Voice Enabled Pulse Oximeter

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Abstract. A pulse oximeter is a device used for monitoring a person's oxygen saturation. A normal pulse oximeter displays the pulse rate. Due to the literacy rates of 72.8% in Telangana and 74% in India, there are still many people who are not capable of understanding what the appropriate heart rate and SpO_2 are, including visually challenged people. Hence, for them, a voice enabled pulse oximeter is provided, which enables the user to know what their heart rate and SpO_2 are through auditory output. This device will be helpful for people to understand clearly if their heart rate and SpO_2 are normal or abnormal and to take proper care of themselves.

Keywords: Pulse oximeter · Heart rate sensor · Auditory output · visually challenged people

1 Introduction

A pulse oximeter is a device that measures the blood oxygen saturation and pulse rate noninvasively [1]. The arms and legs, which are the areas of the human body farthest from the heart, may easily and painlessly be tested to see how efficiently oxygen is being delivered to them.

The pulse rate is the number of heart beats per minute. The arteries expand and constrict with the flow of blood accordingly. Measuring the pulse can reveal the following:

- Heart rhythm
- Strength of the pulse

Normally, the pulse rate should be around 72 beats per minute. With bodily actions, pulse rate can differ. In general, females 12 years of age and older have faster heart rates than boys. Cardiovascular-fit athletes, like runners, can have heart rates close to 40 beats per minute without experiencing any issues. Manually measuring the pulse involves:

- Press firmly but lightly on the arteries with the first and second fingertips until you feel a pulse.
- Begin counting the pulse when the clock's second hand is at 12.
- Count your pulse for 60 s (or for 15 s and then multiply by four to calculate beats per minute).

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- When counting, pay attention to the beats of the heart instead of the ticking timepiece or use a pulse oximeter, which simultaneously displays a person's pulse rate and oxygen saturation level.

Current pulse oximeters display the heart rate and SpO_2 as numerical values and sound an alarm. As a result of Telangana's literacy rate of 72.8% [2], India's literacy rate of 74% [3], 4.95 million blind people, and 70 million visually impaired citizens [4], these people are unable to read, interpret, or perceive what the acceptable heart rate and SpO_2 levels are.

Since the present pulse oximeter gives visual output when showing the result of the person's heart rate and SpO_2 level, an alternative module is made with the help of a heart rate sensor and a playback module to let people know whether their pulse rate is normal or abnormal in audio form.

2 Literature Survey

The heart rate and the SpO_2 of individuals who have different diseases are measured with the help of a pulse oximeter. The calibration of commercially available pulse oximeters on critically ill patients is, however, constrained due to ethical considerations. As a result, measurements in the crucial oxygen saturation region have a high error rate. Consequently, in this description of numerous illnesses, a voice-activated pulse oximeter assists the blind and also the illiterate in determining their blood oxygen saturation level [5].

All day wearing health machines. The suggested organic pulse oximetry sensor heads are monolithically integrated, demonstrating an effective operation at high efficiency light-emitting diodes as well as natural photodiodes with median electric energy as low as 24W developed using optical simulations of color-sensitive incident light mostly under the human surface. There are light sources and detectors placed on the same level since it employs an OPO sensor with a reflecting design. Its design enables the application of pulse oximetry to a range of pulsing human body surfaces, making it simple to put them into everyday wearables like smartwatches and eventually combine them to design a multimodal, integrated health monitoring system. Here is not the situation as opposed to its counterparts with systems that use transmissions. As a result, it is now evident how light passes through the skin and what kinds of sensors may be employed to improve the performance of an oximeter [6].

An algorithm that can be applied to systems for monitoring the safety of swimming pools. The algorithm aids in setting off alarms about potential danger in the event that the SpO_2 levels are noticeably reduced. The number of false positive alarms can be reduced by reacting to a decrease in SpO_2 levels instead of reacting to the saturation value threshold. Therefore, methods for determining heart rate and oxygen saturation, as well as the nearest peak selection method, are used for eliminating motion artifacts [7].

The Markov model compared hospitalization to telemonitoring with a pulse oximeter stimulated treatment of mild to severe COVID-19 patients. Telemonitoring is the practice of a doctor or medical professional watching over a patient remotely. In this home monitoring with a pulse oximeter for 5 days, if the patient has low levels of oxygen in the body, they will be hospitalized under the name of "observation" for 7 days with a pulse oximeter, and if the patient is in a critical care condition, they will be hospitalized in an ICU with the support of ventilators for 10 days. Therefore, the patient data can be accessed at any time if it is necessary [8].

