Design of Heart Rate Device That Measures Oxygen Level by Using an Arduino

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ABSTRACT

This device is designed to measure the rate of oxygen saturation of the blood (blood oxygen) in addition to the heart rate. Method that is both effective and painless. The principle of the device's work is mainly based on the max 03133 sensor, which consists of two optical transmitters (LED), one for infrared and the other for infrared, an optical receiver and optical lenses, in addition to a similar signal processor. The sensor emits beams of infrared and infrared rays. These beams must pass through the finger to reach the receiver. As it passes, some of it will be absorbed by the blood. The unabsorbed part reaches the photoreceptor. The amount of radiation absorbed by the blood changes according to the characteristics of the blood. Where it was found that oxygenated blood (Oxy Hb) absorbs infrared rays more than red rays, while deoxygenated blood (Deoxy Hb) behaves the opposite way. Because it absorbs more red rays than infrared rays, that is: the ratio of both oxygenated and deoxygenated blood can be determined to according to the ratio of red and non-red rays coming to the photoreceptor, and on this principle, the sensor measures the oxygen Content in the blood, while the pulse rate is measured based on infrared radiation. When the heart pumps blood, an increase in the oxygenated blood occurs due to the increase in blood, and as the heart relaxes, the volume of oxygenated blood decreases. By knowing the time between the increase and decrease in the oxygenated blood, the pulse rate is determined. The Arduino is connected to the max03133 sensor via the I2C protocol, which is a serial communication protocol and requires two wires to communicate. As for the second wire, it is called the Serial Clock Line or SCL, and it is responsiblefor transferring the clock signal from the Master to the Slave, then displaying the result on the LCD screen.

Keywords: Heart Rate , Oxygen ,blood

Introduction

It is a technique used to indirectly know the percentage of blood oxidation (the direct method is to take a sample of arterial blood and analyze it) and the device also measures the number of heartbeats. Although the device's oxygen saturation reading (peripheral SpO2) is not always identical to the SaO2 reading from an arterial blood gas analysis, it is a safe, convenient, and not invasive or expensive method of measuring blood oxygen saturation in clinical use. The first device was invented in 1943 by Milliken. A sensor is placed on a thin part of the patient's body, usually around a finger or earlobe, or in an infant's foot. The device passes two waves of light through the body to a photoreceptor. The device measures varying absorbance at each wavelength, allowing it to determine absorbance by pulse of arterial blood alone, excluding venous blood, skin, bone, muscle, fat, and nail polish (in most cases).

Easy and simple to use, it monitors the oxygen rate in the blood and heart rate on an ongoing basis and is useful for patients with lung or bronchiectasis, as it is used by athletes during exercise. In the midst of the Corona pandemic, people with chronic lung or heart disease need to have regular checks of oxygen levels in the blood, to ensure that the heart is pumping and receiving oxygen properly in all organs. A useful device for measuring oxygen levels in the blood is a pulse oximeter. Less commonly, the reflex oximeter is used as an alternative to the oximetry described above. This method does not require a thin part of the person's body, and therefore it is quite suitable for application on any part such as the feet, forehead and chest, but it also has some limitations. It can cause aneurysms and venous blood pooling in the head as a result of the veins returning to the heart and mixing of the arteries and venous pulse in the forehead area, which leads to false results. Such cases occur in patients with congenital heart disease.

1.1 Objectives of the Study

The study has a number of objectives, as shown below:

1- Pulse oximetry is an easy way to see if your lungs and heart are working well and your oxygen supply is adequate.

2- The device helps you to know whether all parts of the body are receiving an abundance of oxygen or not.

0- It also helps in diagnosing any underlying condition because inadequate oxygen is a potential symptom of many problems related to the lungs and heart, and this helps identify chronic lung or heart disease so that you can get treatment in time to prevent further complications.

2.1 Oxygen Rate

As is well known, the next blood delivers oxygen from the lungs utilizing

hemoglobin (hemoglobin), hemoglobin is loaded with oxygen and referred to as Pal (deoxy Hb) or (deoxygenated blood). The hemoglobin loaded with oxygen alleges (oxy Hb) (oxygenated blood) and it can be said: The ratio of oxygen or blood oxygen to satisfy the ratio indicates hemoglobin loaded with oxygen to hemoglobin is loaded.

2.2 Measurement of the oxygen level of in the blood

The sensor emits infrared and infrared beams. These beams must pass through the finger to reach the receiver. As it passes, some of it will be absorbed by the blood. The unabsorbed portion reaches the photoreceptor as shown in figure (2-1).

