EasyChair Preprint

№ 6814

Tabletop and Portable SPO2 Sensor to Diagnostic Cov19 Effect by Mobile Application

Karar Alhamamy, Alia'A Kadhem, Rana Kaabi and Mahdi Hasan

October 9, 2021

Tabletop and Portable SPO2 Sensor to Diagnostic Cov19 Effect by Mobile Application

First Author Karar Aiz Aldean[1]

Kalhamamy1@gmail.com

, Second Author Alia'a Kadhem Gabbar[2]

aliaa85aliaa@gmail.com

Students in Islamic Azad University South Tehran Branches ,IRAN

Third Auther Rana Abbas Al-Kaabi[3]

College of Information Technology, University of Babylon, Hilla, Iraq.

ranaa.net.msc@student.uobabylon.edu.iq

Fourth Author Mahdi saleh hasan[4]

Mahdi_salih92@yahoo.com

Abstract

Iraq's health infrastructure is under strain as the daily COVID-19 case count has surpassed the prior year's high. We urged individuals with minor symptoms to follow their doctor's recommendations for home care, as hospitals are already overcrowded and unable to accommodate additional patients owing to a scarcity of beds. In this situation, and moving forward from here, we must establish a notion of health care and the proper identification of damage cases. The combination of various health sensors, mobile devices, and the Internet has the potential to significantly improve Iraq's health realities. Monitor Your Health Using a Wearable Device. We provide a strong portable heart rate monitor and SpO2 blood oxygen monitoring device. The system is interactive with the user and maintains a basic structure. The application is tiny, and the gadgets are simple to use without the requirement for medical professionals. We base our system on the MAX30102 sensor, which can produce very accurate data that can be stored in the cloud and analyzed afterwards. Anyone using this gadget may move about while monitoring their heart's vital signs and blood oxygen levels. This article discusses real application scenarios in which we employ this sort of technology primarily when the end user has size and mobility constraints. Implementation of a user-friendly interface and interaction on a mobile application for sim-

ultaneous usage by many users, as well as an (Organic Light Emitting Diodes) display for real-time sensor data with outstanding data accuracy.

Keywords

- ✓ **Iot medical care**
- ✓ **esp8266 with NodeMcu**
- ✓ **monitoring,** `wearable sensor`
- ✓ **MAX30102, blynk.**

Introduction

The old population is increasing in all countries, particularly industrialized countries, because of vaccination, improved health care facilities, and medications [1]. This boosts demand for healthcare facilities and medical personnel. The expansion of the electronics industry resulted in the development of a variety of health care equipment and sensors that support human life, including peacemakers, medical glucose monitors, medical heart rate monitors, sphygmomanometers, and electronic stethoscopes. IEEE is now trying to enhance and develop new standards for transmitting and collecting human health data, namely IEEE 11073 [1,2]. Simultaneous monitoring of pulse rate and blood oxygen saturation levels aids in the management of shortness of breath caused by pneumonia or heart attacks, for example, by combining medications and effective breathing techniques to raise their blood oxygen saturation levels from low to 93 percent [3].

As a result, embedded systems may enable patients to monitor their own health at home or at medical facilities without the aid of medical staff, therefore increasing the model's effectiveness while decreasing expenses. Home health care is important for its overall growth, and allowing patients to check themselves medically from home eases strain on patients, decreases the expense of waiting in lines, and adds to the reduction of hospital pressure [6]. As a result, this technology enables more managerial flexibility in health. Medical monitoring has a variety of different health benefits. For instance, its use improves diagnosis and treatment while decreasing medical care costs. The previously reported wearable and non-invasive ring sensors for real-time monitoring of blood pressure and oxygen saturation levels in the blood make up an important step toward attaining customized health monitoring for patients and non-patients. Increased dependence on these medical technologies is necessary to achieve integration of health and contemporary technology, which will have a substantial influence on improving people's lives by increasing self-awareness of personal health and lowering health system costs [4-6]. The financial benefits of medical monitoring are projected to grow as mobile technological capabilities improve. Thus, the goal of this effort is to develop a low-cost, simple-to-use, portable, and reliable system for health monitoring. Utilizing embedded Internet of Things devices and wireless communication protocols to enable the use of low-power sensors [7],

Telemedicine has the potential to transform how clinicians evaluate patients in the case of a pandemic, requiring less work and posing no hazards. In the case of the Covid-19 virus, the patient may experience lung difficulties without feeling ill, but these problems might have substantial long-term repercussions [8].