As the accuracy of the sensor MAX30100 is 97.11% to 98.84% for heart rate and SpO_2, respectively, the likelihood of an error rate in this project is relatively low. The sensor MAX30100 features a high signal-to-noise ratio (SNR), which offers motion robustness and artefact resistance, as well as integrated ambient and light cancellation and high sample rate capabilities with quick data output. The pulse oximeter in this project reveals precisely how low the heart rate and SpO_2 are, whereas the previous model merely supplied a buzzer in swimming pools. This information can allow the person to take care of his condition.

3 Methodology

The system works on the basic principle of "if/else condition". Figure 1 shows the block diagram of the voice enabled pulse oximeter and the main components used in the System are:

- Max30100 Sensor
- Microcontroller (Arduino Uno)
- I2C LCD
- DF Mini Player
- Speaker

Max30100 sensor: It is a sensor that makes it possible to measure both SpO_2 and heart rate simultaneously. In order to regulate LED pulses for SpO_2 and heart rate readings, it incorporates Red and IR LED drivers. It is connected to a microcontroller.

Microcontroller: A microcontroller is a controller where data is processed and controlled in one small integrated circuit that is connected to the I2C LCD and DF mini player.

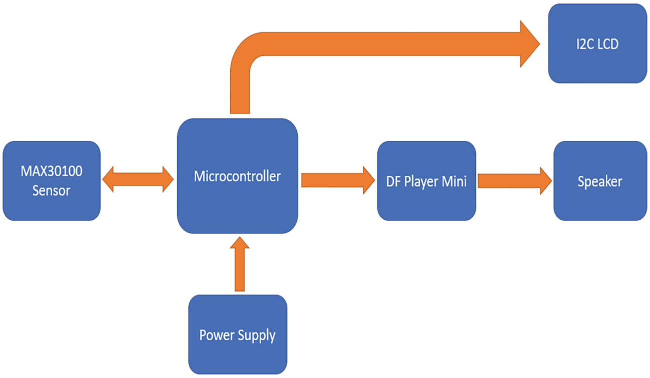

Fig. 1: Block Diagram of the System

I2C LCD: LCD (Liquid Crystal Display) is a component that displays the characters visually. It has a 16-pin configuration. With the help of I2C, the 16-pin configuration of LCDs can be reduced to 4-pin, which helps with smaller connections. It displays the values of heart rate and SpO_2.

DF Player Mini: Insert the DF Player Mini with an SD card loaded with the necessary audio files. Audio files can be accessed by the pre-defined inputs of the Max30100 sensor, which is connected to a speaker. By using DF Player Mini, volume can also be controlled.

Speaker: It is a small and low-priced MP_3 module used to give audio output from the output of the DF Player Mini.

Power Supply: The power supply should be given in DC mode to the Arduino board in order to operate.

For this, the Arduino IDE software should be installed on the PC, and uploaded the code that is developed for this device. The required libraries should be downloaded and installed in the Arduino software.

The above following hardware and software requirements have been used in the working principle. Each component plays its own role and has its own importance. Hence, the voice enabled pulse oximeter with the help of this equipment, can be designed in a way that is user-friendly and can be used by all age groups.

Basically, this project works on four conditions that are uploaded to the code. They are:

1. If the heart rate is between 40–100 and oxygen saturation is greater than equals 96%. It plays audio file 1, which is "Both heart rate and oxygen saturation are normal."
2. If the heart rate is between 101–109 and oxygen saturation is equal to 95%. It plays audio file 2, which says "Both heart rate and oxygen saturation are okay, but be cautious."
3. If the heart rate is between 110–130 and oxygen saturation is between 93%–94%. It plays audio file 3, which is "Consult the doctor."
4. If the heart rate is greater than equals to 131 and oxygen saturation is less than equals of 92%. It plays audio file 4, which is "Medical emergency."

Figure 2 shows the circuit diagram of the voice enabled pulse oximeter; power supply is given to the circuit in order to ON. When a subject places a finger on the Max30100 sensor. The RED and IR light is emitted from the MAX30100 sensor and passes to the subject's finger, then it senses the subject's heart rate and SpO_2. Based on the subject's data, DF Player Mini accesses the audio files in the SD card according to the pre-input conditions given in the code and plays the selected audio file.

Figure 3 shows the prototype of the system, where the input is the subject's finger and the output of heart rate and oxygen saturation can be seen in digital form and also heard in audio form.

