IoT-Based Pulse Oximetry Design as Early Detection of Covid-19 Symptoms

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Abstract—Covid-19 patients experience several symptoms such as shortness of breath, abnormal heart rate, lung function abnormalities that are similar to pneumonia symptoms. These symptom conditions indicate that the saturation of oxygen (O2) levels dissolved in the blood is not normal. To measure oxygen levels in the blood using a medical device, one of which is a Pulse Oximeter. Covid-19 patients in the Sapta Taruna Health Center were 665 patients, of which this patient was counted from January 2022 to April 2022. Based on information obtained from the Sapta Taruna Health Center, the only patients that were counted were those who did the PCR/Swab test, while the people who were suspected infected with Covid-19 there are still many who do not do PCR/Swab tests, this refusal is due to fear because Hoax information is spread in the community such as: PCR/Swab tests are painful, if the PCR/Swab test results are positive, fear of being ostracized, feel healthy and other reasons. other. Patients who have been tested positive for Covid-19 will be given drugs such as fever medicine, antibiotics, anti-virus, Vitamin C, and others according to the level of symptoms they feel, if the symptoms are felt at a moderate, mild or even asymptomatic stage, they will be advised to isolate independently (Isoma) at home, but there is no further monitoring from the Sapta Taruna Health Center, even though patients who are self-isolating at home may experience a decrease in blood oxygen levels drastically, so these patients need medical devices such as pulse oximetry so that patients who are isoma can perform independent checking, henceforth the current pulse oximetry cannot provide remote information related to the condition of oxygen saturation in the patient's blood. Judging from the problems above, the research team made a product, namely Pulse Oximetry based on IoT, this tool is to measure oxygen saturation in the patient's blood and the data from the measurements made by the patient will be automatically sent to the server and can be viewed on the Sapta Taruna Health Center website, so that the Sapta Taruna Health Center can monitoring the condition of the patient in real time without having to meet directly with the patient.

Keywords—Covid-19, oxygen detection, happy hypoxia, Iot, pulse oximetry

1 Introduction

Indonesia is one of the countries experiencing the impact of COVID-19 with 4,043,736 positive confirmed cases and 13,0182 deaths, while Riau Province has 120,707 positive confirmed cases with 3,559 deaths [1].

Covid-19 patients experience several symptoms such as shortness of breath, abnormal heart rate, lung function abnormalities that are similar to pneumonia symptoms. The condition of these symptoms indicates that the saturation of the dissolved O2 content in the blood is not normal[2]. Normal oxygen saturation is 75-100 mmHg, meaning that if it is below normal then a person needs additional oxygen, if it exceeds the normal limit, the lungs will be damaged [3][4]. Some Covid-19 patients experience the phenomenon of happy hypoxia, namely the condition of very low oxygen levels in the blood, but Covid patients do not feel it, or without any symptoms so that they can still carry out activities as usual [5]. One of the reasons people with COVID-19 don't feel any symptoms when experiencing hypoxia is that the brain doesn't respond until oxygen drops to very low[6].

Dr. Tobin, a professor of pulmonary medicine and critical care at Loyola University Medical Center, also suspects that the corona virus can affect the body's receptors so that it does not respond to low oxygen levels[7].

Pulse Oximetry is a tool that is often used in biomedical optics that serves to provide continuous and non-invasive information on two parameters, namely oxygen saturation in the blood and heart rate [8]. A quote from a news portal, health.detik.com, where the World Health Organization (WHO) recommends COVID-19 patients to have an oximeter when self-isolating at home. This oximeter is used to ensure the patient's condition remains under control because the covid-19 virus can cause an unexpected drop in oxygen levels [9].