In the proposed system, a tiny oximeter will be attached to the patient's finger, while the embedded system measures oxygen saturation and pulse. As a result, it is transformed into a digital signal, which is then processed by the platform microcontroller to generate numerical values representing the sensor's results [9]. They then transmitted these values to an Internet-based data server, which streams and collects the received data using the service API and the meta key [10]. Steam transmits data immediately to the server or mobile application, allowing the doctor to see the results and make medical choices about the patient's condition in real time [8]. With these approaches, the doctor may treat the patient remotely, preventing illness from being passed from the patient to the doctor or other individuals who interact with the patient, such as his parents or children, and are aware of his condition. If the patient's health deteriorates rapidly, the doctor can notify the medical staff or ambulance or even operate the oxygen device remotely, according to the specialist's preference, locally or to the emergency room.

This application will benefit many individuals who live in rural regions. Patient monitoring is a critical component of health maintenance and requires several adjustments to enhance the health system. The critical care units and recovery rooms, as well as the treatment of patients who are already out of hospitals, must be prioritized.

One of the system's benefits is that it monitors the patient's health status, which results in a decreased risk of infection and infection, as well as the avoidance of problems that may ensue.

This results in increased patient comfort. Additionally, it can minimize hospital expenses or nurse-monitored patients, as well as the consumption and maintenance costs of the same medical instruments used in hospitals [11].

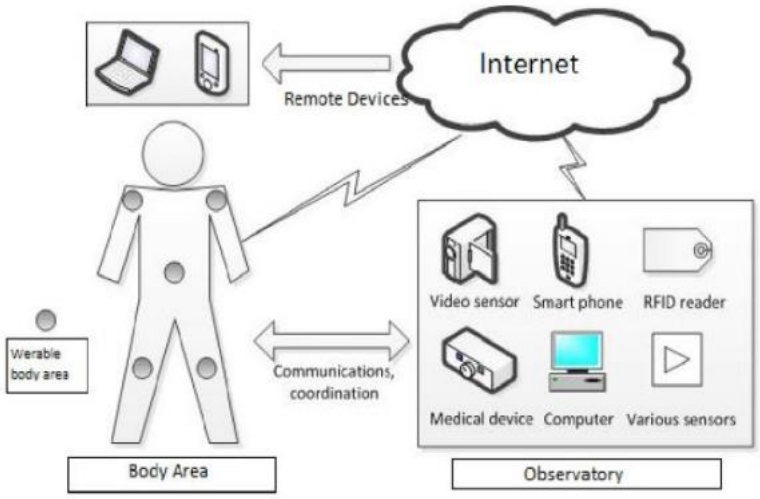


Fig. 1.

Figure -1: Wireless sensor network for health monitoring

1 Proposed design methodology

Pulse oximetry is a measuring oxygen levels.

It is related to the oxygen saturation level in the blood. It is one of the most critical vital signs for determining a patient's health status, and it is one of the most critical readings in general in medicine, in terms of the lungs' functions and the ability of red blood cells to transport oxygen to the body [12].

Thus, peripheral oxygen saturation (SpO2) is defined as oxygen saturation, is a measure of the amount of oxygen-carrying hemoglobin in the blood relative to the amount of hemoglobin not carrying oxygen in the blood (oxygenated and deoxygenated hemoglobin) [13].

Hemoglobin absorbs more red light and scatters less of it, but HbO2 absorbs more infrared light and scatters less of it. In this case, the coefficients are commonly determined using a red LED generating red light with a wavelength of 660 nm and an infrared LED emitting light with a wavelength of 940 nm [14].

