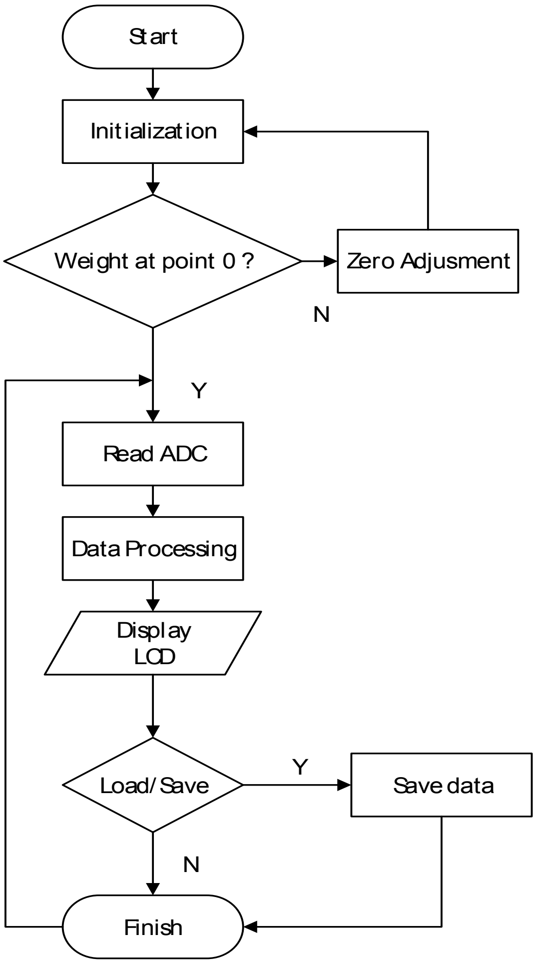

Fig. 3. The Flowchart of Arduino Mega

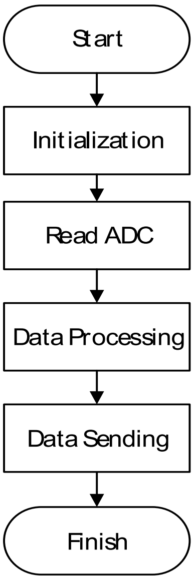

Fig. 4. The Flowchart of Arduino Nano

C. The Flowchart

In the flowchart of Arduino Mega, after the initialization is done, then do a tare calculation. Then the module and sensor make measurements, then the output data from the module and sensor are processed using Arduino which is then displayed on the LCD. Then enter the selection to store data, otherwise it will return to the LCD reading process. Users can display data stored on the LCD, if not done it will return to the process of reading the LCD.

In the flowchart of Arduino Nano, after the initialization is done, the sensor will take measurements, then the data from the sensor output is processed by Arduino Nano then the processed data will be sent to Arduino Mega.

D. The Module MAX30100 Circuit

The Module MAX30100 uses atmega 328 as the microcontroller, the module use a pull up resistor 4,7K Ohm on SDA and SCL pins

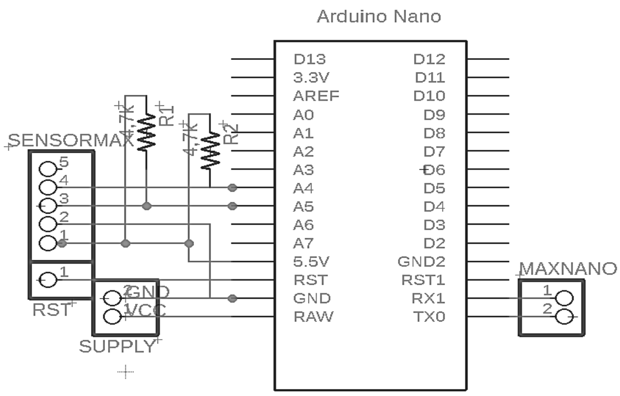

Fig. 5. The MAX30100 Circuit

E. The Whole Circuit

The module works according to the program that has been given. When the ON button is pressed or is ready, the LCD screen will start initializing, and the initial display appears. Then the LCD will display the required parameters. Then the patient lies down and places the index finger in the space provided, the sensor will start reading and processing the Arduino circuit which then results from Arduino processing will be displayed to a 5 inch TFT LCD LCD in the percentage unit of oxygen saturation and BPM. After completion the user can save the data that has been displayed by pressing save and can display the data by pressing load press the back or home button, then the display tool will be in the initial state. From the measurement results indicate an error value, this is due to many factors, such as the movement of the patient when carried out measurements and the effect of light intensity around the sensor will affect the reading results.