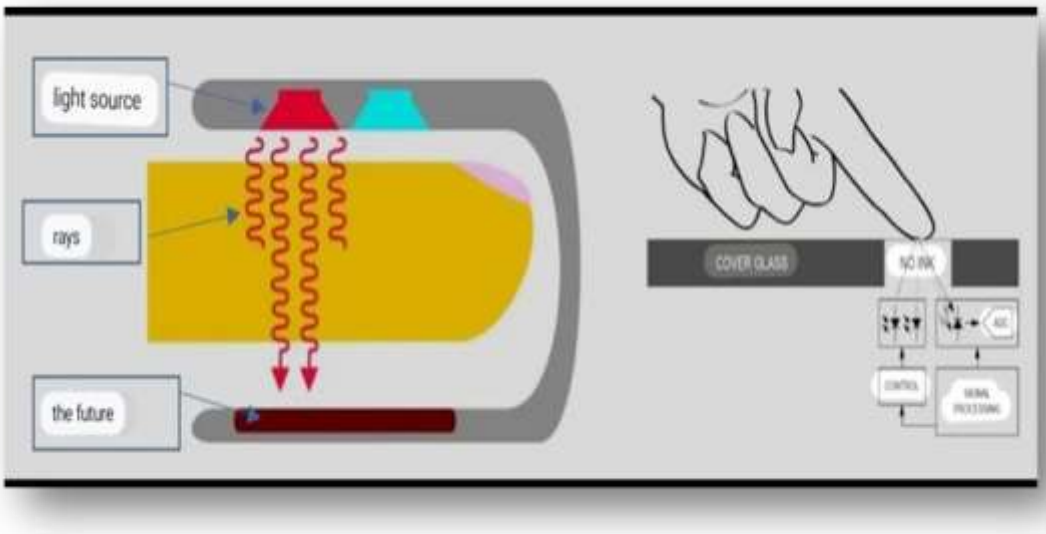
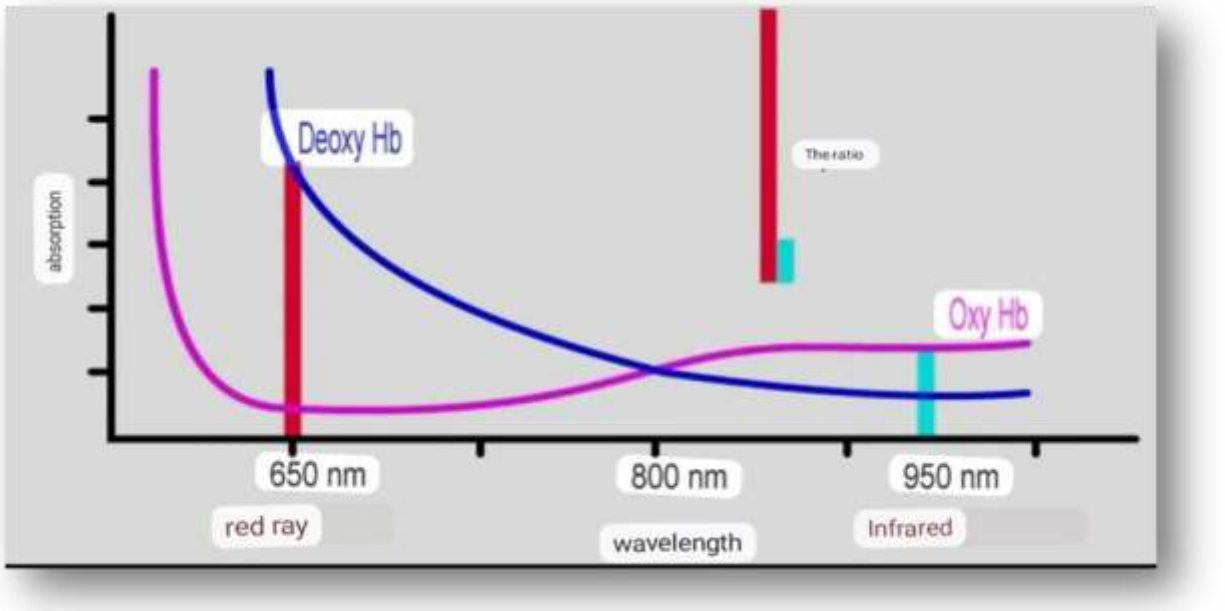


Figure (1-2): Measurement of the level of oxygen in the blood.