Certain oximeters employ parallel configuration LEDs that are switched on and off at a few hundred microsecond intervals between pulses, while the photodiode detects both pulsing blood flow signals. Due to the photodiode's low microampere output during the light conversion process, a transient impedance operational amplifier is employed to convert the photodiode's microampere output to millivolts for the two AC signals generated by the LEDs [15].

The signals are reversed and amplified by a high-gain inverted amplifier after passing through a high-pass filter to reduce background noise. The processed signal consists of two components: the AC component induced by arterial blood uptake and the DC component induced by tissue uptake and non-pulsating blood uptake.[16]. Implementation of a pulse oximetry system with The MAX30102 sensor (Fig. 2), which works at 1.8V and requires a 3.3V LED supply voltage (for infrared and red), also has a 16-bit sigma delta ADC [17].

Fig. 2. 

Figure -2 MAX30102 Pulse Oximeter SPO2 & Heart-Rate Module

Figure 3 shows the block diagram of the MAX30100 sensor system [18], highlighting the internal active components responsible for monitoring the HbO2 and Hb values recorded by the photodiode when illuminated by the red and infrared LEDs.

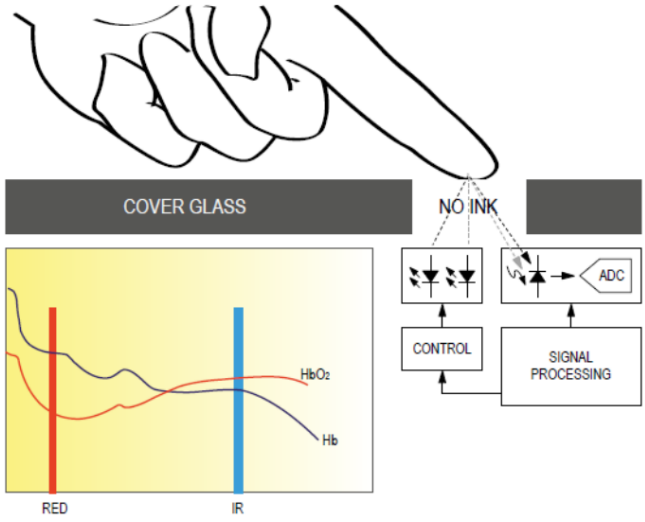
Fig. 3. 

Figure-3. block diagram and absorption spectra of hyperbaric oxygen and Hemoglobin.

To aid in comprehension of the sensor's internal electronic subsystem, he depicted the sensor's functional block diagram in Figure 4, which was derived from the manufacturer's datasheet [19]. The sensor communicates and is controlled externally through the internal I2C data protocol over a connected connection to the embedded

Fig.4.

