JoFRISE 2 (4) (2024)
Journal of Frontier Research in Science and Engineering
https://journal.riau-edutech.com/index.php/jofrise
Publisher :
Andester Riau Edutech
Pusat Inovasi Pendidikan dan Teknologi
ISSN : 3032-0348

Development Of A Non-Invasive Heart Health Measurement Device Using The Max30100 Sensor

Juli Pratiwi[1*], Muhammad Sahal[2]
[1]*Master of Physics Education Study Program, University of Riau, Indonesia*

*Corresponding author's email: julipratiwi41@gmail.com

Submiited: 24/10/2024
Revised: 15/11/2024
Accepted: 15/11/2024
Published: 31/12/2024
Vol. 2
No. 4

© 2024 The Authors.
This open access article is distributed under a (CC-BY License)

Abstract- Lifestyle Healthy is aspect crucial in maintain mental and physical health. Lifestyle covering various activities carried out daily like eat, exercise physical, sleep, etc. Lifestyle can become reason death someone. Besides pattern life, health is also influenced by genetic factors, one of which is diseases that are influenced by genetic factors are disease heart disease caused by chromosome mutations and known as with designation disease heart congenital. Disease heart default must detected as early as maybe for the doctor can give maintenance medical as soon as possible maybe. Research this aiming for develop tool measuring health heart that can measure three component marker disease heart among them temperature body, saturation oxygen as well as beat heart with using the MAX30100 sensor with use design Research and Development research. Based on mark accuracy obtained so can stated that tool measuring health developed heart using the MAX30100 sensor is feasible used by humans.

Keywords: *Measuring Instrument, Heart Health, MAX30100 Sensor*

1 Introduction

Lifestyle Healthy is style life that cares all aspect condition health somebody (Prananda et al., 2023; Shofani et al., 2021). No only question food, but also habits somebody in undergo style life. Health is investment the best and is matter important to support all activities and activities that are carried out (Sumarwati et al., 2022). Lifestyle healthy is aspect crucial in maintain mental and physical health. Lifestyle covering various activities carried out daily like eat, exercise physical, sleep, and others (Shofani et al., 2021). Lifestyle can become reason death somebody (Tang et al., 2024). Lifestyle that is not healthy can cause impact bad for health man (Wilanda et al., 2024). An unhealthy lifestyle Healthy associated with increasing risk poor health and well-being, which leads to suffering individual and decline productivity (Ullberg et al., 2024).

Behavior style life like use tobacco, lack of activity physical, pattern eat no healthy, and use alcohol is behavior that can lower health and ability physique somebody (Dunn et al., 2024; Holder, 2019). Besides pattern life, health is also influenced by genetic factors, one of which is diseases that are influenced by genetic factors are disease heart disease caused by chromosome mutations and known as with designation disease heart default (Ahmed et al., 2024; Dunn et al., 2024). Disease heart is reason main deaths worldwide (Tada et al., 2022). Disease heart default or congenital heart disease (CHD) is abnormality structure or function heart that occurs since born (Lydia Lestari, 2023; Sessa et al., 2024; Ummah, 2019). Abnormalities This caused by a failure in the formation process heart at the moment fetus develop in content (Ummah, 2019). Disease heart default can marked with beat heart no regular (arrhythmia), fever, dizziness and ease tired, difficult breathe or shortness of breath, swelling (edema) in the feet, ankles, or hands, skin colored bluish (cyanosis) and easy faint (Lydia Lestari, 2023).

Disease heart default must detect as early as maybe for the doctor can give maintenance medical as soon as possible maybe. This is important for prevent the occurrence complications disease serious until death. One of the way that can used is with do checking level oxygen and pulse heart body with using an oximeter

How to Cite :
Pratiwi,Juli, & M, Sahal.(2024). Development Of A Non-Invasive Heart Health Measurement Device Using The Max30100 Sensor. *Journal of Frontier Research in Science and Engineering(JoFRISE)*, 2(4), 1-7

(Dwipayana et al., 2022). Checking this use sensor components. Oximeter is tool gauge level oxygen in blood and and measuring beat heart (Kemalasari & Rochmad, 2022). Based on research conducted by Kemalasari (2022) state that the use of the Max30100 sensor has the average percentage error is 0.84% for measurement SpO2 levels, and 1.6% for measurement beat heart, and tools can detect there was 1 person whose SpO2 level was below 90% so can stated that the max30100 sensor is effectiv used for detect disease heart default. Based on background the back that has been outlined so researcher interested for develop tool measuring health heart that can measure three component marker disease heart among them temperature body, saturation oxygen as well as beat heart with using max 30100 sensor. It is expected with development tool this can detect indicator symptoms disease heart with more accurate and simple.