Bukit Raya District is located in the Working Area of the Sapta Taruna Health Center, the Sabta Taruna Health Center which was only established in 2018. Positive Covid-19 cases at the Sabta Taruna Health Center In January 2022 to April 2022, the number is quite high, namely 665 patients, based on data and information which was obtained from the Head of the Sapta Taruna Health Center, Mr. Iswandi, where there were still many people who did not want to do the PCR / Swab test even though they were already showing symptoms of Covid-19 or who had been in close contact with Covid-19 patients, this refusal was due to there is fear because Hoax information is spread in the community such as: PCR/Swab tests are painful, if the PCR/Swab results are positive, they are afraid of being ostracized, as for other reasons according to [10] is the trust factor, this factor is based on the results of the community's first swab was declared positive for Covid-19 but the second swab result was declared negative, from this error it caused the public to be indifferent I believe that with Covid-19, with this incident, other people refuse to do PCR/swab tests. So that people who are suspected of being exposed to COVID-19 are not recorded because they did not carry out PCR / Swab tests. People who have done a PCR/Swab test and have been declared positive are given drugs such as fever medicine, antibiotics, antivirals, anti-inflammatories and others based on the level of symptoms experienced, and ask the patient to self-isolate (Isoma) at home if the symptoms are only experienced mild symptoms or asymptomatic

but from the Sapta Taruna Health Center there is no further control of the condition of the covid-19 patient who is self-isolating at home [11].

2 Related works

Covid-19 was first discovered in December 2019 in Wuhan City, China Province, a number of patients were found to be hospitalized with an early diagnosis of pneumonia. The initial diagnosis of these patients had epidemiological links with animal and seafood markets before developing into a terrible outbreak [3]. The first case of people infected with COVID-19 occurred on December 18, 2019 where within 10 days 5 patients with acute respiratory disorders had been looted and 1 person was declared dead. At the beginning of January 2020, there were 41 patients infected with COVID-19, where most of the patients had congenital diseases such as cardiovascular, hypertension and diabetes. Some of the patients feel symptoms such as asthma and pneumonia, convulsions, cough and body temperature around 38-39 degrees Celsius[12].

Indonesia is also one of the countries affected by covid-19, the first time a positive patient of covid-19 was announced on March 2, 2020 [12], the case of the COVID-19 pandemic.

These 19 are spread to 31 provinces including Riau Province. Data from the WHO and the PHEOC of the Ministry of Health stated that as of August 19, 2021, the total number of positive confirmed cases of Covid-19 was 3,930,300 people. And there were 122,633 deaths (CFR: 3.1%) and 3,472,915 people were declared cured of Covid-19.

IoT-based pulse oximetry has been carried out by previous researchers several times to monitor health conditions, such as heart health conditions, asthma patients, lung health. In addition, during the covid-19 pandemic, many researchers are also conducting research using pulse oximetry to detect and monitor covid-19 patients as was done by [7], [13] who discussed oxygen saturation monitoring using an android-based SPO2Max30100. and displayed to the LCD by utilizing the blynk application for sending data to android, the test results of the Max 30100 sensor can detect oxygen levels with good accuracy seen from the value of each sample of the test results.

Another research that discusses computer-based pulse oximetry is that conducted by firda ryan and friends, in a study entitled computer-based wireless SpO2 monitoring discussing patient monitoring chronic obstructive pulmonary disease (COPD). In the monitoring process using a finger sensor to detect oxygen levels, then processed on the ATmega328P and sent via Bluetooth HC-05 to a PC in an excel display. The drawback in this study is that the input device for the oxygen level sensor is still separate from the monitoring device for the patient's condition [13]. In the article discussed in article [14] about a pervasive health care system to monitor oxygen saturation using pulse oximetry. The study only used SMS warnings to patients to take preventive action and doctors received SMS related to the patient's condition if the oxygen saturation was less than 50 so that doctors could provide immediate treatment to patients.

Subsequent research was written by [15] in which this study discusses pulse oximetry measurements using a camera, with the use of a camera, patients do not have

to be in direct contact with the device, oxygen saturation is obtained from images of human faces obtained online. However, the human face image must be free from any disturbances, such as poor lighting, or movement occurs when taking pictures, and the results of the measurements cannot be viewed online.

Based on the results of the literature review above, the research team submitted a research proposal to discuss and examine matters that have not been studied by other studies such as the Design of IoT-Based Pulse Oximetry as a Tool for Early Detection of Symptoms of Covid-19. There are several things that are different from other studies, namely patients can detect oxygen saturation independently and the value of oxygen saturation will be sent directly to the server and can be seen by the Sapta Taruna Health Center. The Sapta Taruna Health Center can view progress reports directly from smartphone devices, PCs/laptops in real time from reports that can be accessed by the Sapta Taruna Health Center.

