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# Design of The WBAN in The Mobile Health Monitoring System

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## ABSTRACT

*WBAN (Wireless Body Area Network) technology is used in this study to provide an integrated health monitoring platform. The device utilizes MLX90615 for measuring body temperature, a Blood Pressure Sensor for measuring blood pressure and pulse rate, and a MAX30102 Sensor for measuring blood oxygen and blood glucose levels. The output of this utility is displayed on an OLED screen and is controlled by the NODEMCU ESP8266. The test reveals an accuracy of 94.8%, indicating that the instrument can provide accurate results and has a relatively low error rate on each sensor. Heart Rate Error on Blood Pressure Sensor 0; Spo2 Error on MAX 30102 Sensor 1; and Blood Sugar Error on MAX 30102 Sensor 2.0. Real-time health monitoring that is more accurate and efficient. This device has the potential to be a practical solution for routine health monitoring and provides significant benefits for maintaining health.*

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## 1. INTRODUCTION

Health is a priceless value in our lives. Health encompasses the physical, mental and social balance that enables us to live a fit and meaningful life. Without good health, it isn't easy to experience the joy and happiness of life. Therefore, maintaining good health is a top priority, allowing us to reach our full potential in living a better life.[1]

Maintaining a healthy body is important to undergo regular health checks. With this, we can detect potential health problems early before they become more serious and difficult to overcome [2]. Health checks include measuring vital signs such as blood pressure [3], oxygen in the blood [4], body temperature [5], heart rate [6], and blood sugar [7].

In checking these vital signs to monitor a person's health condition, clinical tools such as a thermometer, oximeter, tensimeter, oscilloscope and glucometer are needed [8]. However, these clinical tools are used separately and are not integrated with one health device. As a result, medical personnel must check or measure patients individually.

In connection with this, a multisensory/multifunctional health monitoring device integrated with one device using health service technology, namely, WBAN (Wireless Body Area Network), has been developed and designed. WBAN is a wireless sensor network application that uses Internet of Things (IoT) technology [9] to monitor the condition of the human body. In addition, WBAN can also perform non-invasive checks, which allows medical personnel to monitor and measure patients in real time without the need to check one by one [10].

Based on these developments, this study develops technology using several sensors/multi-sensors and components to design a health monitoring tool. The sensors used include the MLX90615 Sensor, Blood pressure Sensor, MAX30102 Sensor, and NODEMCU ESP8266 Mini microcontroller.

The control of the parameter sensors and the presentation of the results on an Organic Light Emitting Diode (OLED) make this research extremely significant [11]. The System On Chip ESP8266 (NODEMCU ESP8266) is an open-source Internet of Things platform created by the espressif system [12]. In some earlier research using IoT-based techniques, NODMCU ESP8266 was always employed [13].

The MLX90615 sensor is an infrared temperature sensor that can measure body temperature or an object non-contact. This sensor uses infrared technology to detect the measured object [14]. A blood Pressure Sensor is a sensor used to measure patients' blood pressure and heart rate [15]. MAX30105 sensor is a sensor used to measure oxygen levels in the blood (SpO2) and is also used to measure glucose levels in the blood [16].

In previous research, [17] made a heart rate and body temperature monitoring tool to get good accuracy with a percentage accuracy of 99.1% for heart rate and 99.4% for body temperature. Other health measurement research was also conducted [18] using the android-based NOD MCU ESP8266 microcontroller, which only uses three parameters: body temperature, heart rate, and blood pressure. This study tested normal measuring instruments with the designed tools, NODMCU and parameter sensors have high accuracy, namely, the results of measuring body temperature accuracy of 99.21% with a maximum error of 0.79%, measuring heart rate accuracy of 98.30% with a maximum error of 1.70%, and measuring blood pressure for systolic accuracy 94.94% and diastolic 93.55%. And for a maximum error of 5.06% systolic and 6.45% diastolic

Based on the description above, a health monitoring device is designed that combines several sensors to measure body temperature, heart rate, blood pressure, oxygen in the blood and blood sugar levels. This tool uses the NODMCU ESP8266 microcontroller to integrate and process sensor data. With this tool, the author hopes to provide great benefits in health monitoring and can provide accurate and real-time information about the body's health condition and become a practical and efficient solution in checking health regularly.

