Bio-State Band

Team #47

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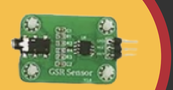
Abstract

Electrodermal activity (EDA) measures autonomic nervous system responses linked to stress and cognitive load. Existing systems are costly, non-portable, and closed-source – limiting accessibility for researchers. This project presents an open-source wearable that integrates EDA, heart rate variability, temperature, and motion sensing using custom analog circuitry and a low-cost microcontroller. Signal processing via Python and NeuroKit2 achieves research-grade quality. The result is an affordable, portable, and accessible platform for physiological monitoring.

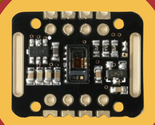
Hardware Design

A 3.3V Li-ion battery powers 8+ hours of continuous use. The microcontroller streams EDA and HRV data to PC software, with a hardware low-pass filter and gyroscope suppressing electrical and motion noise. Iterative prototyping refined the two-part enclosure into a lightweight, wearable glove design.

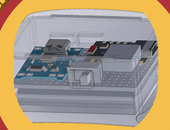
EDA



HRV



Enclosure



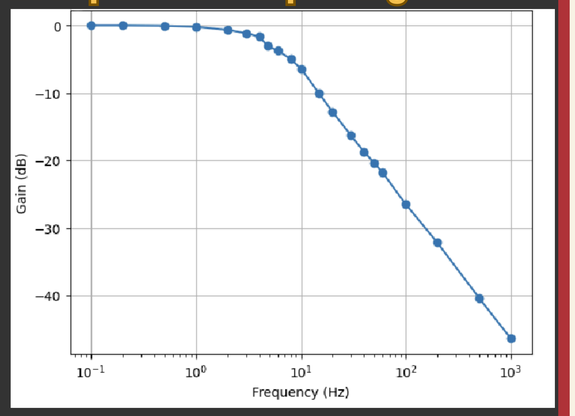
Methodology

Iterative prototyping optimized the device's ergonomics and reliability. The first design placed all components on top of the wrist, while the second distributed them between the top and bottom. The final design separated the power system (wrist) from the sensors (hand). This improved comfort and accessibility, and incorporated a low-pass filter for noise reduction.

Prototype 1

Prototype 2

Low-pass filter improving SNR



EDA Decomposition & HRV

EDA is decomposed into Tonic (baseline stress) and Phasic (event-driven reactions) components. PPG data is cleaned, peak-extracted, and processed into HRV via RMSSD. Together, EDA and HRV provide a holistic assessment of the wearer's autonomic stress response.

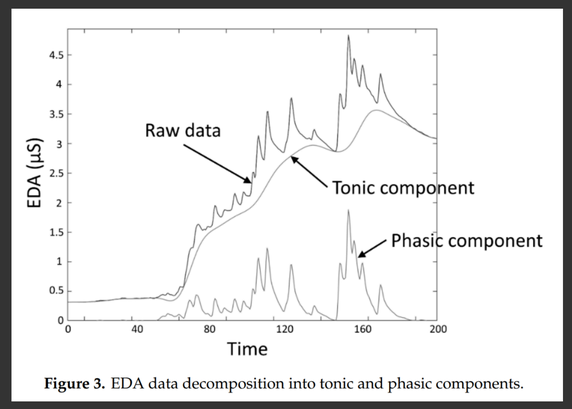


Figure 3. EDA data decomposition into tonic and phasic components.

Software Design

Signal Processing: Raw EDA → noise filtering → power spectral density → sympathetic band analysis → baseline comparison

UI: Tab-based layout separates setup, recording, and analysis. Split-pane graphs pair raw signals with decomposed metrics. Event-flagging and recording controls are accessible from the main dashboard.

Prototype Validation

- **Hardware**: Circuits simulated before assembly; enclosure modeled from caliper measurements.
- **Software**: Firmware independently tested; modular architecture for reliability.
- **Verification**: Algorithms validated against WESAD dataset; UI refined via user feedback; signals confirmed via oscilloscope.
- **Upcoming**: Live trials to assess wearability and researcher usability.