3 Methodology

The stages in this study are shown in the following figure:

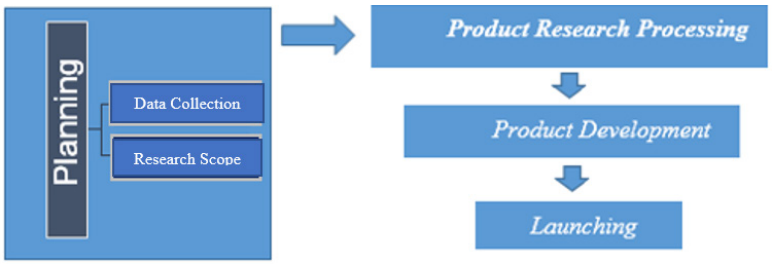

Fig. 1. Research methodology

The explanation of the above stages can be seen in the explanation below:

1. Planning

At this stage, planning is carried out, such as data collection, the required data and the scope of the research[16]. For data collection, researchers carried out several techniques such as observing the Sapta Taruna Health Center, conducting interviews and asking for data on Covid-19 patients with the head of the Sapta Taruna Health Center, the head of the TU, the tracing doctor and the PE Team Leader, Mrs. Ninna Apriani. The other technique is to conduct a literature review related to the research topic

2. Product Research Processing

This stage analyzes the hardware and software requirements needed in the manufacture of IoT-based oximetry tools, and will then be designed and started to be assembled until the formation of an Oximetry tool that can be connected to a Web system to monitor results after measuring blood oxygen levels using a pulse oximetry device that has

been made[17][18]. After the tool is formed it will be tested tools and systems. Tests carried out first are sensor testing, namely the MAX30100 sensor, the sensitivity level of the sensor is compared to the sensitivity of the pulse oximetry belonging to the medical staff.

3. Product Development

This stage is carried out when the tool has been repaired after repair and has been connected to IoT[19][20]. From the results of the final test, the tool made, namely IoT-based pulse oximetry, can already be used for the community and for monitoring it can also be done by the Sapta Taruna Health Center. IoT-based pulse oximetry already meets the criteria and the resulting value is not much different from the value generated by pulse oximetry tools that are often used by medical professionals[21].

4. Launching

The official launch of the research product is the result between the research team and the Pekanbaru City Sapta Taruna Health Center, the product produced in this study is an IoT-based Pulse Oximetry which is used to detect Covid-19 early and monitor the oxygen saturation value in the blood in patients.

4 Analysis and design

based on the results of the study, the system requirements and design of the system were obtained. The components needed in making systems and tools are as follows: Raspbery, Max30100 Sensor, LCD, and others, while for the manufacture of a monitoring system, it is seen from the needs of the medical party, namely patient data, oxygen saturation value (SPO_2) and the time of the examination.

monitoring is only given to the medical team or the Sapta Taruna Health Center, in order to make it easier for the Sapta Taruna Health Center to monitor the condition of patients who are self-isolating in their respective homes, and if the SPO_2 value system is not normal, the Sapta Taruna Health Center can take action to help the patient.

The for the design of tools and systems can be seen in the design point.

4.1 Analysis

at the system analysis stage, data analysis will be carried out that will be needed in the manufacture of systems and tools, the first step is to analyze the needs of the components that will be used in making the tool, the selection of sensors that are in accordance with the research topic, here the sensor selected is the max30100 sensor. After that, the system analysis is carried out according to user needs. for the design can be seen in the design points below.