2 Research Methodology

Study in development tool measuring health heart non-invasively conducted by researchers use design Research and Development. Research and Development is a the method used with focus the main thing is produce a product (Sugiyono, 2017). Research done with through stage design, manufacture, and testing tool.

2.1 Tool Design

At the stage design, researcher make a Hardware design Measuring tools health heart non-invasively can see in figure 1.

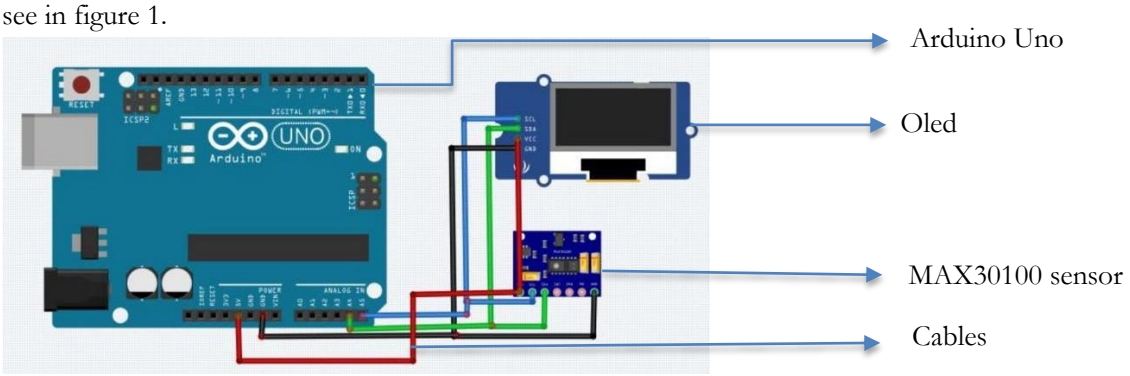

Figure 1. Design tool measuring health heart

Based on image 1, we can see that Arduino, OLED and MAX30100 sensor are interconnected connected by cables. Components main used in study this is the Max30100 sensor, arduino uno and oled. Measuring tool the utilizing the integrated Max 30100 sensor with Arduino For detects and processes measurement data. The Max 30100 sensor is an optical sensor that uses two LEDs, namely the red LED and the infrared LED, which function as functioning transmitter and photodiode as a photodetector. The MAX30100 sensor uses red LED and infrared LED because oxyhemoglobin (HbO_2) namely hemoglobin bindingoxygen (O_2), absorbs more lots infrared light and passes through more lots light red. While deoxyhemoglobin (RHb) namely hemoglobin binding carbon dioxide (CO_2) and releases O_2, will absorb more lots light red and miss more lots infrared light (Kemalasari & Rochmad, 2022).

Arduino acts as an open source electronic prototype (Martínez et al., 2023). Arduino is a combination of hardware and a sophisticated Integrated Development Environment (IDE). IDE is a software that plays a very important role in writing programs, compiling them into binaries and uploading them to microcontroller memory (Sutono & Al Anwar, 2020). The MAX30100 sensor reading will be forwarded to the microcontroller with the parameters that have been set. While the OLED is used as a screen to display measurement data.

2.2 Tool Making

Stage Making done with assembling hardware tools integrated heart health measure with upload the program via arduino software. When the sensor detects existence change and reflection light, arduino software will display data and output will displayed on the LCD.

2.3 Tool Testing

Stage the first thing to do for test tool measuring health is through stage calibration. Calibration functioning For increase quality in data (Ionascu et al., 2021). At the stage calibration, data collection for calibration done with take sample blood from volunteer sample for tested level oxygen, pulse heart as well as temperature body invasively using an oximeter and a regular thermometer. Blood pressure data oxygen, pulse heart as well as temperature the body that has been taken use invasive methods then compared to with testing level oxygen , pulse heart as well as temperature body use Heart health tools that have developed (Ionascu et al., 2021). The data obtained then processed in a way statistic with linear trade line analysis for get mark correlation. Researchers do testing tool with compare results measurement level oxygen, pulse heart as well as temperature body to 5 volunteers in a non-invasive manner. Comparison results measurement from second method the done for know level accuracy tool measuring health the heart that has developed as alternative tool medical for measure oxygen, pulse heart as well as temperature body. Accuracy tool measuring health heart analyzed with look for the relative error for each measurement level oxygen, pulse heart as well as temperature body sample. Error value obtained through equation (1) as following (Shofani et al., 2021):

$$Relative\ Error = \frac{\text{Meassured Error} - \text{Expected Value}}{\text{Actual Value}} x\ 100\% \quad \text{.....(1)}$$

3 Results and Discussion

Heart Health measuring tool developed in study this can seen as in figure 2.