## 2. RESEARCH METHOD

This study is carried out in the implementation stages: Component Selection and Hardware Design, Circuit Design, Tool Assembly and tool testing or trials. The research framework show in Figure 1:

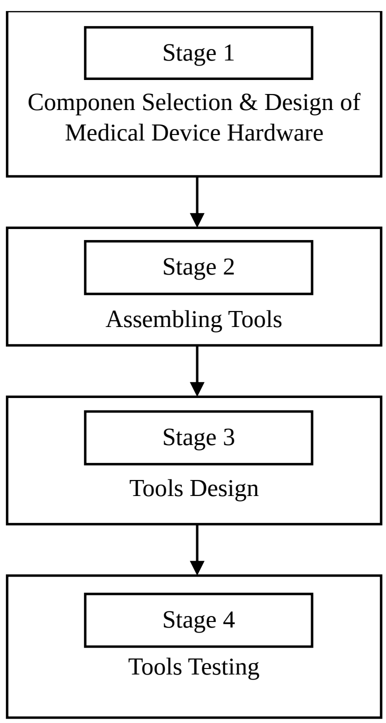



**Figure 1**. Research Outline

### 2.1. Hardware Design

In Hardware Design, a component is needed to make a device, and below are the components used in the health monitoring device.

#### 2.1.1. NODEMCU ESP8266 Mini

NodeMCU is an IoT platform that is Opensource. It consists of hardware as a system on chip ESP8266 from ESP8266 but espresso system. NodeMCU has packaged ESP8266 into a board that has been integrated with various features such as a microcontroller and accessibility to wifi and a communication chip in the form of USB to serial [12].

#### 2.1.2. Arduino Nano

Arduino is an open-source electronic board with a main component, namely, an Atmega328 microcontroller chip of the AVR type from the Atmel company. Arduino nano board is small in size, so it makes it easier to make small tools such as this health monitoring tool. This Arduino nano has the same functional advantages as any type of Arduino [19][20].

#### 2.1.3. Sensor MLX90615

MLX90615 is an industry-standard digital temperature sensor with an analogue to digital converter, integrated delta (ADC), and I 2C interface. MLX90615 provides 9-bit digital temperature readings with an accuracy of +4oC, so the temperature sensor's accuracy is quite accurate when used [14].

#### 2.1.4. Sensor MAX30102

This sensor is a module that contains a red LED, infrared LED and photodiode, and this sensor uses I2C communication. This sensor uses reflectance mode, where the red LED, infrared LED and photodiode are placed in one line. Light from the red and infrared LED will radiate, and then the light waves from the infrared LED will be absorbed by the blood if it contains a lot of oxygen [16].

### 2.2. Assembling Device

At this stage, after the components needed by the device have been collected, then here the components are assembled into a health monitoring device.

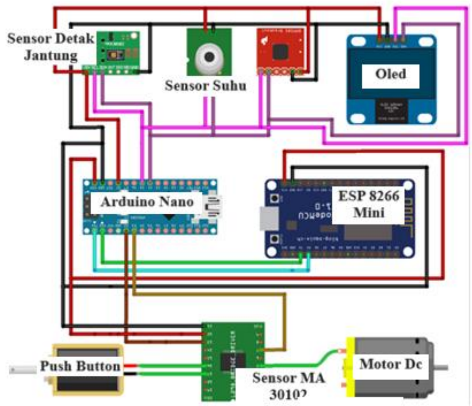



**Figure 2**. Circuit Schematic Device

Figure 2 is the overall circuit design scheme that has been designed using components from hardware. These components consist of several sensors, namely, MAX30102 sensor as a sensor of oxygen levels in the blood and blood sugar, AP3 models blood pressure sensor as a sensor of blood pressure and heart rate, mini DC motor as an air pressure pump, solenoid as a place that regulates the exit and entry of pressure, NodeMCU ESP8266 mini as a wifi module and microcontroller, OLED as a display tool, and Arduino nano as a program controller.

## 2.3. Design of Devices

After the device has been assembled or the tool has been completed, the next stage is to design the device. This instrument is designed to be worn on the wrist and is sufficiently compact to make its use more efficient and effective.