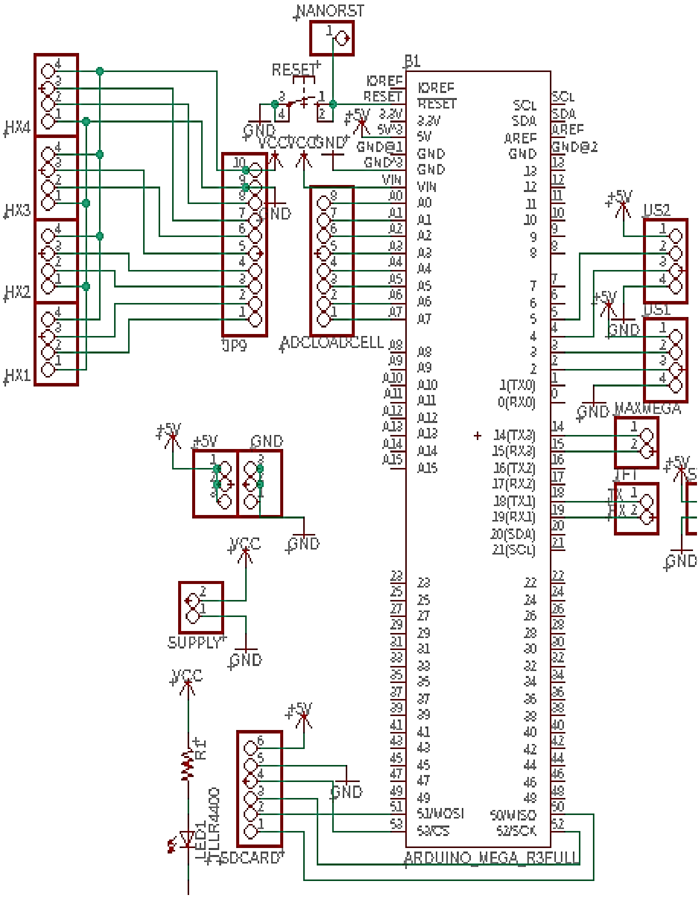

Fig. 6. The Whole Circuit .

III. RESULTS

Research has been conducted on modules and compared these results with standard comparison tools

Fig. 7. The Module Design

In figure 6 is the result of the overall module design, where the modules of the MAX30100 sensor, ultrasonic, and loadcell are combined together on the bed

1) The listing program for initialization

```
d1 = ultrasonic1;
d2 = ultrasonic2;
d3= heartBPM;
d4 = d3 * 70;
d5 = SaO2;
d6 = (k1 * d8/100 * d8/100 * d8/100) + (k2 * d7) + k3;
d7 = LDTOTAL;
d8 = 188 - d1 - d2;
```

The program above is an initialization of the variable variable data that will be included in the Arduino program before it is run

2) The listing program for displaying the data variable on LCD display

```
void kirim () {
  Serial1.print("txbpm.val=");
  Serial1.print(d3);
  Serial1.write(0xff);
  Serial1.write(0xff);
  Serial1.write(0xff);

  Serial1.print("txspo2.val=");
  Serial1.print(d5);
  Serial1.write(0xff);
  Serial1.write(0xff);
  Serial1.write(0xff);

  Serial1.print("txco.val=");
  Serial1.print(d4);
  Serial1.write(0xff);
  Serial1.write(0xff);
  Serial1.write(0xff);
```

.

The above program functions to display the variable data used, then which value or object will be determined to be displayed on the LCD TFT. the program above is an example of displaying data on BPM, CO and SpO_2 to LCD TFT.

3) The listing program for sending and processing data from arduino nano to arduino mega

```
void parsing () {
  if (Serial3.available()>0){
    String data=Serial3.readStringUntil('\n');
    int a = data.indexOf("A");
    int b = data.indexOf("B");
    int c = data.indexOf("C");
    s1 = data.substring(a+1,b);
    s2 = data.substring(b+1,c);
```