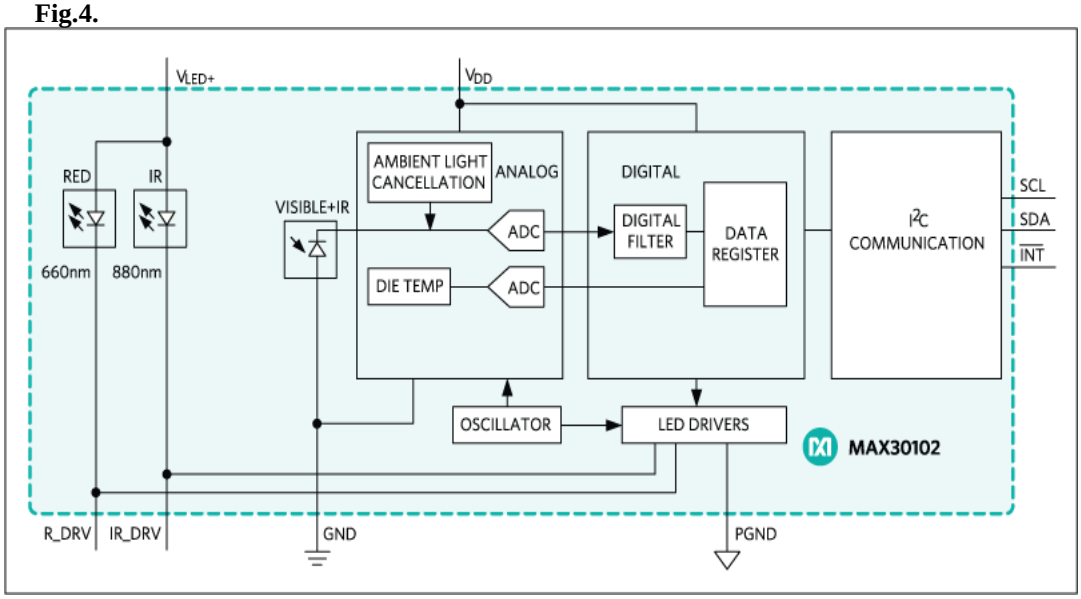


Figure-4 block diagram MAX30102 sensor functional.

2 NODEMCU

The ESP8266 module includes a WiFi module. It connects to a WiFi router and collects sensor data. The gadget must be connected to the IP address of the code hosting server in order to monitor it. There are two possibilities to perform signal processing and a graphical user interface for the user: The code can be executed directly from a smartphone, tablet, computer or any other device. Here, we just run the HTML page directly from the phone, eliminating the need for a server. However, it is acceptable to serve as a reference. The server provides processing and GUI code.[20]

3 Medical device

The BT-780 patient monitor measures physiological parameters like blood oxygen saturation (SpO2) and temperature. The signals are converted to digital data and processed, and the resulting data is verified and displayed for alert circumstances. The patient monitor is designed for use in clinical areas of the hospital, such as intensive care units, cardiac care units, operating rooms, and emergency departments, to offer extra information on the patient's physiological status to medical and nursing staff. The BT-780 patient monitors are intended for usage only when clinical professionals are present. Adults, toddlers, and babies can all use it. Hospitals and clinics are intended locations for usage.

Indications and contraindications Blood oxygen saturation (SpO2)

Indication medical device :

- Monitoring effectives of oxygen therapy
- I need a reading to facilitate the completion of an early warning score to inform clinical assessment
- Sedation or anesthesia
- Transport of patients who are unwell and require oxygenation assessment
- Haemodynamic instability (cardiac failure or Myocardial Infarction)
- Respiratory illness asthma, chronic obstructive pulmonary disease
- Monitoring during administration of respiratory depressant drugs, opiate epidural or patient-controlled analgesia.
- Assessing oxygen saturation during physical activity in pulmonary rehabilitation

4 The mobile application

Blynk is an internet of things platform that enables remote control of electronic gadgets via its iOS and Android applications. It includes a dashboard from which the user may design a graphical user interface using various widgets. Additionally, Blynk can store and show sensor data. Blynk includes libraries for the majority of popular hardware platforms, including Arduino and the ESP8266[21].

work in:

- Industrial equipment and air conditioning
- Start-ups
- Food and drinks
- Smart home
- Medical care

5 Prototype

The application helps to communicate with medical devices reading sensors in real time with the effect of a slight delay in the Internet a few parts of a millisecond and according to the data path, if it is the same network or through the cloud path through the Internet

Here is what you need to Blynk:

This application is an application used for IOT applications by creating and designing a suitable platform with spatial tools that offered by this application like Value display, Gauge, LCD, etc. This application is free to use.

In our project we used this application to create a monitor tool that displays the value of Max30102 [spo2 and heart rate]. the steps are very easy as below:

-Create a new project
-set the name of the project: SPO2 and heart rate
-choose the micro-control type: NodeMCU
-choose the connection type: Wi-Fi

after that, we will design the monitor screen:
- Adding Value display tool [2], one for SPO2 and the other for heart rate
- specify the value of Input [V7] and [v8].
- Adding Gauge Tool [2], one for Spo2 and the other for heart rate.
- specify the value of Input [V7] and [v8].

The application will then produce an auth token automatically and randomly; We will use this auth token in our code to establish a connection between the nodemcu and the application. Thus, when the mobile device is linked to an A.P.I and a micro-controller, the application displays the values read by the sensor.

