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Pulse Oximeter Using Max 30100 Sensors

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***Abstract*: A pulse oximeter is a medical electronic instrument that measures the oxygen saturation (SaO/sub2/) of arterial blood and pulse rate by non-invasive techniques. It enables prompt recognition of hypoxemia. In the transmittance type pulse oximeter that CSIO has developed, the absorption of light by oxygenated and reduced hemoglobin is measured at two wavelengths 660 nm (red) and 940 nm (infrared). At each wavelength, the light detected by the photodiode consists of a cardiac synchronous AC signal arising from arterial blood volume pulsations, superimposed on a DC level. The DC level depends on LED intensity, tissue absorption, path length, and detector sensitivity. The tissue absorption and path length may vary widely between individuals and probe site. The ratio of red and infrared signals after normalisation is calculated and is related to arterial oxygen saturation. The SaO/sub 2/ is finally calculated using the well known Mendelson and Kent equation which is derived based on Beer Lambert law. In CSlO's pulse oximeter, a Nellcor finger clip probe is employed. The system operates at 400 Hz which is locked with power line frequency. Constant current feedback circuits are employed for driving the LEDs in a particular sequence. The detector output is given to sample and hold circuits for demultiplexing the three signals namely red, ambient and infrared. Our oximeter has provision for high and low alarm settings of SaO/sub 2/ from 50% to 100% and pulse rate setting from 30 BPM to 250 BPM. It also gives alarm conditions if the probe is accidentally disconnected from the finger. The SaO/sub 2/ is correctly measured in the range of 65 to 100% within /spl plusmn/2% accuracy and pulse rate within /spl plusmn/3 bpm.**

I. INTRODUCTION

A pulse oximeter is a medical instrument that indirectly measures the saturation oxygen level of a patients' blood, i.e. what proportion of the oxygen-carrying molecules in the blood (called hemoglobin) are actually carrying oxygen [1-3]. This is known as oxygen saturation or SpO_2.

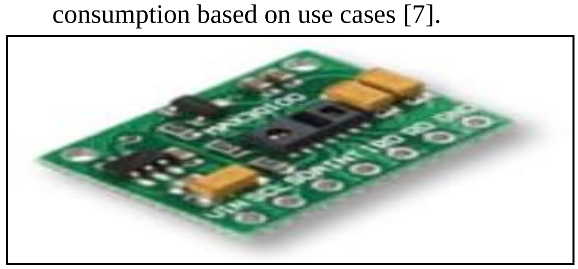
We proposed to develop a pulse oximeter to measure the saturation point oxygen level. In this project, we seek to monitor a patient's heart rate and blood-oxygen level using a pulse oximeter [4-5].

II. COMPONENTS

MAX 30100

a. Temperature Sensor →The MAX30100 has an on-chip temperature sensor for (optionally) calibrating the temperature dependence of the SpO_2 subsystem. The SpO_2 algorithm is relatively insensitive to the wavelength of the IR LED [6], but the red LED's wavelength is critical to correct interpretation of the data. The temperature sensor data can be used to compensate the SpO_2 error with ambient temperature changes.

b. LED Driver →The MAX30100 integrates red and IR LED drivers to drive LED pulses for SpO2 and HR measurements. The LED current can be programmed from 0mA to 50mA (typical only) with proper supply voltage. The LED pulse width can be programmed from 200µs to 1.6ms to optimize measurement accuracy and power consumption based on use cases [7].



NODE MCU ESP 8266

c. ESP8266 →The ESP8266 is a low-cost WiFi chip with full TCP/IP stack and MCU (Microcontroller Unit) capability. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

d. NODE MCU →The microcontroller used for interfacing the sensor is the Node MCU. It is a lua based microcontroller consisting of an ESP8266 WiFi module. This is the controller used for communicating the results to online web server. It is an open source IoT platform. It includes firmware which runs on the ESP8266 WiFi from Espressif system, and hardware, which is based on the ESP-12 module.

12C OLED DISPLAY

e. OLED DISPLAY→The *organic light-emitting diode* (OLED) display that we'll use in this tutorial is the SSD1306 model: a monocolor, 0.96-inch display with 128×64 pixels as shown in the following figure. The OLED display doesn't require backlight, which results in a very nice contrast in dark environments. Additionally, its pixels consume energy only when they are on, so the OLED display consumes less power when compared with other displays. The model we're using here has only four pins and communicates with the node mcu 8266 using I2C communication protocol. There are models that come with an extra RESET pin. There are also other OLED displays that communicate using SPI communication.

III. WORKING PRINCIPLE

Our pulse oximeter works on the principle of light absorption. Pulse oximeter emits RED and INFRARED LIGHT and detect by photo detector.
The ratio of the absorption of this two wavelengths is calibrated to direct measurement of atrial blood oxygen saturation [8].

Oxygen saturation = C (hbO_2) x 100%
= C (hbO_2)+C(hb)

Where, C(hb) = concentration of deoxygenated haemoglobin & C(hbO_2) = concentration of oxygenated hemoglobin

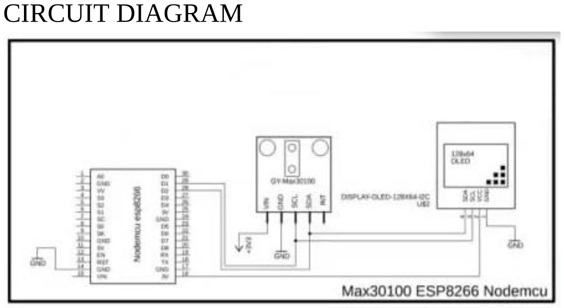
Red(R)=650nm, Infrared (IR)=970nm

Oxygenated & deoxygenated hemoglobin have different light absorption rate:
1. Oxygenated hemoglobin absorbs more infrared light.
2. Deoxygenated hemoglobin absorbs more red light.

IV. HOW IT WORKS

Light is emitted from light sources which are detected by the light detector placed in MAX 30100 pulse oximeter sensor. The amount of light absorbs depend on the 3 physical properties:
1. The concentration of the light absorbing substance.
2. Length of the light path in the absorbing substance.
3. Oxyhemoglobin & deoxyhemoglobin absorb red and infrared light differently.
The MAX30100, or any optical pulse oximeter and heart-rate sensor for that matter, consists of a pair of high-intensity LEDs (RED and IR, both of different wavelengths) and a photodetector. The wavelengths of these LEDs are 650nm and 970nm, respectively [9-10].
The MAX30100 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector [11-12]. This method of pulse detection through light is called Photo plethysmogram.

CIRCUIT DIAGRAM



V.ADVANTAGE

1. Low cost compared to market value of other oximeters.
2. Accuracy level is better than the other oximeter.

3. Long lasting
4. Easy to use

VI. APPLICTIONS

1. ICU
2. Emergency Department
3. Endoscopy suits
4. Cardiac Catharization Laboratary
5. Delivery suits

VII. CONCLUSION

Now a days, the IoT Enabled Pulse Oximeter developed has been a relative success compared to mainstream Pulse Oximetry and Pulse-Rate devices. Thus our aim to make the system accessible and portable has been proved and tested thoroughly. In future, with the connection with the Internet, even remote doctors can assess the condition of the person by checking the result from the web. Hence, the device has proved to be fruitful despite its challenges.

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