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Bed Measuring Estimate Blood Volume and Cardiac Output With TFT Display Equipped With Data Storage (SpO2 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 , Article Info Abstract Article History: Received June 9, 2019 Revised July 20, 2020 Accepted Jan 11, 2020 Keywords: SpO2 BPM EBV CO MAX30100 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 SpO2 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 SpO2. 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 This work is an open access article and licensed under a Creative Commons Attribution-Non Commercial 4.0 International License. I. INTRODUCTION SpO2 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 Journal of Electronics, Electromedical, and Medical Informatics (JEEEMI) 6 tools are equipped with supporting facilities with SpO2 parameters and height but there are still shortcomings namely Pr ogram A 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 R sit, then when the measurement process becomes less comfortable and has not been equipped with data storage so that Pr ogram D patient data cannot be traced. U From the above problems, the author would like to I develop "BED EBV MEASURING AND TFT-LOADED Arduino Nano N MEASURES COMPLETED WITH DATA STORAGE (SpO2 and BPM)" O MAX30100 Modul e II. MATERIALS AND METHODS M A. Experimental Setup E This study used twenty normal subjects with the criteria the LCD TFT G ages above 18 years old. The subjects were randomly sampled A and the data collection is repeated for 3 times 1) Materials and Tool Fig. 1. The Diagram Block 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. 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. Start C. The Flowchart In the flowchart of Arduino Mega, after the initialization is done, then do a tare calculation. Then the module and sensor Initialization 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 Weight at point 0 ? Zero Adjusment the LCD. N 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 Y data will be sent to Arduino Mega. Read ADC D. The Module MAX30100 Circuit The Module MAX30100 uses atmega 328 as the DataProcessing microcontroller, the module use a pull up resistor 4,7K Ohm on SDA and SCL pins Displ ay LCD Load/ Save Y Save data N Finish Fig. 3. The

Flowchart of Arduino Mega Fig. 5. The MAX30100 Circuit Start E. The Whole Circuit The module works according to the program that has been Initialization 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 Read ADC 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 Data Processing 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 Data Sending 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 Finish results. Fig. 4. The Flowchart of Arduino Nano Fig. 6. The Whole Circuit . III. RESULTS Research has been conducted on modules and compared these results with standard comparison tools 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 SpO2 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); Fig. 7. The Module Design s2 = data.substring(b+1,c); } 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 Respo SPO2 Measurements ndent Device 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 Module 98 99 98 13 Comparison 98 98 98 Module 99 97 98 14 Comparison 97 98 98 Module 99 98 98 15 Comparison 98 98 98 Module 99 98 98 16 Comparison 99 99 99 Module 98 98 98 17

Comparison 98 98 99 Module 99 99 98 18 Comparison 98 98 98 Module 99 98 99 19 Comparison 98 98 99 Module 99 97 97 20 Comparison 98 97 96 Table 1. SpO2 Measurement 99,0 98,3 0,34% 98,0 98,0 0,34% 97,7 98,3 0,34% 98,0 98,3 0,67% 99,0 98,0 0,34% 98,3 98,7 0,68% 98,0 98,7 0,34% 98,3 97,7 0,69% 97,0 Based on the measurement of SpO2 that has been done, the biggest error value is 0.69% and the smallest is 0%. NO Device Module 1 Comparison Module 2 Comparison Module 3 Comparison Module BPM Measurements x1 x2 x3 Mean 62 62 64 62,7 62 64 65 63,7 78 78 79 78,3 77 80 80 79,0 70 70 72 70,7 70 70 70 70,0 69 66 65 66,7 Error % 1,57% 0,84% 0,95% 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% Comparison 93 93 93 Module 69 68 68 10 Comparison 69 67 67 Module 65 68 68 11 Comparison 67 67 68 Module 68 68 69 12 Comparison 68 68 68 Module 83 84 83 13 Comparison 83 83 83 Module 74 74 76 14 Comparison 75 74 77 Module 68 67 69 15 Comparison 68 68 68 Module 101 100 98 16 Comparison 100 103 102 Module 104 105 104 17 Comparison 103 104 104 Module 85 85 83 18 Comparison 84 85 85 Module 98 97 98 93,0 68,3 67,7 67,0 67,3 68,3 68,0 83,3 83,0 74,7 75,3 68,0 68,0 99,7 101,7 104,3 103,7 84,3 84,7 97,7 0,99% 0,50% 0,49% 0,40% 0,88% 0,00% 1,97% 0,64% 0,39% 1,35% 19 Comparison 99 99 99 Module 69 67 68 20 Comparison 66 66 67 Table 2. BPM Measurement 99,0 68,0 2,51% 66,3 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 Module 4340 4340 1 Comparison 4340 4480 Module 5460 5460 2 Comparison 5390 5600 Module 4900 4900 x3 4480 4550 5530 5600 5040 Mean Error % 4386,7 1,57% 4456,7 5483,3 0,84% 5530,0 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% 6930,0 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 (SpO2 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. REFERENCES [1] e. kartini et al., “fingerstip pulse oxymeter tampil pc ( bpm ) sensitif untuk mengetahui kadar oksigen dalam darah ( spo2 ) dan dari akibat perbedaan kepekatan,” pp. 1–8, 2015. [2] m.tubagus ” kursi penghitung ebv dan co pada responden pre op berdasarkan berat badan dan bpm menggunakan finger sensor" 1-16 [3] anis m hubungan kecemasan dengan cardiac output pada responden pre operasi sectio caesarea di instalasi kamar operasi rumah sakit umum islam orpeha tulungagungi. - 1433 issn online: 2579 - 7301,” vol. 6, no. 2, pp. 171–175, 2018. 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