Wireless Blood Oxygenation Sensor

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Problem Statement

Patient blood oxygen level measurement devices used in healthcare require wire connections that take up space and hinder the movement of healthcare workers. Our team aims to create a blood oxygenation sensor that uses a Bluetooth connection to reduce the inconvenience to healthcare personnel.

Background

• A pulse oximeter measures the oxygen concentration (SpO2) in the blood.
• A person’s SpO2 level can warn healthcare professionals of potential dangers to the person’s health.
• Our pulse oximeter detects SpO2 levels by utilizing the fact that molecules in the blood have different absorptivity for different lightwaves (Figure 1).

Project Overview

Our overall goal is to design a wireless pulse oximeter. To do this, we need parts working on detecting human finger oxygen signals and the device sending these signals out, and a device to receive this signal and convert it into readable results. To detect human finger oxygen signals, we can use Texas Instrument’s AFE4403. To send the signals, we could use Gecko board’s EFR32 to send via Bluetooth. To receive signals, we use a laptop via Bluetooth. To convert the data into results and display it, we use a web page with a python script. Since we need the hardware works as a whole, we need the EFR32 read data in AFE4403, we need to design a PCB to do that. Therefore, our overall workflow and design will look like the following chart:

Bluetooth Implementation (Signal Transmission)

• We programmed the BRD4182A (a Bluetooth chip) on the Gecko board named EFR32.
• We firstly used the Bluetooth empty example on Silicon Lab to check the connection with cellphone and laptop.
• We modified the Bluetooth code on Silicon Lab based on the previous code to ensure the sample with data could be transmitted between cellphone and laptop.
• We used the pin tools on Silicon Lab to fit the pin change on the PCB design. We followed the pin configuration and changed the functions on the ports.

Test & Conclusion

• We connected the PCB board with the Arduino Atmega 2560 board and use the Arduino board to setup the AFE4403. Also, the Arduino board will provide power to the PCB. Then we connected the SPI pins (MISO, MOSI, SCK, SpiSel) to the digital logic analyzer form DigiView to analyze the output from each pin.
• We could detect the corresponding SPI signals from the AFE4403 by using the digital logic analyzer. But, we need a way to translate the signals to the real SpO2 number after the Bluetooth part can functionally work.

Future Work and Acknowledgements

• Set up the AFE4403 without using Arduino. Find another way to setup the AFE4403 without connect other board.
• Translate the signal received from the AFE4403 to the SpO2 concentration.
• Continue working on Bluetooth connection between Gecko board and the web client to transfer the data.
• Continue working on a web client that can receive, analyze and display the SpO2 data at the same time.

References:

https://derangedphysiology.com/cicm-primary-exam/required-reading/respiratory-system/Chapter%20121/absorption-spectroscopy-hemoglobin-species

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