Biosensing for Dynamic Difficulty Adjustment Glasses

Mock Design Review
ECE 445

T.A Henry Duwe

Members:
Frank Huang    Christopher Dunaway    Joseph Lorenzini

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**Table of Contents**

1. Block Diagram 3

2. Circuit Schematic of Sensor PCB 4

3. Power Calculation of IR Pulse Sensor 5

4. Plot 6

5. Block Description 7

6. Requirements and Verifications 8

7. Safety 9

8. Citations 10
1. Block Diagram

![Block Diagram]

**Legend**
- Power
- Signal (cable)
- Digital Signal (wireless)
- TTI to USB

*Figure 1. Block Diagram*
2. Circuit Schematic of Sensor PCB

Figure 2. IR Pulse Sensor Circuit Schematic
3. Power Calculations of IR pulse sensor

Powering our circuit from the power bench we know that the maximum voltage and current consumption of our circuit is 5v and 0.041A respectively.

\[ V = 5v \]  
\[ I = 0.041A \]  
\[ P = I \times V = 0.205W \]

The power consumption of the IR pulse sensor module is thus 0.205W
4. **Plot**: Voltage Across the Infrared Pulse Sensor Over Time while in Contact with Finger
5. Block Description

The infrared pulse sensor is designed on PCB and uses a 940nm IR photodiode that detects the systole blood flow reflected from a 940nm IR LED. The expanding blood flow from the systole cycle would reflect more IR than the diastole cycle and generate a larger current through the photodiode. The circuit consists of two LM386 op amps circuits to establish a baseline for the signal, amplify the peaks, and filter out signal noise.

The sensors measure pulse rate by emitting infrared spectrum radiation via the IR LED positioned on the glasses touching the user’s temple. By measuring the spikes of infrared light reflected off the blood in each pulse, the sensors will detect 5 second increments of heart rate changes by seeing the changes in frequency of reflected pulses. The sensor takes in 5V input from battery and outputs binary heart rate signals to the ATmega328 microcontroller.
### 6. Requirements and Verifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
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<tbody>
<tr>
<td>1. The output signal must produce voltages between 0 and a max voltage where the max voltage is between 2V and 5V and resembles a pulse.</td>
<td>1. To verify a pulse signal with a max voltage between 2V and 5V.</td>
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<tr>
<td>2. The module must produce a 90% accurate output signal.</td>
<td>a. Connect output of the module to an oscilloscope.</td>
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<tr>
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<td>b. Check that the max output signal falls between 2V and 5V.</td>
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<td>c. Verify the output resembles the systole and diastole sinusoid of a pulse.</td>
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<tr>
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<td>2. Purchase off the shelf medical grade pulse sensor (+/-2%) and measure difference of pulse from sensor output for a volunteer’s heart rate on oscilloscope.</td>
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<td>a. Verify that rising edge of the two overlayed pulses are within +/-12% of each other.</td>
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### 7. Safety Statement
The IR pulse sensor monitors changes in heart rate. In an adverse situation, the PCB circuit could short circuit and connect our Sunkee industrial grade LED wires directly to 5v and ground. Undamaged human skin has a resistance of about 100kΩ and damaged/wet skin has resistance of about 1kΩ [1]. In this circumstance, we would have a maximum of 5mA of current which would only register as a painless slight shock[2]. The user would be able to feel the shock but would not be harmed. If necessary, current limit diodes can be connected in series to the IR LED and photodiode to maintain a current cap of >1mA.
8. Citations