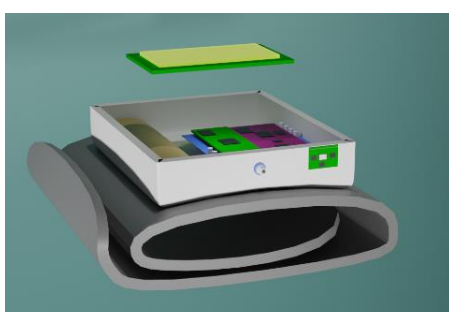


**Figure 3**. Device Design

Figure 3 depicts a design for a tool in which all sensors are set in one location and connected to the NODMCU ESP8266 microcontroller that serves as the device's microcontroller. Figure 4 depicts the arrangement of all used components:

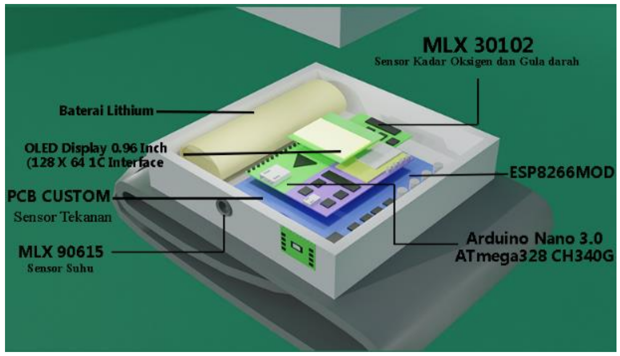
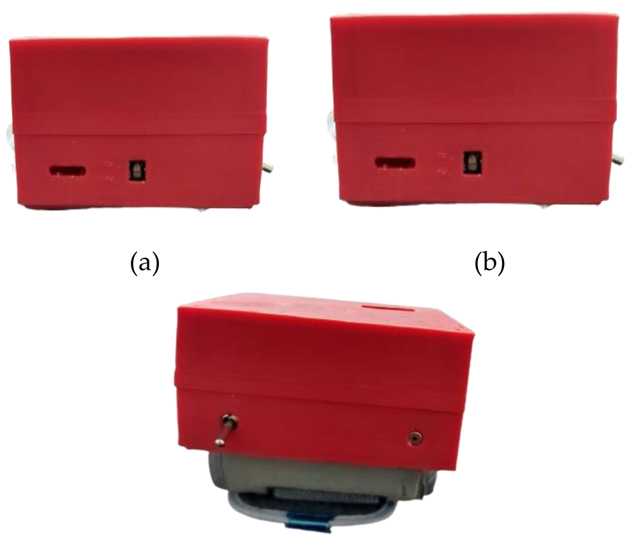



**Figure 4**. Component Layout

Figure 4 which displays the orderly arrangement of components within a box or casing, is an example of best practices in electronic device design. It can also facilitate maintenance, repairs, and enhancements over a longer period.

## 2.4. Device Set

The next stage, following the creation of the device design and component layout, is to assemble the actual device using the sensors and components that were previously chosen. The device is depicted show in Figure 5.



(a) (b)

(c)

**Figure 5**. Device Set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## 3. RESULTS AND DISCUSSION

### 3.1. Evaluation of Device Performance

The device is subjected to performance testing to determine if it is able to function as intended and if all sensors operate as they should. The testing of device efficacy is detailed in Table 1:

**Table 1**. Medical Device Performance Testing based on the level of stability in a time span of 1 hour

| No | Date | Time | Age | Temprature (°C) | Systolik (mmHg) | Diastolik (mmHg) | Heart Rate | Spo2 | Glukosa (mg/dL) | Male/ Female | Duration/ Second |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 July | 14.50 | 20 | 42 | 128 | 88 | 100 | 100 | 98 | Male | 1.16.90 |
| 2 | 29 July | 14.53 | 20 | 36 | 117 | 84 | 96 | 98 | 98 | Male | 1.15.29 |
| 3 | 29 July | 14.56 | 20 | 36 | 67 | 53 | 25 | 87 | 98 | Male | 1.08.40 |
| 4 | 29 July | 14.59 | 20 | 36 | 120 | 86 | 87 | 97 | 98 | Male | 1.15.98 |
| 5 | 29 July | 15.02 | 20 | 36 | 121 | 84 | 89 | 97 | 98 | Male | 1.16.02 |
| 6 | 29 July | 15.05 | 22 | 37 | 111 | 83 | 87 | 87 | 97 | Male | 1.15.20 |
| 7 | 29 July | 15.08 | 22 | 41 | 119 | 84 | 90 | 92 | 100 | Male | 1.15.12 |
| 8 | 29 July | 15.11 | 22 | 36 | 121 | 82 | 98 | 100 | 98 | Male | 1.16.67 |
| 9 | 29 July | 15.14 | 22 | 31 | 114 | 76 | 89 | 93 | 98 | Male | 1.17.12 |
| 10 | 29 July | 15.17 | 22 | 36 | 63 | 51 | 18 | 92 | 98 | Male | 1.11.78 |
| 11 | 29 July | 15.20 | 21 | 36 | 129 | 90 | 96 | 96 | 98 | Male | 1.16.91 |
| 12 | 29 July | 15.24 | 21 | 37 | 128 | 89 | 92 | 98 | 98 | Male | 1.11.89 |
| 13 | 29 July | 15.27 | 21 | 36 | 130 | 91 | 91 | 96 | 98 | Male | 1.16.98 |
| 14 | 29 July | 15.29 | 21 | 36 | 129 | 79 | 91 | 97 | 99 | Male | 1.16.12 |
| 15 | 29 July | 15.32 | 21 | 31 | 129 | 82 | 103 | 88 | 98 | Male | 1.18.29 |
| 16 | 29 July | 15.35 | 20 | 36 | 52 | 34 | 70 | 99 | 98 | Female | 1.11.12 |
| 17 | 29 July | 15.38 | 20 | 36 | 94 | 77 | 89 | 98 | 98 | Female | 1.12.14 |
| 18 | 29 July | 15.41 | 20 | 36 | 94 | 78 | 90 | 97 | 98 | Female | 1.11.90 |
| 19 | 29 July | 15.44 | 20 | 36 | 90 | 76 | 90 | 97 | 99 | Female | 1.13.02 |
| 20 | 29 July | 15.47 | 20 | 36 | 94 | 76 | 86 | 95 | 98 | Female | 1.12.34 |
| 21 | 29 July | 15.49 | 19 | 37 | 100 | 80 | 79 | 93 | 97 | Female | 1.12.74 |
| 22 | 29 July | 15.52 | 19 | 32 | 101 | 79 | 80 | 97 | 100 | Female | 1.10.22 |
| 23 | 29 July | 15.55 | 19 | 36 | 100 | 83 | 82 | 98 | 98 | Female | 1.12.01 |
| 24 | 29 July | 15.58 | 19 | 36 | 102 | 83 | 82 | 98 | 99 | Female | 1.13.09 |
| 25 | 29 July | 16.00 | 19 | 37 | 104 | 89 | 85 | 99 | 98 | Female | 1.14.56 |

The table above (Table 1) is a device performance test based on the stability level in 1 hour. From the device performance data results, 25 data were obtained, of which there were data that did not match / error. Is due to several obstacles, such as:

The following specifications apply to the temperature sensor (MLX90615): The temperature sensor cannot read the patient's condition against the temperature if the patient's temperature is not detected. In this case, the temperature sensor automatically determines the room's temperature. If the temperature data does not reach the usual (36-37), it is caused by the distance of the patient's fingers from the temperature sensor being too great. However, if the temperature is above average (36-38), the patient's digits cover the entire temperature sensor, causing it to read abnormally. If the temperature is above average (36-38 degrees Fahrenheit), the patient's fingers are covering the entire temperature sensor, causing the sensor to detect abnormally. To take accurate temperature readings, the patient's fingers should be brought closer to the sensor without covering all of it and not too far from the sensor, as shown in the image below (shown in figure 6).

**Figure 6**. Example of incorrect temperature measurement due to fingers too far and too close to the temperature sensor (MLX90615)

**Figure 7**. The finger is placed in front of the sensor

Figure7 is the correct position to measure the temperature near and far from the temperature meter (MLX90615). If the measurement is performed accurately, the temperature sensor will emit pertinent information regarding the patient's condition. The following is a description of the Blood Pressure Sensor: The patient is tense or unrelaxed, which causes inaccurate blood pressure data. Other causes include the patient's hand not being parallel to the heart's height when taking their blood pressure. Ideally, the arm should be similar to the size of the patient's heart when taking their blood pressure. If the blood pressure reading is off, the patient's heart rate reading is also off because the heart rate follows the blood pressure reading. In any case, the heart rate and blood pressure sensors are on the same sensor. Additionally, the patient's psychological state, including how


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relaxed or worried they are, significantly impacts the findings of heart rate measurements. For these reasons, it is advised that the patient be prepared to take measures before any measurements are taken.