Figure 2. Hardware tools measure heart health

Figure 1 shows series and display from tool measuring health heart. When the sensor reads reflection light from finger patient, then Oled will display reading level testing saturation oxygen (SpO2) next to right part top, beat heart rate per minute (BPM) next to left part top and temperature body in the left below. Heart

health measuring instrument testing this done with compare the result data measurement use tool developed measure with a regular oximeter and thermometer used in clinics or hospital. Next, with compare results measurement between tool said, then can know how much big accuracy tool measuring health developed heart in measure saturation oxygen, pulse heart and temperature body patient.

Measurement results use tool measure heart health show existence difference mark results measurement on each sample. Reading results measurement saturation oxygen, pulse heart and temperature body on tool this utilizes the MAX30100 sensor as one of the infrared sensors. The princip work from the MAX30100 alone is with detect color light hemoglobin in body human. Infrared LEDs play a role as a transmitter (send the signal) from absorption color and intensity infrared rays of the object. Signal the will received by the phototransistor LED and forwarded to arduino for do reading results measurement.

3.1 Measurement results Saturation Oxygen (SpO2)

Stage beginning measuring instrument testing health heart as tool detection level saturation oxygen is tested to 5 samples for calibration tools. As for the sample taken in a way random consisting of over 3 women and 2 men with range age 20-40 years. The results measurements obtained can see as in table 1 below:

Table 1. Measurement Results saturation oxygen (SpO2)

No	Heart Health Measuring Instrument (mmHg)	Oximeter (mmHg)	Error (%)
1	93	97	4.30
2	95	96	1.05
3	94	94	0.00
4	95	97	2.10
5	97	94	3.19
	Average		2.12
	Accuracy		97.88

Table 1 shows the measurement data. level saturation oxygen (SpO2) to 5 samples with average tool error result by 2.12%. Measurement level saturation oxygen (SpO2) using a measuring tool developed own accuracy by 97.88%. Based on minister of health regulation no. 20 of 2022 states that tool proper medical used by humans is a tool that has accuracy more from 95% (Kemenkes, 2022). Then tool measure heart health can stated fulfil standard tool proper medical used by humans. Based on results analysis conducted by researchers, differences results measurements that occur between tool heart health measure developed with an oximeter due to some factors including error reading scale when measuring , the difference accuracy tool and environmental factors (Anonym, 2022).

3.2 Measurement results Beat Heart (BPM)

Stage beginning testing tool measuring health heart as tool detection beat heart rate (BPM) is tested to 5 samples for calibration tools. As for the sample taken in a way random consisting of over 3 women and 2 men with range age 20-40 years. The results measurements obtained can see as in table 2 below:

Table 2. Measurement Results Beat heart rate (BPM)

No	Heart Health Measuring Instrument (BPM)	Oximeter (BPM)	Error (%)
1	76	79	3.94
2	96	97	1.04
3	72	74	2.77
4	77	75	2.66
5	87	86	1.16
	Average		2.31

Accuracy	97.69

Table 2 shows the measurement data. beat heart rate (BPM) to 5 samples with average tool error result by 2.31%. Measurement beat heart use tool developed measure own accuracy by 97.69%. Based on minister of health regulation No. 20 of 2022 states that tool proper medical used by humans is a tool that has accuracy more from 95% (Kemenkes, 2022). Then tool measure heart health can stated fulfil standard tool proper medical used by humans. Based on results analysis conducted by researchers, differences results measurements that occur between tool heart health measure developed with an oximeter due to some factors including error reading scale when measuring, the difference accuracy tool and environmental factors (Anonym, 2022).

3.3 Measurement results Temperature Body

Stage beginning testing tool measuring health heart as tool detection temperature body tested to 5 samples for calibration tools. As for the sample taken in a way random consisting of over 3 women and 2 men with range age 20-40 years. The results measurements obtained can see as in table 3 below:

Table 3. Measurement Results Temperature Body

No	Heart Health Measuring Instrument (° C)	Thermometer (° C)	Error (%)
1	34.00	34.40	1.17
2	34.80	34.60	0.57
3	33.50	34.00	1.49
4	32.50	34.00	4.61
5	32.00	31.87	0.40
Average			1.64
Accuracy			98.36

Table 3 shows the measurement data. temperature body to 5 samples with average tool error result by 1.64%. Measurement beat heart use tool developed measure own accuracy by 98.36%. Based on minister of health regulation No. 20 of 2022 states that tool proper medical used by humans is a tool that has accuracy more from 95% (Kemenkes, 2022). Then tool measure heart health can stated fulfil standard tool proper medical used by human. Based on results analysis conducted by researchers, differences results measurements that occur between tool heart health measure developed with thermometer due to some factors including error reading scale when measurement, difference accuracy tool and environmental factors (Anonym, 2022).