The amount of rays absorbed by blood changes depending on the blood properties. Where it turns out that the oxidized blood (Oxy HB) absorbs more infrared rays than red rays, while the non -oxygenated blood (Deoxy)

HB) is a opposite behavior; Because it absorbs the red rays more than infrared rays, that is: the proportion of both oxygenated and non - oxygenated blood can be determined and according to the ratio of red and non -red rays coming to the optical receptor, and on this principle the sensitivity measures the level of oxygen in the blood as shown in figure (2- 2).



Figure(2-2): Determining the ratio of both oxygenated and deoxygenated blood according to the ratio of red and infrared light.

2.0 Heart rate measurement

In terms of heart rate, it is measured using infrared radiation only as shown in figure (2-0), as follows:

When the heart pumps blood, an increase in the oxygenated blood occurs as a result of the increase in blood, and as the heart relaxes, the volume of oxygenated blood decreases. By knowing the time between the increase and decrease in the oxygenated blood, the pulse rate is determined.

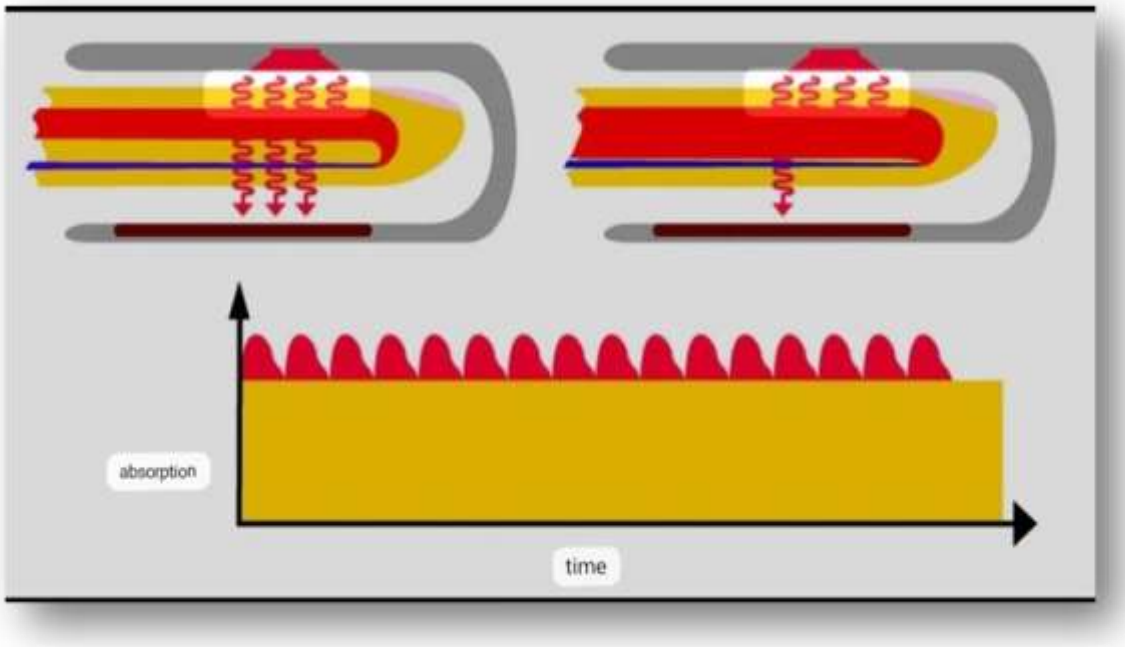


Figure (2-0):Pulse Rate Measurement

Methodology

0.1 Materials

This patient management system consists of four main parts which are:

1. The power supply.
2. Microcontroller unit

0. oxygen sensor max03133..

4. Lcd screen 16*2.

All these component are enclosed in a plastic box with the following dimensions:

1. Length = 13 cm.

2. Width = 13 cm.

0. Height = 6 cm.

With a total volume of 633 cm0

0.1.1 The power Supply

This device works with 5 volts and gets its supply directly from the computer through the USB cable as shown in figure (0-1).

Figure (0-1) USB Cable

0.1.2 Microcontroller Unit

For controlling the input and output data we used Arduino UNO R0 which is based on ATMEGA028 Microcontroller.

Arduino UNO

It is an open-source microcontroller board based on the Microchip ATmega028P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino

IDE (Integrated Development Environment), via type B USB cable as shown in figure (0-2).

Figure (0-2) Arduino UNO R0.

It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 23 volts. It is similar to the Arduino Nano and Leonardo.

0.1.0 oxygen sensor max03133

The MAX03133 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart- rate signals. The MAX03133 operates from 1.8V and 0.0V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times as shown in figure (0-0).