The effect that different test durations have on patients is due to:

a. The level of stability of the hand position when performing blood pressure, if the arm position is stable, the analysis of the device for measuring the Blood Pressure sensor will be easier, the data will be correct, and faster / second.
b. On the Spo2 sensor (MAX30102): The sensor's difficulty level penetrates the fingertip's surface during spo2 measurement. If the patient being measured has a fingertip with a thin and bright skin surface, then the test tends to be faster, whereas if the patient has a thick and dark fingertip surface, the measurement will take longer than for patients who have a thin and bright fingertip surface, this is because the scanning method performed on the spo2 sensor is based on photo reflective on the fingertip blood flow.
c. Influence on gender because women generally have a lower blood pressure than men. Is likely due to different hormonal variations.

Why does the blood sugar data look the same in all patients? It is not because the sensor is damaged, but because the sensor cannot use real blood from the patient but uses the surface of the fingertip that will be scanned by the MAX30102 sensor, which should be if you want to check blood sugar must use real blood from the patient. But that does not mean the data displayed is wrong / not by the patient's blood sugar condition.

**Table 2**. Medical Device Data on the Elderly

| No | Age | Time | Temprat ure(°c) | Systolik (mmHg) | Diastolik (mmHg) | Heart Rate | Spo2 | Glukosa (mg/dL) | Male/ Female | Status | Duration second |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55 | 09.00 | 38 | 86 | 62 | 101 | 90 | 97 | Male | Not Healthy | 1.16.20 |
| 2 | 60 | 09.15 | 36 | 140 | 90 | 83 | 92 | 97 | Female | Healthy | 1.20.21 |
| 3 | 63 | 09.30 | 36 | 128 | 85 | 84 | 85 | 98 | Male | Healthy | 1.18.11 |
| 4 | 59 | 09.45 | 37 | 121 | 80 | 80 | 96 | 101 | Female | Healthy | 1.15.15 |
| 5 | 66 | 09.55 | 37 | 133 | 81 | 81 | 96 | 98 | Female | Not Healthy | 1.15.90 |
| 6 | 67 | 10.10 | 37 | 129 | 81 | 91 | 95 | 100 | Female | Healthy | 1.17.87 |
| 7 | 81 | 10.25 | 36 | 125 | 88 | 88 | 95 | 90 | Female | Healthy | 1.17.11 |
| 8 | 58 | 10.40 | 36 | 119 | 85 | 87 | 95 | 100 | Male | Healthy | 1.21.14 |
| 9 | 70 | 11.00 | 36 | 112 | 80 | 88 | 96 | 97 | Male | Healthy | 1.20.09 |
| 10 | 79 | 11.15 | 36 | 140 | 92 | 89 | 96 | 100 | Male | Not Healthy | 1.22.11 |
| 11 | 69 | 11.30 | 36 | 125 | 80 | 62 | 98 | 98 | Female | Healthy | 1.16.78 |
| 12 | 59 | 11.45 | 36 | 134 | 82 | 100 | 99 | 98 | Male | Healthy | 1.21.89 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 69 | 12.00 | 36 | 125 | 81 | 90 | 99 | 100 | Female | Healthy | 1.16.15 |
| 14 | 66 | 12.15 | 37 | 126 | 85 | 80 | 99 | 99 | Female | Healthy | 1.16.90 |
| 15 | 77 | 12.30 | 36 | 135 | 80 | 98 | 99 | 91 | Female | Healthy | 1.17.14 |

Data collection of this medical device is carried out in the morning, which is carried out five times / per person, and the average medical device checked on elderly patients takes 1.17.52 seconds.