Based on third results measurements that have been done can stated that accuracy measurement temperature body more tall compared to measurement saturation oxygen and pulse heart. This is in line with research conducted by Septiar Rizkiansyah Sunarto (2024) which states that the MAX30100 sensor produces greater accuracy high on measurement temperature body compared to measurements saturation oxygen (SpO2) and heart rate heart. Based on analysis conducted matter this due to the measurement temperature body, skin measured direct touch with the developed sensor, while in the measurement saturation oxygen and pulse heart there is space between the sensor and the skin so that allow existence the light reflected by the LED (infrared) is scattered before reflected sensor. In the measurement temperature body this obtained more value low compared to with normal temperature ranges from 37 ° C (Atosuo et al., 2024). This is due to the measurement temperature the done in the mouth (oral) or armpit, while the heart health device that was developed do measurement temperature on the skin (palms hand) so that the resulting temperature more low.

4 Conclusion

Development tool measuring health heart use non- invasive method succeed made with use arduino and MAX30100 sensor. Measurement data level saturation oxygen, pulse heart and temperature body use method invasive shows good data. Measuring tools health developed heart own mark accuracy tool by 97.88% in test level saturation oxygen (SpO2), 97.69% in measure beat heart and 98.36% in measure temperature body. Based on mark accuracy obtained so can stated that tool measuring health developed heart using the MAX30100 sensor is feasible used by humans. With creation development tool measuring health heart as tool measuring level saturation oxygen, pulse heart and temperature body this so was created innovation alternative tool measuring easy, cheap, non-invasive medical treatment add accumulation waste medical and not painless (non- invasive).

Reference

Ahmed, A., Cule, M., Bell, J. D., Sattar, N., & Yaghootkar, H. (2024). Differing genetic variants associated with liver fat and their contrasting relationships with cardiovascular diseases and cancer. *Journal of Hepatology*, 1–9. https://doi.org/10.1016/j.jhep.2024.06.030

Anonym. (2022). Modul 01-Dasar Pengukuran dan Ketidakpastian MODUL 01. *Dasar Pengukuran Dan Ketidakpastian Pengukuran*, 4–5.

Atosuo, J., Karhuvaara, O., Suominen, E., Virtanen, J., Vilén, L., & Nuutila, J. (2024). The role of gamma globulin, complement component 1q, factor B, properdin, body temperature, C-reactive protein and serum amyloid alpha to the activity and the function of the human complement system and its pathways. *Journal of Immunological Methods*, *531*(February). https://doi.org/10.1016/j.jim.2024.113709

Dunn, A., Olamijuwon, E. O., & McGrath, N. (2024). In sickness and health? Examining the co-occurrence and concordance of healthy lifestyle behaviours among spouses in Namibia. *Public Health*, *235*, 111–118. https://doi.org/10.1016/j.puhe.2024.06.031

Dwipayana, I. M. A. A., Pramaita, I. N., & Setiawan, W. (2022). Rancang Bangun Pengukur Jumlah Denyut Jantung, Kadar Oksigen Dalam Darah Dan Suhu Tubuh Berbasis Internet Of Things (Iot). *Jurnal Ilmiah TEKNIK DESAIN MEKANIKA*, *11*(4), 1910–1917.

Holder, M. D. (2019). The Contribution of Food Consumption to Well-Being. *Annals of Nutrition and Metabolism*, *74*(Suppl2), 44–51. https://doi.org/10.1159/000499147

Ionascu, M. E., Castell, N., Boncalo, O., Schneider, P., Darie, M., & Marcu, M. (2021). Calibration of CO, NO2, and O3 using airify: A low-cost sensor cluster for air quality monitoring. *Sensors*, *21*(23), 120841. https://doi.org/10.3390/s21237977

Kemalasari, & Rochmad, M. (2022). DETEKSI KADAR SATURASI OKSIGEN DARAH (SpO2) DAN DETAK JANTUNG SECARA NON-INVASIF DENGAN SENSOR CHIP MAX30100. *Jurnal Nasional Teknologi Terapan (JNTT)*, *4*(1), 35–50. https://doi.org/10.22146/jntt.v4i1.4804

Kemenkes. (2022). Peraturan Menteri Kesehatan Republik Indonesia Nomor 30 Tahun 2022 Tentang Indikator Nasional Mutu Pelayanan Kesehatan Tempat Praktik Mandiri Dokter Dan Dokter Gigi, Klinik, Pusat Kesehatan Masyarakat, Rumah Sakit, Laboratorium Kesehatan, Dan Unit Transfu. *Menteri Kesehatan Republik Indonesia Peraturan Menteri Kesehatan Republik Indonesia*, *879*, 2004–2006.