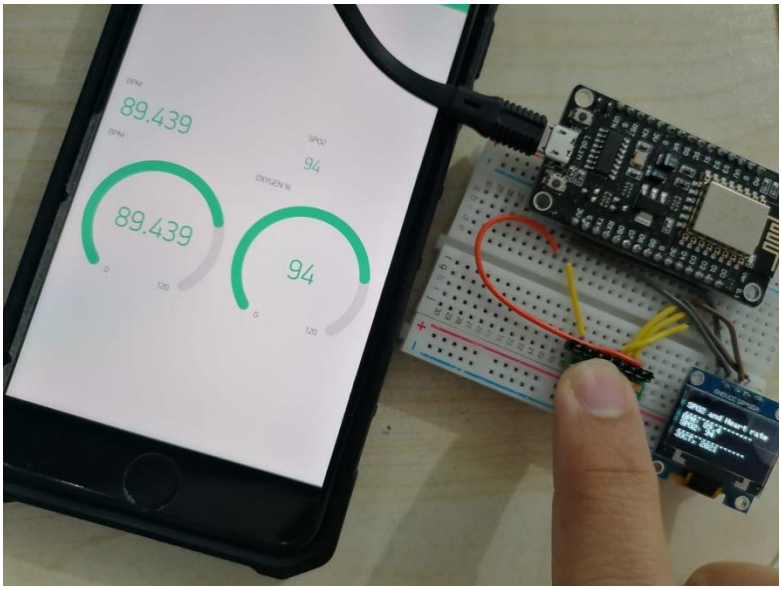


Fig .5 .

Resulte:

The results were compared to those of currently available medical equipment and the prototype created by us, and it was discovered As seen in the table below, when patients are moderately or mildly infected with Corona 19, the readings from the two devices are near and the average error rate is low.

Patient	MAX30102 pulse oxime-ter		Medical pulse oximeter		Error ratio Pulse prototype %	Error ratioSPO2 prototype %
No.	Spo2 "%"	Pulse "pbm"	Spo2 "%"	Pulse "pbm"	1.021	1.026
1	95.0	95	97.0	97	1.020	1.022
2	93.0	99	95.0	101	1.012	1.021
3	94.0	82	96.0	83	1.024	0.997
4	96.0	82	95.0	84	1.021	1.026

Table.1 different pulse oximeters competition with patient results.

We will now make a comparison according to the results we obtained based on the ratings of physical devices to know the Criteria of each and what is best when using them, as it is necessary before starting work and using the medical devices we know. Some basics of use and through the comparison will become clear the full picture of these two devices what are the two devices and what is the best way to develop them?

Criteria	Medical device BT-780	Our prototype
Cost	Hight	low
Size	Hard to use and carry	Easy to use and carry
Mobility	Read data in the same location only	Read data in the same site or any other site (portable)
Modifying	We cannot modify it	Easy to modify and customize its functions
Manufacturing	It is difficult to repair and can only be done in specialized centers by specialists	Easy repair and replacement of parts
Power	High power consumption	Very low power consumption and battery operated
Customizing	It is not possible to add devices that are not assigned to the device only	It is possible to add additional function devices to the same microcontroller
Monitoring	Display the results on the attached screen only	We can display the results on the attached screen or through the mobile application or the cloud
Resulted	We only displayed the results on the screen (passive resulted)	Send the results to over one competent authority at the same time
Result accuracy	Height	Less Hight
Scalability	Measuring one reading for one patient	Measuring more than one patient by adding just sensors

Table.2 competition the prototype and medical device depend on criteria

Conclusion

In the COVID-19 pandemic, there are many health sectors that can use such technologies. And that is through the use of the Internet of Things and the work of a complete interconnected system to take advantage of these devices. IoT devices are also evolving by sending data directly to display devices such as mobile devices or to the Internet and collecting and analyzing data.

Implementation of future portability requires an independent power source Based on rechargeable Li-Ion battery, such as NodeMcu sensor and MAX30102 Less power can be consumed by relying on hardware programming to allow data to be read on a lower periodic basis, and also by lower power consumption for NFC technologies and transmission to a terminal through which the cloud is sent for data storage and study, as well as triggering notifications when a patient has dangerously abnormal readings.