**Table 3**. Medical Device Data on Adults

| No | Age | Time | Temp (°c) | Systolik (mmHg) | Diastolik (mmHg) | Heart Rate | Spo2 | Glukosa (mg/dL) | Male/ Female | Status | Duration/ Second |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 45 | 08.00 | 37 | 93 | 62 | 84 | 94 | 97 | Female | Not Healthy | 1.08.19 |
| 2 | 41 | 08.15 | 38 | 138 | 96 | 87 | 97 | 97 | Male | Not Healthy | 1.20.21 |
| 3 | 40 | 08.30 | 36 | 91 | 82 | 94 | 94 | 98 | Female | Healthy | 1.10.20 |
| 4 | 50 | 08.50 | 35 | 78 | 71 | 81 | 82 | 97 | Female | Not Healthy | 1.09.90 |
| 5 | 44 | 09.00 | 36 | 129 | 84 | 80 | 97 | 113 | Female | Healthy | 1.12.35 |
| 6 | 33 | 09.10 | 36 | 114 | 87 | 78 | 97 | 104 | Male | Healthy | 1.17.15 |
| 7 | 37 | 09.25 | 37 | 120 | 84 | 76 | 97 | 98 | Female | Healthy | 1.15.23 |
| 8 | 39 | 09.40 | 36 | 115 | 85 | 71 | 98 | 98 | Male | Healthy | 1.19.56 |
| 9 | 30 | 09.55 | 36 | 130 | 88 | 80 | 97 | 102 | Male | Healthy | 1.18.34 |
| 10 | 48 | 10.10 | 37 | 133 | 84 | 85 | 97 | 98 | Male | Healthy | 1.18.90 |
| 11 | 49 | 10.25 | 37 | 131 | 83 | 86 | 92 | 98 | Male | Healthy | 1.17.01 |
| 12 | 45 | 10.40 | 36 | 125 | 82 | 69 | 96 | 102 | Female | Healthy | 1.11.21 |
| 13 | 30 | 11.00 | 37 | 145 | 100 | 86 | 100 | 98 | Male | Not Healthy | 1.22.67 |
| 14 | 25 | 11.20 | 36 | 90 | 89 | 80 | 98 | 98 | Male | Healthy | 1.15.87 |
| 15 | 40 | 11.35 | 36 | 91 | 83 | 88 | 87 | 97 | Male | Healthy | 1.14.08 |
| | | | | | | | | | | | Average: 1.5.39 |

Data collection of this medical device is carried out in the morning, where data collection is carried out five times/per person, and the average time of medical devices checked on adult patients is 1.15.39 seconds.

**Table 4**. Medical Device Data on Adolescents

| No | Age | Time | Tempra ture (°c) | Systolik (mmHg) | Diastolik (mmHg) | Heart Rate | Spo2 | Glukosa (mg/dL) | Gender | Status | Duration/ Second |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 21 | 10.00 | 35 | 97 | 64 | 66 | 81 | 98 | Female | Not Healthy | 1.09.09 |


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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 22 | 10.20 | 36 | 82 | 63 | 94 | 87 | 97 | Female | Not Healthy | 1.07.87 |
| 3 | 21 | 10.35 | 36 | 79 | 67 | 89 | 92 | 98 | Female | Not Healthy | 1.07.21 |
| 4 | 20 | 10.50 | 36 | 104 | 87 | 89 | 90 | 98 | Male | Healthy | 1.14.08 |
| 5 | 21 | 11.05 | 36 | 119 | 85 | 77 | 96 | 100 | Male | Healthy | 1.16.14 |
| 6 | 23 | 11.20 | 36 | 121 | 84 | 76 | 93 | 97 | Male | Healthy | 1.16.90 |
| 7 | 22 | 11.35 | 36 | 114 | 82 | 74 | 96 | 91 | Female | Healthy | 1.11.14 |
| 8 | 21 | 11.50 | 36 | 124 | 86 | 73 | 94 | 98 | Male | Healthy | 1.15.90 |
| 9 | 20 | 12.10 | 37 | 97 | 81 | 80 | 92 | 97 | Female | Healthy | 1.10.98 |
| 10 | 22 | 12.25 | 36 | 114 | 85 | 74 | 97 | 101 | Male | Healthy | 1.16.16 |
| 11 | 23 | 12.35 | 36 | 118 | 86 | 93 | 95 | 98 | Male | Healthy | 1.15.09 |
| 12 | 20 | 12.50 | 38 | 130 | 97 | 87 | 91 | 98 | Male | Not Healthy | 1.19.98 |
| 13 | 23 | 13.00 | 36 | 90 | 82 | 89 | 94 | 97 | Female | Healthy | 1.10.12 |
| 14 | 19 | 13.15 | 36 | 121 | 89 | 95 | 97 | 98 | Male | Healthy | 1.16.65 |
| 15 | 20 | 13.30 | 37 | 111 | 83 | 90 | 96 | 98 | Male | Healthy | 1.15.07 |
| | | | | | | | | | | | Average: 1.13.49 |

The collection of medical device data is carried out during the day, which is carried out five times / per person, and the average time for medical devices checked on Teenage patients is 1.13.49 seconds.

