Harnessing Biometric Sensors : A Study of Stress Reduction Through Meditation

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Motivation

1. Modern technology significantly contributes to the stress experienced by individuals worldwide
2. Meditation is a tool that has long been used to reduce stress
3. Biometric sensors are the modern technology that enable the investigation of meditation

Circuit Schematic

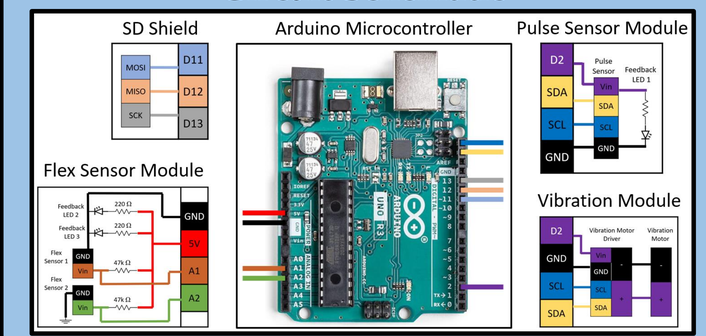

Figure 1 : Circuit schematic showing relationship between Arduino and modules.

CAD Models

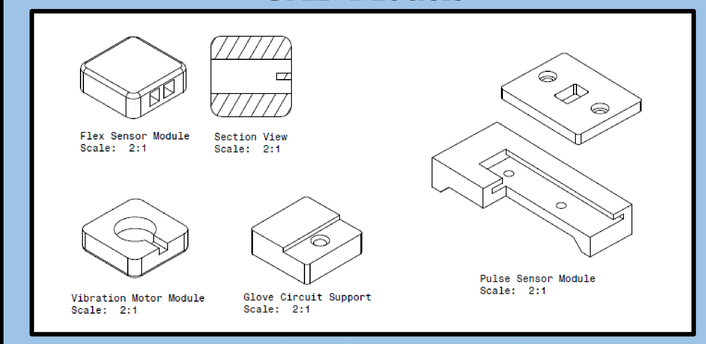

Figure 2 : CAD drawing of PresentPulse glove hardware.

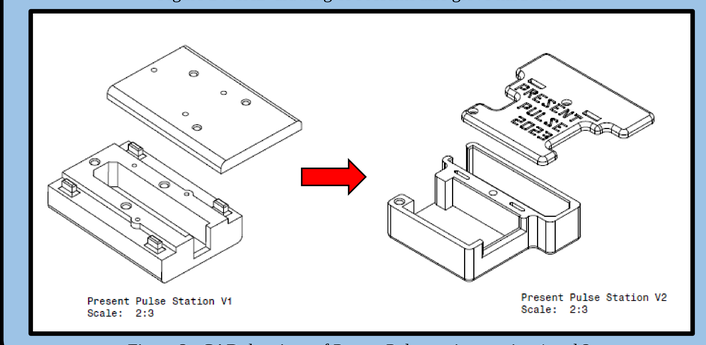

Figure 3 : CAD drawings of PresentPulse station version 1 and 2.

Abstract

In John L. Mason's *Guide to Stress Reduction*, an elevated pulse rate is identified as a key characteristic of the stress response. This research aims to investigate the influence of meditation on an individual's pulse rate and in turn their stress levels through biometric sensing. Significant progress has been made on a biometric data collection device, PresentPulse, in the areas of Arduino and MATLAB code, 3D printing, circuit design and soldering, prototype assembly, and preliminary biometric data collection. This investigation represents a crucial step towards a more mindful and stress resilient society including the aviation community.

Data Collection Procedure

Type:	Steps:
General	1. Equip glove and station 2. Check station for SD card 3. Connect power 4. Follow each specific procedure for 10-minute trials 5. Disconnect power 6. Remove SD card and upload data to computer for analysis
Rest	1. Sit in a comfortable position 2. Rest your hands on lap
Activity	1. Walk at a comfortable pace 2. Avoid bumping the glove
Meditation	1. Lay down in a comfortable position with hands at sides 2. Breathe deeply and focus on each breath

Table 1 : General and specific data collection procedure.