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```
}
     heartBPM = s1.toInt();
     SaO2 = s2.toInt();
}}
Void loop(){
   pox.update();
   if (millis() - tsLastReport > REPORTING_PERIOD_MS) 1000
{    Serial.print("A");
     Serial.print(pox.getHeartRate());
     Serial.print("B");
     Serial.print(pox.getSpO2());
     Serial.println("C");
     tsLastReport = millis();
   }}
```

The program above has a functions to send and process data from Arduino nano to Mega Arduino. on data transmission commands using the parsing command to separate whatever data is sent. on data processing commands, the command uses the program listed in the max30100 module sensor library

4) The result of measurement data analysis

Respondent	Device	SPO2 Measurements				
		x1	x2	x3	Mean	Error %
	Module	**97**	**98**	**99**	**98,0**	**0,68%**
1	**Comparison**	**99**	**98**	**99**	**98,7**	
	Module	**98**	**98**	**98**	**98,0**	**0,68%**
2	**Comparison**	**97**	**98**	**97**	**97,3**	
	Module	**98**	**98**	**98**	**98,0**	**0,68%**
3	**Comparison**	**97**	**97**	**98**	**97,3**	
	Module	**99**	**99**	**99**	**99,0**	**0,68%**
4	**Comparison**	**98**	**99**	**98**	**98,3**	
	Module	**99**	**99**	**97**	**98,3**	**0,68%**
5	**Comparison**	**97**	**98**	**98**	**97,7**	
	Module	**98**	**98**	**97**	**97,7**	**0,68%**
6	**Comparison**	**98**	**99**	**98**	**98,3**	
	Module	**99**	**99**	**99**	**99,0**	**0,34%**
7	**Comparison**	**98**	**99**	**99**	**98,7**	
	Module	**98**	**98**	**99**	**98,3**	**0,34%**
8	**Comparison**	**98**	**98**	**98**	**98,0**	
	Module	**98**	**98**	**98**	**98,0**	**0,68%**
9	**Comparison**	**97**	**98**	**97**	**97,3**	
	Module	**97**	**98**	**98**	**97,7**	**0,3%**
10	**Comparison**	**99**	**97**	**98**	**98,0**	
	Module	**97**	**97**	**98**	**97,3**	**0,68%**
11	**Comparison**	**98**	**98**	**98**	**98,0**	
12	**Module**	**99**	**99**	**99**	**99,0**	**0,00%**
	Comparison	**99**	**99**	**99**	**99,0**	
	Module	**98**	**99**	**98**	**98,3**	**0,34%**
13	**Comparison**	**98**	**98**	**98**	**98,0**	
	Module	**99**	**97**	**98**	**98,0**	**0,34%**
14	**Comparison**	**97**	**98**	**98**	**97,7**	
	Module	**99**	**98**	**98**	**98,3**	**0,34%**
15	**Comparison**	**98**	**98**	**98**	**98,0**	
	Module	**99**	**98**	**98**	**98,3**	**0,67%**
16	**Comparison**	**99**	**99**	**99**	**99,0**	
	Module	**98**	**98**	**98**	**98,0**	**0,34%**
17	**Comparison**	**98**	**98**	**99**	**98,3**	
	Module	**99**	**99**	**98**	**98,7**	**0,68%**
18	**Comparison**	**98**	**98**	**98**	**98,0**	
	Module	**99**	**98**	**99**	**98,7**	**0,34%**
19	**Comparison**	**98**	**98**	**99**	**98,3**	
	Module	**99**	**97**	**97**	**97,7**	**0,69%**
20	**Comparison**	**98**	**97**	**96**	**97,0**	

Table 1. SpO_2 Measurement

Based on the measurement of SpO2 that has been done, the biggest error value is 0.69% and the smallest is 0%.

NO	Device	BPM Measurements				
		x1	x2	x3	Mean	Error %
	Module	62	62	64	62,7	1,57%
1	Comparison	62	64	65	63,7	
	Module	78	78	79	78,3	0,84%
2	Comparison	77	80	80	79,0	
	Module	70	70	72	70,7	0,95%
3	Comparison	70	70	70	70,0	
	Module	69	66	65	66,7	0,99%
4	Comparison	67	67	68	67,3	
	Module	97	91	93	93,7	0,72%
5	Comparison	95	92	92	93,0	
	Module	88	90	91	89,7	0,37%
6	Comparison	90	89	91	90,0	
	Module	87	84	86	85,7	2,80%
7	Comparison	83	83	84	83,3	
	Module	95	95	94	94,7	1,43%
8	Comparison	93	94	93	93,3	
9	Module	96	95	95	95,3	2,51%

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	Comparison	93	93	93	93,0	
	Module	69	68	68	68,3	0,99%
10	Comparison	69	67	67	67,7	
	Module	65	68	68	67,0	0,50%
11	Comparison	67	67	68	67,3	
	Module	68	68	69	68,3	0,49%
12	Comparison	68	68	68	68,0	
	Module	83	84	83	83,3	0,40%
13	Comparison	83	83	83	83,0	
	Module	74	74	76	74,7	0,88%
14	Comparison	75	74	77	75,3	
	Module	68	67	69	68,0	0,00%
15	Comparison	68	68	68	68,0	
	Module	101	100	98	99,7	1,97%
16	Comparison	100	103	102	101,7	
