

## **Development of Portable Oxygen Concentrator Device for COVID-19 Patient**

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**Abstract:** Coronavirus disease (COVID-19) threatens to overwhelm our medical infrastructure at the global stage causing spikes in mortality rates because of the shortage of critical medical equipment such as ventilators. Most of the people infected with the SARS-CoV2-virus will experienced shortness of breath due to low levels of oxygen in the body known as hypoxia. This condition is referred to as "silent" or "happy hypoxia," when oxygen saturation is below 90% within the body, but the person can still normally breathe. Therefore, it is very vital to regularly monitor COVID-19's patient oxygen saturation level in order to supply adequate oxygen needed through the oxygen concentrator of a portable oxygen compressor. Thus, the main objective of this project is to develop a portable oxygen concentrator device to help patient with low oxygen level particularly the COVID-19's patient. The device was developed with pulse oximeter to measure the oxygen level (oxygen saturation) of the blood with curved cylindrical shape prototype body. The system powered by the rechargeable solar battery that supply direct current to the system. The ESP8266 Wemos NodeMCU was used as the main microcontroller while the GY-MAX30100 oximeter is used to monitor the SpO2 level and determine the user's condition, the severity of silent hypoxia and to figure out the necessity of oxygen therapy. The result and suggestions will be displayed on an OLED screen together with a light indicator after the testing and tracking is done. In addition to that, if the user hypoxia is too severe, SpO2 level less than 86% is detected, buzzer will be alarmed, and light indicator will be lighted up asides from displaying and sending notifications to the user.

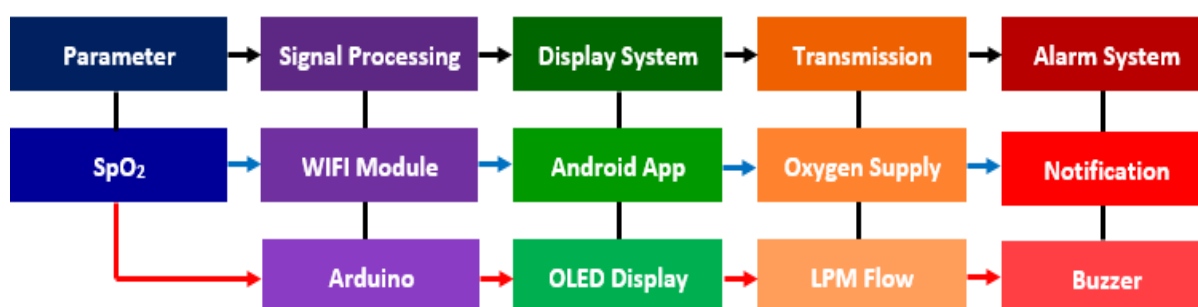
**Keywords:** Hypoxia, Oxygen Concentrator, Oxygen Level, COVID-19

## 1. Introduction

Hypoxia can be divided into a few types of severity which can be treated using different types of methods. Generally, the ventilators are used to treat the patients with more severe conditions of hypoxia. Therefore, in this study, the portable oxygen compressor is suggested to be implemented in the least severe patients and can be treated by the breathing therapy facilitated by the oxygen concentrator. The main consideration of implementing the oxygen concentrator in this study is to regulate the oxygen saturation of the COVID-19's patient. This is due to COVID-19's patients often experiencing low oxygen saturation levels in their body which are commonly a symptom of hypoxia that will contribute to shortness of breath [1]. The condition is referred to as "silent hypoxia" or "happy hypoxia," where oxygen saturation is below 90% within the body, but the person can still normally breathe [2,3]. Besides, the portable oxygen compressor that is available in the market nowadays does not have the functionality of monitoring the patient's oxygen saturation level. The pulse oximeter is the main medical device used to monitor the patient's oxygen saturation level [4]. Hence, the portable oxygen compressor is suggested to be modified to have a more effective usage in which we can combine the function of pulse oximeters together so the oxygen saturation levels of COVID-19's patient can be monitored from time to time. Lastly, the venturi mask is also suggested to replace the nasal cannula to help COVID-19's patient with a more effective way in the delivery of oxygen therapy [5].