Lydia Lestari, D. (2023). Penyakit Jantung Bawaan pada Anak. *Scientific Journal*, *2*(4), 134–142. https://doi.org/10.56260/sciena.v2i4.100

Martínez, B., Tinoco, J. O., Julieta, S. G., & Alvador, H. L. (2023). Arduino based intra-cerebral microinjector device for neuroscience research. *HardwareX*, *15*, e00446. https://doi.org/10.1016/j.ohx.2023.e00446

Prananda, A., Multahadi, F., & Pebiola, N. (2023). Pola Hidup Sehat Dan Faktor-Faktor Yang Memengaruhi Mahasiswa Perantau Di Lingkungan Kampus. *Jurnal Pendidikan Jasmani Olahraga Dan Kesehatan*, *2*(1), 100–109. http://jurnal.anfa.co.id/index.php/PJKR

Septiar Rizkiansyah Sunarto. (2024). Prototype Pengukur Detak Jantung, Saturasi Oksigen, Dan Suhu Tubuh Manusia Secara Portable. *Jurnal Teknik Dan Science*, *3*(2), 84–93. https://doi.org/10.56127/jts.v3i2.1535

Sessa, F., Chisari, M., Salerno, M., Esposito, M., Zuccarello, P., Capasso, E., Scoto, E., & Cocimano, G. (2024). Congenital heart diseases (CHDs) and forensic investigations: Searching for the cause of death. *Experimental and Molecular Pathology*, *137*(April), 104907. https://doi.org/10.1016/j.yexmp.2024.104907

Shofani, M., Hardianto, F., Sumarti, H., Studi, P. S., & Fisika UIN Walisongo Semarang, P. (2021). Alkukosrat : Pengembangan Alat Ukur Kolesterol dan Asam Urat Secara Non-Invasif Menggunakan Sensor TCRT-5000. *Prosiding SNFA (Seminar Nasional Fisika Dan Aplikasinya) 2021* , 57–66.

Sugiyono. (2017). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D*. Alphabeta.

Sumarwati, M., Mulyono, W. A., Nani, D., Swasti, K. G., & Abdilah, H. A. (2022). Pendidikan Kesehatan tentang

Gaya Hidup Sehat Pada Remaja Tahap Akhir. *Jurnal Abdimas BSI: Jurnal Pengabdian Kepada Masyarakat*, *5*(1), 36–48. https://doi.org/10.31294/jabdimas.v5i1.11354

Sutono, S., & Al Anwar, F. (2020). Perancangan dan Implementasi Smartlamp berbasis Arduino Uno dengan menggunakan Smartphone Android. *Media Jurnal Informatika*, *11*(2), 36. https://doi.org/10.35194/mji.v11i2.1036

Tada, H., Fujino, N., Hayashi, K., Kawashiri, M. aki, & Takamura, M. (2022). Human genetics and its impact on cardiovascular disease. *Journal of Cardiology*, *79*(2), 233–239. https://doi.org/10.1016/j.jjcc.2021.09.005

Tang, J., Ma, Y., Hoogendijk, E. O., Chen, J., Yue, J., & Wu, C. (2024). Associations between healthy lifestyle and mortality across different social environments: a study among adults with frailty from the UK Biobank. *European Journal of Public Health*, *34*(2), 218–224. https://doi.org/10.1093/eurpub/ckae003

Ullberg, O. H., Toivanen, S., King, A. C., & Bälter, K. (2024). Using citizen science to explore barriers and facilitators for healthy and sustainable lifestyles in office environments. *Health and Place*, *90*(October). https://doi.org/10.1016/j.healthplace.2024.103377

Ummah, M. S. (2019). Gagal jantung pada kehamilan. *Sustainability (Switzerland)*, *11*(1), 1–14. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Wilanda, A., Mubarok, A. S., Suprayitno, E., Sumarni, S., & Imran, S. (2024). Pengaruh Gaya Hidup Sehat, Kualitas Tidur, dan Pola Makan terhadap Tingkat Kesehatan Mental pada Pekerja Kantoran di Jawa Barat. *Jurnal Multidisiplin West Science*, *3*(01), 69–77. https://doi.org/10.58812/jmws.v3i01.946