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Stress Measurement Wearable Device Optimized for use in the Clinical ICU

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CASE SCHOOL OF ENGINEERING
CASE WESTERN RESERVE UNIVERSITY

Agenda

1. Introduction / Background
2. User Needs
3. Concept Generation & Selection
4. Prototyping
5. Testing
6. Moving Forward
7. Acknowledgements
8. References

Introduction / Background

- Evaluating patient stress is critical in the Intensive Care Unit
- Current methods are inefficient and have severe limitations
  - Perceived Stress Questionnaire
  - Measuring cortisol as a stress biomarker
- Clinicians and nurses could benefit from a more efficient stress measurement system

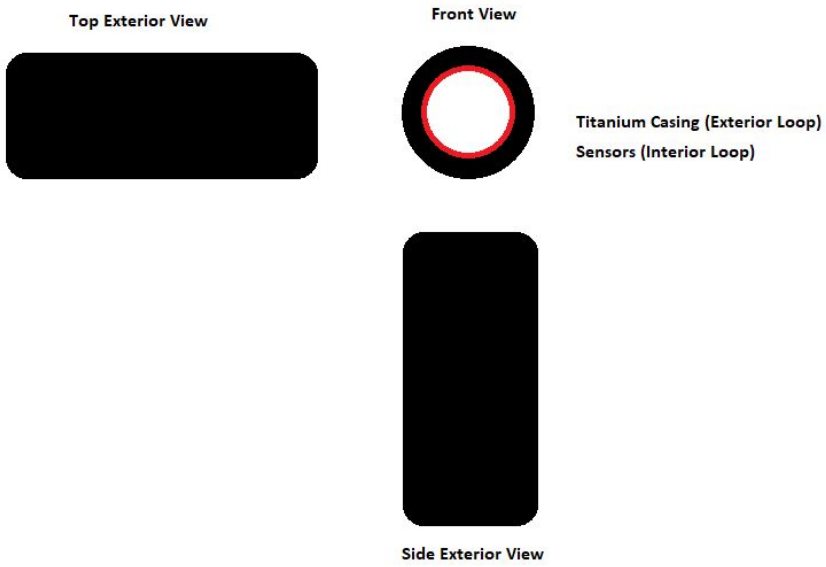
References: [1], [2]

User Needs Condensed

1. Efficient system for measuring patient stress to improve treatment efficacy and patient state.
2. Real-time measurement, storage, and analysis of galvanic skin response (GSR) and heart rate (HR) biosignals to produce a stress metric.
3. Display real-time analysis on external screen.

Concept Generation & Selection

- 3 designs moved forward into final Concept Selection from Concept Generation Phase.
  - Ring, Wristwatch, Vest



Comparison Matrix

- Concept Selection aided by the use of a Comparison Matrix.

Mechanism for Sensing Galvanic Skin Response (Finger)

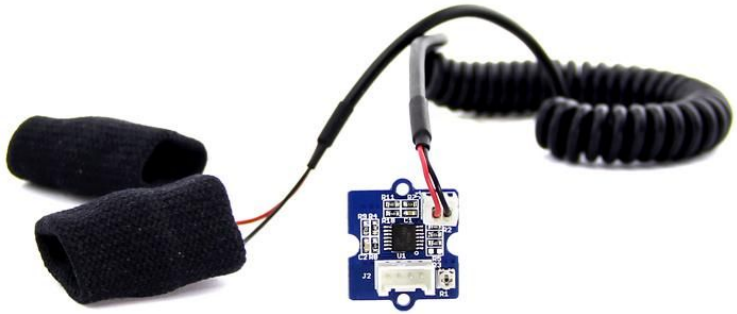
Mechanism	Optical (SE)	Electrode (SE)
Signal strength and robustness against noise	1.2 (0.6)	**3.4 (0.2)**
Comfort	N/A*	N/A*
Ease of use	N/A*	N/A*
Potential cost	2.0 (0.0)	**3.2 (0.2)**
Durability	N/A*	N/A*
Wireless capability	N/A*	N/A*
Ability to be sanitized	N/A*	N/A*
Ability to be used by a diverse population of patients	2.0 (0.3)	**2.8 (0.2)**
Total	5.9 (0.9)	**9.4 (0.2)**

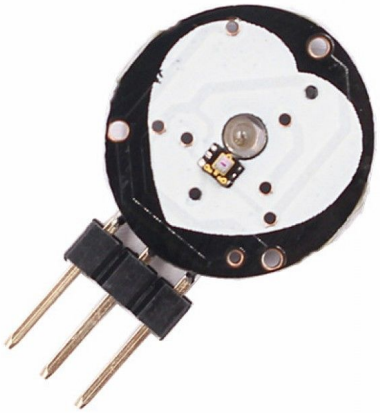
*The mechanism for sensing galvanic skin response is not anticipated to have a significant impact on the comfort, ease of use, durability, wireless capability, and ability to be sanitized of the device.

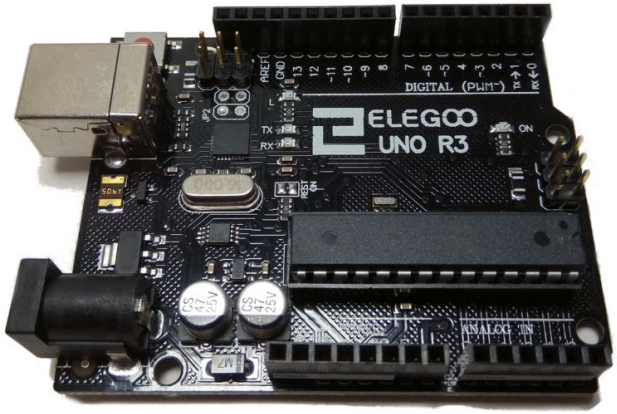
Prototyping

Current Progress:

- Heart rate sensor
- Galvanic skin response sensor







References: [3], [4], [5]

Testing

Signal-to-Noise Ratio (SNR)

- Signal strength of desired output given constant input
- Mean absolute deviation (noise) of output
  - GSR: Resistance
  - HR: Beats per minute (bpm)

Signal Accuracy

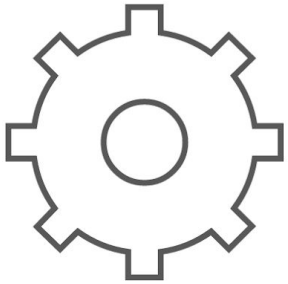
- Percent error of desired output given constant, known input
  - GSR: Output resistance
  - HR: Output bpm

Temporal Resolution Frequency/Period

- Critical frequency where outputs appear constant given oscillating input
- Increase frequency until critical frequency
  - GSR: Oscillate between resistances
  - HR: Pulsate an LED wavelength

Moving Forward

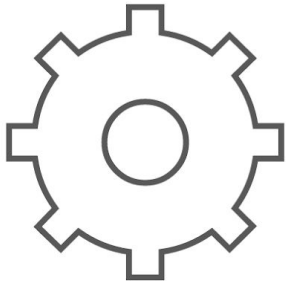
Fall 2020



Prototype hardware

Ideate hardware and software

Spring 2021



Prototype hardware

Prototype software

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[5] https://wiki.seeedstudio.com/Grove-GSR_Sensor/