4.2 System design

The system built is website-based, this system is used to monitor the oxygen saturation value in the patient's blood, while the design can be seen in the Figure 2:

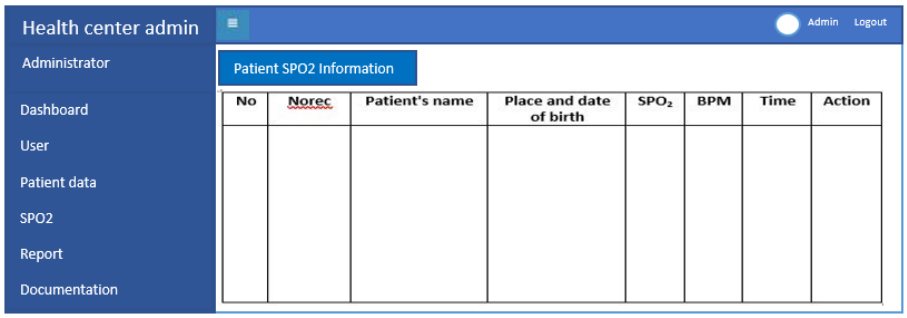

Fig. 2. Patient SPO_2 monitoring design

The design of the workflow of this IoT-based pulse oximetry begins with designing a tool, namely the selection of parameters to be used, for the first step is the selection of sensors and devices that support the installation of the sensor. The sensor used is Max30100, the sensor used to calculate the value oxygen saturation in the blood. The design of the components used are as follows.

In the Figure 3 and 4 it can be explained that the Mx30100 sensor is connected to the Raspberry Pi 3, the output of the measurement results will be displayed via the LCD. In sending data, Raspberry can function as a receiver for access point signals to connect to the internet to send data to the database.

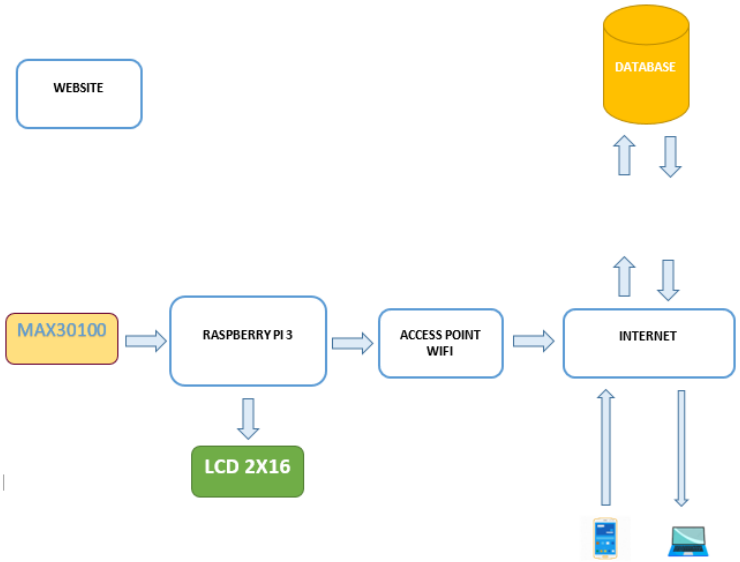

Fig. 3. System design diagram

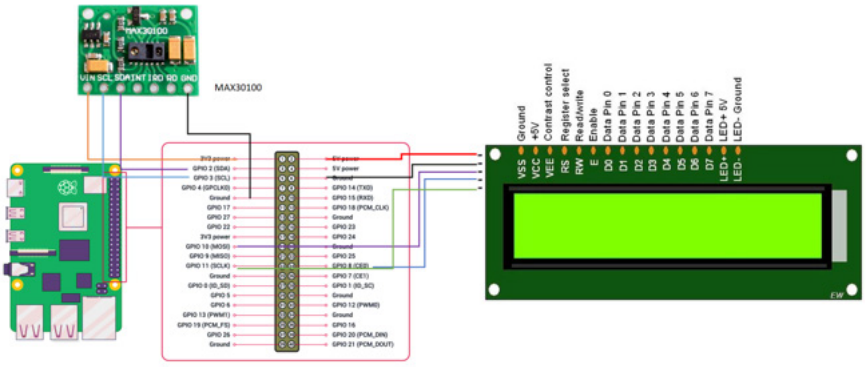

Fig. 4. Tool design

5 Results

The results of this study can be seen in the Figure 5:

Fig. 5. IoT based pulse oximetry display

The following is the display of the website page that is used to monitor the state of the land in real time.