Figure (0-0): oxygen sensor max03133

Features & Specifications:

1– Operating Voltage: 1.8v – 5.5v

2-Interface Type: I2C Serial Interface

0-Complete Pulse Oximeter and Heart-Rate Sensor Solution

4- Simplifies Design Integrated LEDs, Photo Sensor, and High-Performance Analog Front-End

5- Tiny 5.6mm x 2.8mm x 1.2mm

6- Optically Enhanced System-in-Package.

7- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices

8- Programmable Sample Rate and LED Current for Power Savings

9- Ultra-Low Shutdown Current (3.7µA, typ)

13- Advanced Functionality Improves Measurement Performance

11- High SNR Provides Robust Motion Artifact Resilience

12- Integrated Ambient Light Cancellation

10- High Sample Rate Capability

14- Fast Data Output Capability

15- Module Weight: 1.2g (Header + module)

0.1.4 Lcd screen 2*16.

2 x 16 type LCD screen, light blue color and white letters, can be programmed using the I2C protocol directly as it contains its own operating unit, and it is ready with the screen, as the company started to connect it to the screen, in addition to the processing link from a 5V source. Numbers Display two lines on the screen and 16 characters of letters or numbers or any symbol readable for each line. The I2C 16×2 LCD monitor uses an I2C communication interface. That means it only needs 4 pins for the LCD screen: VCC, GND, SDA, SCL. It will save at least 4 digital/analog pins on

the MCU as shown in figure (0-4).

Figure (0-4): LCD screen Features

1- LCD display module with blue backlight.

2- Wide viewing angle and high contrast.

0- Built-in industry standard HD44783 equivalent LCD controller.

4- Commonly used in copiers, fax machines, laser printers, industrial test equipment, networking equipment such as routers and storage devices. 5- Can display 2-lines X 16-characters

Specifications

1- I2C Address: 3x23

2- LCM type: Characters

0- Backlight Background: Blue

4- Characters Color: White

5- Supply voltage: 5V

6- Size: 82x05x18 mm

7- Viewing area size: 64.5mm x 16mm.

0.2 Working Principle

The goal of this proposed approach is to design a device that helps you find out whether all parts of the body are receiving an abundance of oxygen or not. It also helps diagnose any underlying condition because hypoxia is a potential symptom of many problems related to the lungs and heart, and this helps identify lung disease or chronic heart disease. Required components used in this system include a power supply, an Arduino Uno (ATmega028 microcontroller), a max03133 oxygen sensor, a 2*16 LCD monitor, and a computer. The working of this device can be explained with the help of block diagram as shown in figure (0-5). The internal components of the device as shown in figure (0-6) and external device shown in figure

(0-7).