4 Results

The developed system was tested on five subjects between ages 22–50. The obtained values have been verified with fingertip pulse oximeter.

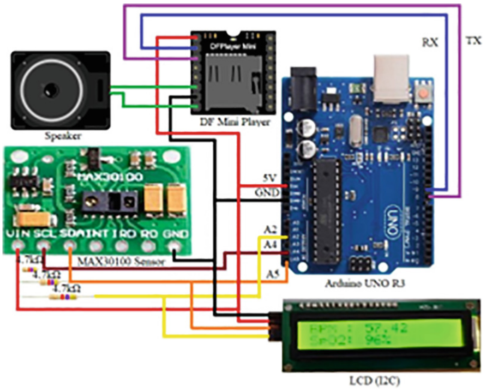

Fig. 2: Circuit Diagram

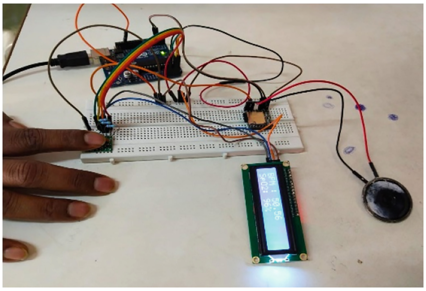

Fig. 3: Prototype of the System

Figure 4 shows the values of heart rate and SpO_2 of the developed system for subject 1 which gives audio output in the form of "Both heart rate & Oxygen saturation are normal".

Figure 5 shows the values of heart rate and SpO_2 of the developed system for subject 2 which gives audio output in the form of "Both heart rate & Oxygen saturation are normal".

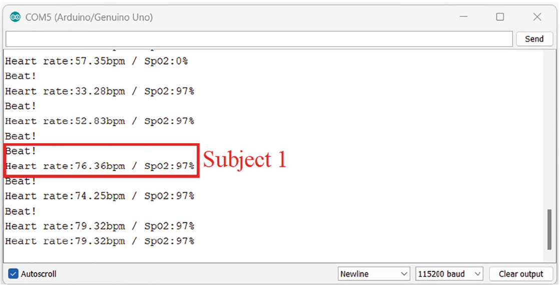

Fig. 4: Results for Subject 1

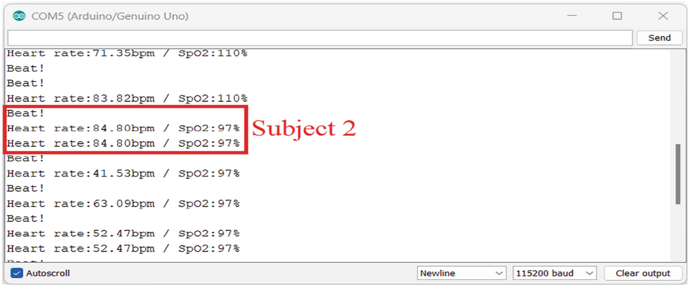

Fig. 5: Results for Subject 2

Table 1 shows the comparison between the subject's test results of the developed system (voice enabled pulse oximeter) and fingertip pulse oximeter. The results are found to be accurate with 98.3% for heart rate and 98.7% for SpO_2.

Table 1: Subject's Test Results

Subject	Age	Voice Enabled Pulse Oximeter Values			Meditech Fingertip Pulse Oximeter Values		Accuracy%	
		Heart Rate (HR)	SpO_2%	Voice Output	HR	SpO_2%	HR	SpO_2%
1	22	76	97	Both heart rate & Oxygen saturation are normal	75	96	98.6	98.9
2	32	84	97	Both heart rate & Oxygen saturation are normal	88	99	95.5	97.9
3	42	94	96	Both heart rate & Oxygen saturation are normal	94	98	100	97.9
4	47	83	98	Both heart rate & Oxygen saturation are normal	83	97	100	98.9
5	50	89	98	Both heart rate & Oxygen saturation are normal	91	98	97.8	100

5 Conclusion

The voice enabled pulse oximeter has been designed and developed successfully with the help of the Microcontroller and playback module. This device will help many uneducated, elderly and visually challenged people who need to know whether their heart rate and SpO_2 are normal or not. Presently, this device gives voice output only in one language, which is English. People with no knowledge of English may not be able to understand the voice output. So, in the future, local languages could be added and they can be used widely in rural areas. The developed device is user-friendly. Hence, this device makes lives simpler and easier.

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