The testing conducted using Multifunctional Health Monitoring Using Wireless Body Area Network Technology involved three age groups, namely adolescents, adults, and the elderly, and was performed five times per individual in the morning and afternoon. This testing appears to be designed to collect extensive health data from various age groups and at different times throughout the day.

By including different age groups in the testing, the purpose may be to identify differences in health parameters and body responses between adolescents, adults, and the elderly. The testing conducted in the morning and afternoon can also provide insights into how an individual's health parameters may vary throughout the day.

## 3.2. Device Accuracy Calculation

**Calculation of Systolic Error on Blood Pressure Sensor as follows:**

$$\%Error = \frac{\text{True Value - Experiment Value}}{\text{True Value}} \times 100$$

$$\%Error = \frac{89\text{-}86}{89} \times 100$$

% = 3,3

**Calculation of Diastolik Error on Blood Pressure Sensor as follows:**

$$\%Error = \frac{\text{True Value - Experiment Value}}{\text{True Value}} \times 100$$

$$\%Error = \frac{86\text{-}87}{86} \times 100$$

% = -1,1

**Calculation of Heart Rate Error on Blood Pressure Sensor as follows:**

$$\%Error = \frac{\text{True Value - Experiment Value}}{\text{True Value}} \times 100$$

$$\%Error = \frac{89 - 89}{89} \times 100$$

% = 0

**Calculation of the Spo2 Error on the MAX 30102 Sensor is as follows:**

$$\%Error = \frac{\text{True Value - Experiment Value}}{\text{True Value}} \times 100$$

$$\%Error = \frac{96\text{-}95}{96} \times 100$$

% = 1,0

**Calculation of Blood Sugar Error on MAX 30102 Sensor as follow:**

$$\%Error = \frac{\text{True Value - Experiment Value}}{\text{True Value}} \times 100$$

$$\%Error = \frac{99\text{-}97}{99} \times 100$$

% = 2,0

**Accuracy** = 100 - $\%Error$

= 100 – 5,2 %

= 94,8 %

Based on the error calculations provided for the parameters measured by the Blood Pressure sensor and MAX 30102 sensor, it can be concluded that the accuracy of both sensors is approximately 94.8%. This means that the measurement results from these sensors have an error rate of about 5.2%.


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Although there is a slight margin of error in the measurements, the accuracy level of approximately 94.8% is considered good, especially when these sensors are used for medical or diagnostic purposes. This indicates that the sensors can provide results that are reasonably close to the actual values and are generally reliable for clinical use. However, it's important to always consider that sensor measurements can impact medical decisions, and therefore, it's advisable to keep in mind that these results may require further confirmation or additional monitoring in critical clinical situations.

A 94.8% accuracy level for the device indicates that it has a good level of accuracy and can compete with standard clinical instruments such as thermometers, oximeters, blood pressure monitors, oscilliscopesm, and glucometers. A 5.2 % eror rate is a competitive figure in the context of medical measurements anda health monitoring.

## 4. CONCLUSION

The health monitoring device's accuracy in measuring body temperature, heart rate, blood pressure, blood oxygen levels, and blood sugar levels is 94.8%. Comparisons with currently available medical equipment on the market demonstrate this. The device succeeded in providing accurate results and has a relatively low percentage of error on each sensor, including 3.3 Systolic error on the blood pressure sensor, -1.1 Diastolic error on the blood pressure sensor, 0 Heart Rate error on the blood pressure sensor, 1.0 Spo2 error on Sensor MAX 30102, and 2.0 Blood Sugar error on MAX 30102 Sensor.

Distance, position, and patient state are all variables that can alter the measurement findings while utilizing these medical devices. Careful testing is also required to ensure the device's limitations in producing accurate and meaningful data for patient health diagnosis are achieved.

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