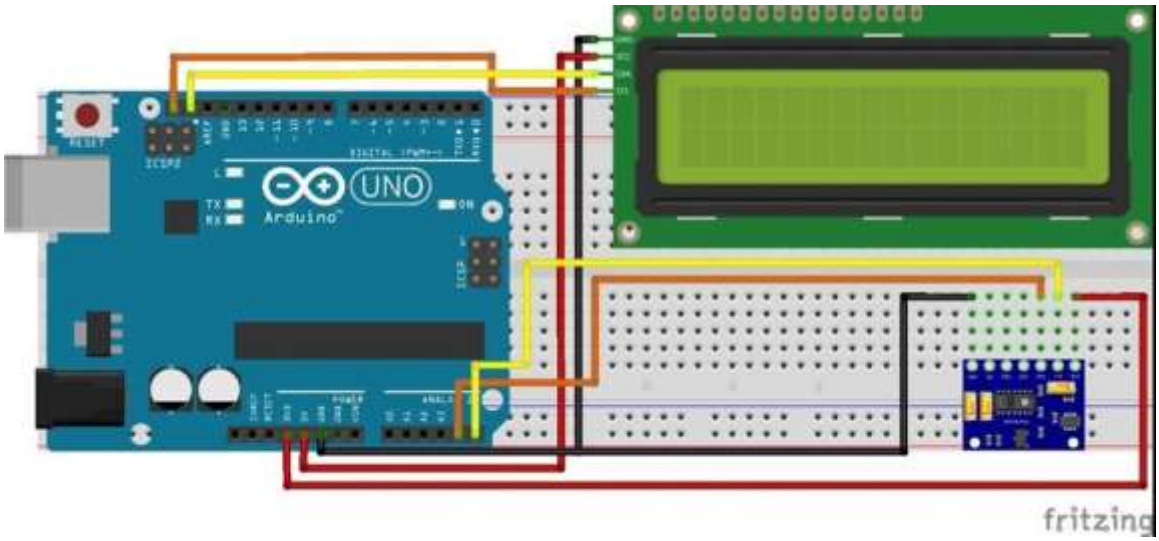


Figure (0-5): Device block diagram

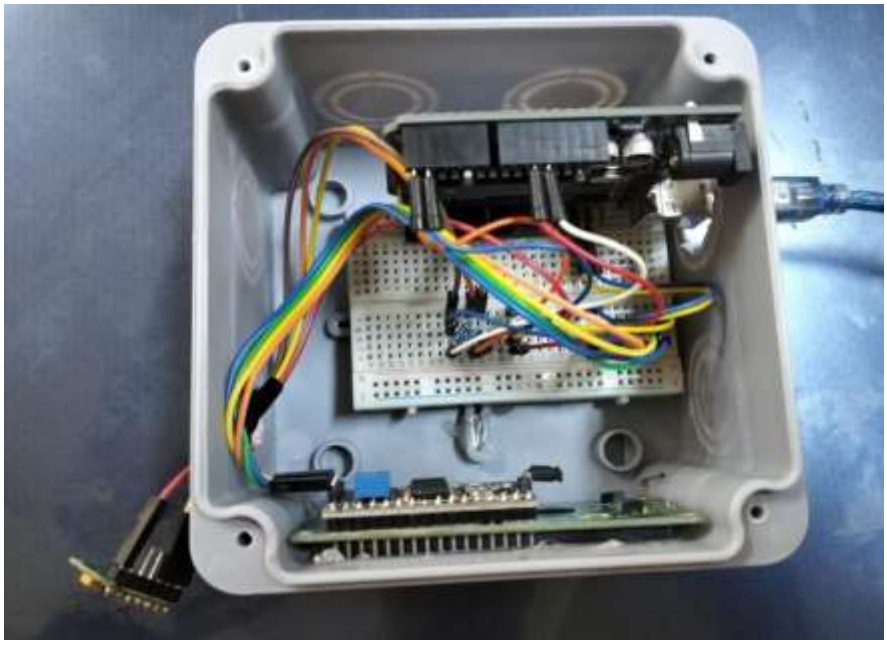


Figure (0-6): Internal components of the device.

Figure (0-7): External components of the device

4.1 Results

When the power is turned on, the device starts to work, we put the tip of the finger on the sensor and it must be stable, the device begins to give readings that appear on the LCD screen as shown in figure (4-1)

Figure (4-1):Read the results

The oxygen meter shows two readings as follows:

1- The acronym Spo2 stands for blood oxygen saturation levels, which are expressed as a percentage.

2- The abbreviation PR stands for pulse rate.

Oxygen should be above 93-929 measured in Spo2 and heart rate from 63- 133 measured in PR and any number lower than this indicates hypoxia that needs medical intervention.

4.2 Discussion

The oximeter measures the amount of oxygen saturation of blood in the arteries by calculating the light absorption of the vascular tissue pulse in two successive wavelengths. It measures the amount of oxygen in the blood without withdrawing any drop of blood from the patient. It is used to take readings in the following cases:

1- Operating room. Monitoring the patient's condition outside the operating room.

2- Monitor oxygen levels and heart rate while giving the patient a strong anesthetic and analgesic.

0- Knowing the patient's situation inside the home (the patient can use it without the need for help from another person).

4- Routine monitoring to ensure that the patient is not at risk of developing hypoxemia.

5- It serves as an early warning system for people at increased risk of death from silent pneumonia and heart disease.

This device is one of the easiest ways in which the patient's oxygen level can be monitored.

5.1 Conclusion

An Arduino UNO board, an oxygen sensor, and an LCD screen were used to create this device. The device is easy to operate and inexpensive. It is non- invasive way to measure oxygen saturation, unlike blood gas analysis that requires analysis of a blood sample drawn in the laboratory. Because of its simplicity of use and ability to provide continuous and instantaneous oxygen saturation values, it is available anywhere a patient's oxygen is unstable including most hospital wards, operating rooms, emergency rooms, and intensive care The ox meter is of sensitive importance in emergency medicine and is also very useful for patients with respiratory or heart problems, especially chronic obstructive pulmonary disease, or for diagnosing certain sleep disorders such as apnea and dyspnea. Portable battery-powered dosimeters are useful for pilots operating in a non- pressurized aircraft above 130333 feet (120533 ft in the US) where supplemental oxygen is required. Portable oximeters are also useful for mountaineers and athletes whose oxygen levels may drop at high altitudes or with exercise. Some portable dosimeters use software that tests your blood's oxygen and pulse, and serves as a reminder to check your blood's oxygen levels. The device can be used as a wearable device, in Fitness Assistant Device, and as a medical monitoring device.

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