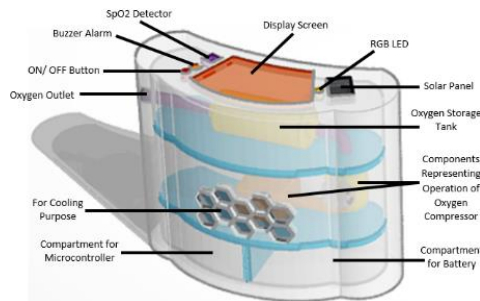
## 2. Materials and Methods

Figure 1 shows the flow chart of the Portable Oxygen Concentrator system. The system powered by the rechargeable solar battery that supply DC current to the system. The power supply will power the microcontroller ESP8266 Wemos NodeMCU, GY-MAX30100 oximeter and the light-dependent resistor (LDR) sensor module. NodeMCU was chosen as the microcontroller for the system because it holds a simple and clear programming environment which is convenient to apprentices and at the same time flexible to advanced users too, especially with the ESP embedded, regardless it is serial communication or I2C communication, it comes into handy for IoT project compared to other microcontroller. The GY-MAX30100 oximeter is used to monitor the saturation of peripheral oxygen (SpO<sub>2</sub>) level and determine the user's condition, the severity of silent hypoxia and to figure out the necessity of oxygen therapy. The result and suggestions will be displayed on an organic light-emitting diode (OLED) screen together with a light indicator after the testing and tracking is done. In addition to that, if the user hypoxia is too severe, SpO<sub>2</sub> level less than 86% is detected, buzzer will be alarmed, and light indicator will be lighted up asides from displaying and sending notifications to the user. To ensure the accuracy is reached, the Portable Oxygen Concentrator device will track the user's SpO<sub>2</sub> level from time to time, every two hours. However, considering rest is necessary to human beings, the device is implemented with an LDR sensor module to sense the light intensity of the room, determining the wakefulness level of the user to ensure zero disturbance to the user during his/ her resting time. On the other hand, considering the issue where there exist users with poor vision, the tested SpO<sub>2</sub> level, user's condition, and notifications will be sent to the user's mobile application, utilizing ESP8266, to ensure all the notices can successfully reach the user.



**Figure 1: The flow chart of the Portable Oxygen Concentrator system**

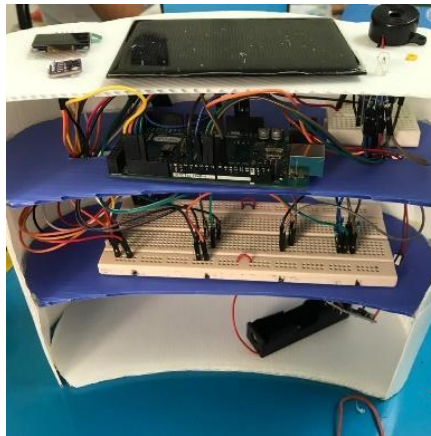
Figure 2 shows the Portable Oxygen Concentrator prototype drawing. The body of the prototype was designed to have a curved and cylindrical shape using the THINKERCAD software. Curvey shape was preferable because it is more user-friendly and minimize the sharp structure that will lead to engineering failures [7]. The curve shapes design appearances was also bring a more pleasant view to the viewer and attract more attention than those rectangular shapes [7]. This can greatly enhance the interest of the stakeholders as it is marketable and profitable. On the other hand, one of the requirements of the oxygen concentrator must be user friendly and portable means it can be brought to anywhere without much impediment. The marketable design of portable oxygen concentrators usually will provide a strip bag for the user to carry from place to place easily. Therefore, the curve shape design can greatly decrease the impact of the portable oxygen concentrator towards our body parts such as ilium when we carry the portable oxygen concentrator using the strip bag. In this design, a 3.7V lithium ion-based battery is used to supply power to the system. It is used as it is small in size, enabling the product to be carried easily. The device's structure is designed with a corrugated board. The material was selected due to its lightweight and able to minimize shock that can damage the components. Last but not least, the colour, shape, size and weight are taken into consideration to the customer's needs.



**Figures 2: Portable Oxygen Concentrator Prototype Drawing**

### 3. Results and Discussion

Figure 3 shows the prototype of the Portable Oxygen Concentrator. The SpO2 sensor will detect the oxygen saturation in a patient's blood and display in an OLED display which can perform various visual presentations like text and graphics. The data transmitted from the Arduino will be declared as text form in OLED whether the SpO2 level normal, slightly abnormal, abnormal, or severe. If the range of SpO2 is below 86%, automatically the buzzer will sound to notify the user to consult a doctor and should be hospitalized for his/ her low SpO2 saturation in his/ her blood, and at the same time, the device will supply an amount of oxygen to the user temporarily for support. If the SpO2 range is between 86% to 95%, the device will supply oxygen to the user with respect to the user's classified condition. The Wi-Fi Module (ESP8266-01) required the user to open the application on an electronic device and data as well as notifications will be shared wirelessly to the user's android to give instruction and guidance to operate the portable oxygen concentrator. Other than that, the android app will notify the user regarding his/ hers SpO2 saturation level and conditions, besides showing the amount of oxygen flow (LPM) supplied by the device referring to the tracked SpO2 reading. Suggestive notification will be sent to the user on venturi jet colour recommendation that can be selected and used according to his/ her need, and at the same time, RGB LED will be lighted up with respect to the suggestive jet colour.



**Figure 3: The prototype of the FILIKOS Portable Oxygen Concentrator**

#### **4. Conclusion**

Based on the survey done which consists of COVID-19 patients, medical staff, and technicians, most of them have the common interest and agree that the portable oxygen concentrator must be user-friendly which is small and can be carried away easily by the users. According to that, the device is well designed, portable and easy to use. The durability of the device is taken into consideration as the durable material is a very important aspect because it will affect the lifespan of the device. In addition, the designed oxygen compressor able to function swimmingly in supplying oxygen with precise flow rate to support the one in need. The proposed portable oxygen concentrator developed with a SpO<sub>2</sub> detector built in complimentary with the device together. This is a new design on the addition of SpO<sub>2</sub> detector features in the device which is the existing marketable device without coming out with this feature. Furthermore, the design also contains the quality characteristics such as affordable, safe, portable, easy to use, beautiful design, massive data storage and IoT technology in order to meet customer's needs.

#### **Acknowledgement**

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