Collected Data

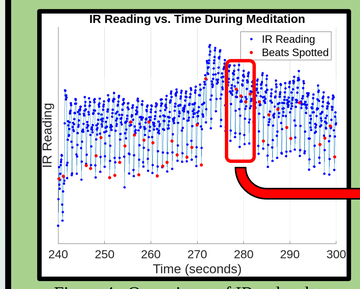

Figure 4 : One minute of IR pulse data.

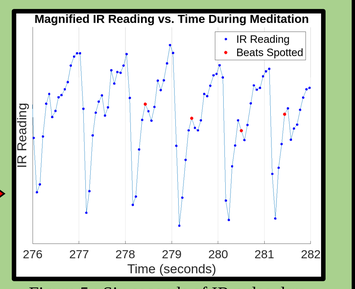

Figure 5 : Six seconds of IR pulse data.

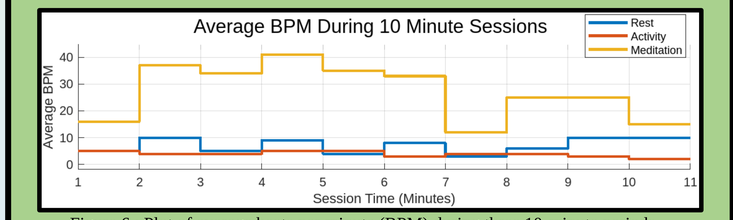

Figure 6 : Plot of average beats per minute (BPM) during three 10-minute periods.

Requirements

Progress:	The device must:
Achieved	Be powered by a rechargeable battery
Achieved	Operate with a battery life $\geq$ 1 hour
Achieved	Weigh less than 0.5 kg
Achieved	Be noninvasive during meditation
Achieved	Store session data in an SD card
Achieved	Be constructed of modular components for testing
Achieved	Sense the user's pulse through Photoplethysmography (PPG)
In Progress	Sense the user's pulse with < 5% error
In Progress	Allow the user to control the device with hand gesture
In Progress	Provide haptic feedback to gesture controls

Table 2 : Project requirements including achieved and in progress tasks.

Current Hardware

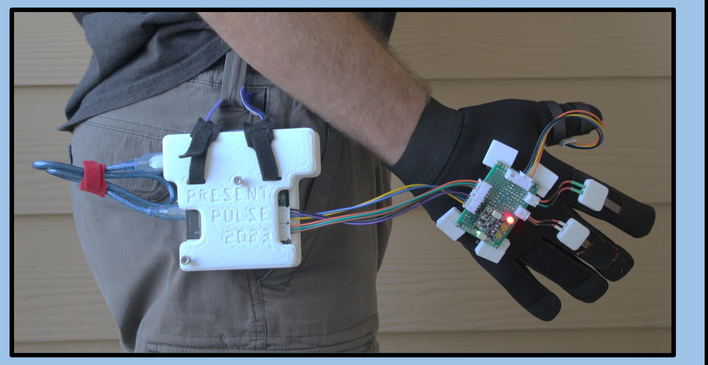

Figure 7 : Current state of PresentPulse glove and station.

Conclusion

This research aims to investigate the effects of meditation on pulse rate and subsequently stress. A prototype of the data collection device was created and preliminary data was gathered.

The initial hypothesis was that the act of mediation causes a decrease in heart rate. The collected data suggests the opposite. The reason is that more heartbeats were detected during the meditation trial than during the rest and activity trial. These tests prove the device capable of collecting pulse data with a large margin of error.

To improve the device, the heartbeat detection error will be investigated to achieve more accurate results. The gesture control and haptic feedback functionality will be implemented as well.

References

[1] Mason, L. John. *Guide to Stress Reduction*. Peace Press, 1985.

[2] Sparkfun (2016) Sparkfun_MAX3010x_Sensor_Library [Source code]. https://github.com/sparkfun/SparkFun_MAX3010x_Sensor_Library.