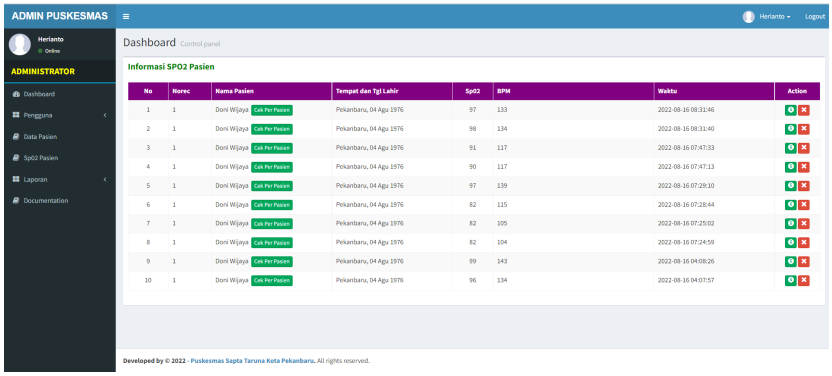

Fig. 6. SPO2 value page display in patients

5.1 Test result

The test was carried out by testing the sensor to detect oxygen levels in the blood, so that the MAX30100 sensor was obtained as the sensor to be used. After testing the Max30100 sensor, it is connected to the website, and it is tested so that the results of the patient's SPO_2 value can appear on the LCD and the System/Website display.

From the test results obtained results as below:

Table 1. Sensor comparison test results

No	Component Name	Calibration	Response	Results
1	Max30100 sensors	SPO2 > 95% - 100% = Good SPO2 93% - 94% =Patient should lie down to increase oxygen levels SPO2 <= 92% Not Good, requires medical treatment	The sensor responds well	Success
2	Cloud Server	Connection Check Data Save Test	Connect Stored	Success Success
3	Web/Mobile Applications	Connection with cloud servers Data management connection from cloud server	Connect Success information is displayed	Success Success

The next test is to compare the IoT-based pulse oximetry with the Jumper brand Pulse oximetry. The results of the comparison of the two tools are not too much different, while the results obtained can be seen in the table below:

Table 2. Comparison of IoT-based pulse oximetry with jumper brand pulse oximetry

Tool's name	Sensor Sensitivity	Measurement time	SPO_2 value
IoT-based Pulse Oximeter	+- 7 Second	+- 6 Minute	100%
IoT-based Pulse Oximeter	+- 3 Second	+- 4 Minute	98%

Documentation of comparative testing of the two tools can be seen in the figure below:

Fig. 7. Comparison of IoT-based pulse oximetry with Jumper brand pulse oximetry

From the picture above it can be seen that pulse oximetry with the Jumper brand produces an SPO_2 value of 100% while IoT-based pulse oximetry produces a SPO_2 value of 98%, the values of the two oxygen saturation results are normal.

6 Conclusion

The results of the research carried out can be concluded that this IoT-based pulse oximetry works well, the Max30100 sensor has a good sensitivity value so that the IoT-based pulse oximetry tool works or can detect the oxygen saturation value in the blood (SPO_2) well, after comparison with pulse oximetry which is commonly used in the medical world with IoT-based pulse oximetry and the results of the tests carried out, it can be concluded that IoT-based pulse oximetry produces a good accuracy value and a fairly good sensor sensitivity value, which is approximately 5 seconds.

In addition, this tool can also perform processing so that it is connected using the IoT concept to a web server so that the Pekanbaru City Sapta Taruna Health Center can see and monitor the condition of the patient's oxygen saturation value.

This IoT-based pulse oximetry was developed so that it can detect the oxygen saturation value in the patient's blood and can be monitored by the Pekanbaru City Sapta Taruna Health Center in real time, so that if there is a decreased oxygen saturation condition, or in abnormal circumstances, the Sapta Taruna Health Center can make a decision to take immediate action.

Suggestion for further research is to add tracking of the location of Covid-19 patients who show oxygen saturation below normal status.

7 Acknowledgement

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