Regarding the device we made, it can be made miniaturized and made a strong box to resist falling or breaking What matters is the error rate the sensor reads. We can set it programmatically if the error rate is constant or close, so the device gives us true and reliable readings.

Reference

1. Badawi, H. F., Laamarti, F., & El Saddik, A. (2018). ISO/IEEE 11073 personal health device (X73- PHD) standards compliant systems: A systematic literature review. IEEE Access, 7, 3062–3073.

2. Agarwal, T. (2015). Know about electronics applications in medical field. Retrieved October 13, 2017, from https ://www.edgef x.in/medic al-electronics-application-engineering/

3. Ho, R. C. (2013). Uses and benefits of pulse oximeters. Retrieved October 16, 2017, from https ://www. amperordirect.com/pc/help-pulse -oximeter/z-uses-benefits-oxime ter.html.

4. Zachary, C., Shyqyri, H., & Amar, A. (2016). Pulse oximetry optical sensor using oxygen-bound hemoglobin. Journal Optical Express, 24(9), 10115–10131. https ://doi.org/10.1364/OE.24.01011 5.

5. Zachary, C., & Shyqyri, H. (2017). Optical based sensor prototype for continuous monitoring of the blood pressure. IEEE Sensors Journal, 17(13), 4258–4268. https ://doi.org/10.1109/JSEN.2017.27040 98.

6. Haxha, S., & Jhoja, J. (2016). Optical based non-invasive glucose monitoring sensor prototype. IEEE Photonics Journal. https ://doi.org/10.1109/jphot .2016.26164 91.

7. Vasile, I., Vasile, V., Diaconu, E., Andrei, H., Angelescu, N., Journal of Science and Arts, 3, 793, 2019.

8.Dhont, S., Derom, E., Van Braeckel, E. et al., Respiratory Research, 21, 198, 2020.

9.Castaneda D., Esparza A., Ghamari M., Soltanpur C., Nazeran H., International Journal of Biosensors & Bioelectronics, 4, 195, 2018.

10.Dimiter, V.D., Healthcare Informatics Research, 22, 156, 2016.

11. Yuce, M. R. and H. CheeKeong, "Implementation of body area networks based on MICS/WMTS medical bands for healthcare systems", Engineering in Medicine and Biology Society, 2008, EMBS 2008, 30th Annual International Conference of the IEEE, 2008, pp.3417-3421.

12.Chan, Edward, D., Chan, Michael, M., Chan, Mallory, M., Respiratory Medicine, 107, 789, 2013.

13.Coyle, S., Diamond, D., Woodhead Publishing Series in Textiles, Multidisciplinary Know-How for Smart-Textiles Developers, 420, 2013.

14.Von Chong, A., Terosiet, M., Histace, A., Romain, O., Microelectronics Journal, 88, 128, 2019.

15.López Silva, S. M., Dotor Castilla, M. L., Silveira Martín, J. P., Journal of Biomedical Optics, 8, 525, 2003.

16.Chatterjee, S., Kyriacou, P. A., Sensors, 19, 789, 2019.

17. Rodrigues, Eduardo M.G., Godina, R., Cabrita, Carlos M.P., Catalão, João P.S., Biomedical Signal Processing and Control, 31, 419, 2017.

18. Partha Pratim, R., Dinesh D., Neeraj K., Computer Communications, 160, 111, 2020.

19. Suprayitno, E. A., Marlianto, M. R., Mauliana, M. I., Journal of Physics: Conference Series, 1402, 2019.

20. Škraba A, Kolozvari A, Kofjac D, et al (2019) Prototype of Group Heart Rate Monitoring with ESP32. 2019 8th Mediterr Conf Embed Comput MECO 2019 – Proc https://doi.org/10.1109/MECO.2019.8760150.

21. blynk, "http:// blynk.io/," blynk, 2021. [Online]. Available: http:// blynk.io/.