	Module	104	105	104	104,3	0,64%
17	Comparison	103	104	104	103,7	
	Module	85	85	83	84,3	0,39%
18	Comparison	84	85	85	84,7	
	Module	98	97	98	97,7	1,35%
19	Comparison	99	99	99	99,0	
	Module	69	67	68	68,0	2,51%
20	Comparison	66	66	67	66,3	

Table 2. BPM Measurement

Based on BPM measurements that have been done, the biggest error value is 2.8% and the smallest is 0%.

		CO Measurements				
NO	Device	x1	x2	x3	Mean	Error %
	Module	4340	4340	4480	4386,7	1,57%
1	Comparison	4340	4480	4550	4456,7	
	Module	5460	5460	5530	5483,3	0,84%
2	Comparison	5390	5600	5600	5530,0	
	Module	4900	4900	5040	4946,7	0,95%
3	Comparison	4900	4900	4900	4900,0	
	Module	4830	4620	4550	4666,7	0,99%
4	Comparison	4690	4690	4760	4713,3	
	Module	6790	6370	6510	6556,7	0,72%
5	Comparison	6650	6440	6440	6510,0	
6	Module	6160	5880	6370	6136,7	2,59%
	Comparison	6300	6230	6370	6300,0	
	Module	6090	5880	6020	5996,7	2,80%
7	Comparison	5810	5810	5880	5833,3	
	Module	6650	6650	6580	6626,7	1,43%
8	Comparison	6510	6580	6510	6533,3	
	Module	6720	6650	6650	6673,3	2,51%
9	Comparison	6510	6510	6510	6510,0	
	Module	4830	4760	4760	4783,3	1,0%
10	Comparison	4830	4690	4690	4736,7	
	Module	4550	4760	4760	4690,0	0,50%
11	Comparison	4690	4690	4760	4713,3	
	Module	4760	4760	4830	4783,3	0,49%
12	Comparison	4760	4760	4760	4760,0	
	Module	5810	5880	5810	5833,3	0,40%
13	Comparison	5810	5810	5810	5810,0	
	Module	5180	5180	5320	5226,7	0,88%
14	Comparison	5250	5180	5390	5273,3	
	Module	4760	4690	4830	4760,0	0,00%
15	Comparison	4760	4760	4760	4760,0	
	Module	7070	7000	6860	6976,7	1,97%
16	Comparison	7000	7210	7140	7116,7	
	Module	7280	7350	7280	7303,3	0,64%
17	Comparison	7210	7280	7280	7256,7	
	Module	5950	5950	5810	5903,3	0,39%
18	Comparison	5880	5950	5950	5926,7	
	Module	6860	6790	6860	6836,7	1,35%
19	Comparison	6930	6930	6930	6930,0	
	Module	4830	4690	4760	4760,0	2,51%
20	Comparison	4620	4620	4690	4643,3	

Table 3. CO Measurement

Modulee testing was carried out on 20 adult respondents consisting of 10 male respondents and 10 female respondents. The results of the CO measurements that have been made have the highest error value of 2.8% and the smallest is 0%.

IV. DISCUSSION

In making this Module the author uses a Module circuit from Arduino Mega as the main controller and Arduino Nano as a MAX30100 sensor data processor. In Arduino Mega, several programs are used to run the tool Modules, among others: program performance from TFT, data storage, load cell data processing, ultrasonic data processing. The Arduino Mega program is used to process data from the Max30100 Module and send data to Arduino Mega.

From the Modules that have been made, there are some disadvantages of the Module, The disadvantages are : If there is an artifact movement that results from the movement of the respondent's finger, this will increase the error value, the intensity of the light around the MAX30100 sensor can affect the results of reading the measurement parameters of SpO2, BPM, and CO.

V. CONCLUSION

Based on the results of the discussion and goals can be concluded that the Module can be made a tool the bed for measuring EBV and CO with TFT display equipped by data storage (SpO$_2$ and BPM). Arduino software can be created to process measurement results and display and store data on measurements on the TFT LCD. Our Modules provide measurements consisting of 6 parameters namely EBV, CO, SpO2, BPM, weight and height.The biggest error value in BPM measurements is 2.8%. The biggest error value in the measurement of SpO2 is 0.69%.The biggest error value in measuring CO is 2.8%. The Development in this research can be done at : the place to press the MAX30100 sensor is made more tightly so that the movement of the patient's index finger can be reduced and the tool has a cover on the MAX30100 sensor to protect it from the intensity of light around the sensor.

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