Dual Monitoring System

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Abstract

The dual monitoring system measures brain activity and calculates the user's heart rate in a non-intrusive, low-cost manner. Employing a binary classification model enables the system to make physiological state inferences from recorded EEG readings. Health information is displayed in an easily digestible format on an LCD, while the PCB's form factor heightens its portability and user comfort.

Hardware

- FRDM MCXN947
- LCD-PAR-S035 Board
- Custom PCB
- Breakout Boards

Software

- KiCAD
- LTspice
- GitLab
- MCUXpresso

Motivations

Portability & Affordability
System designed to be low-cost and compact for everyday use

Interpretable
Simple data displays enables users to track their own physiological information

EEG Data & ML Model
FFT-transformed EEG recording helps identify cognitive states

Onboard Storage
Stored data can be referenced during consultations

References

- W. Saadeh *et al.*, "A 0.5V PPG-Based Heart Rate and Variability Detection System," *Proc. IEEE BioCAS*, pp. 1–4, 2018.
- P. Tawheed *et al.*, "Low-Cost PC-Based EEG Acquisition System for Education and Research," *Proc. IEEE R10-HTC*, pp. 1–6, 2021.

System Design Summary

The main PCB can be powered either by a 3.7V Li-ion battery or via USB 2.0 Type-A from a separate daughter board connected through headers. Power is regulated to 3.3V by an LDO, and a charging circuit recharges the battery when USB is connected. The system is built around a 32-bit dual-core Arm processor (MCXN947VNLT). The LCD communicates with the MCU via SPI and uses the 3.3V supply for its backlight and logic. EEG and PPG modules also run on 3.3V, with their signals filtered and fed into separate ADCs. Processed data is stored on an SPI-connected SD card.

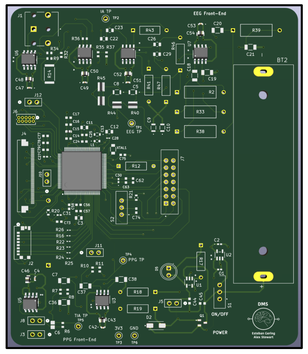

Figure 1: Custom PCB

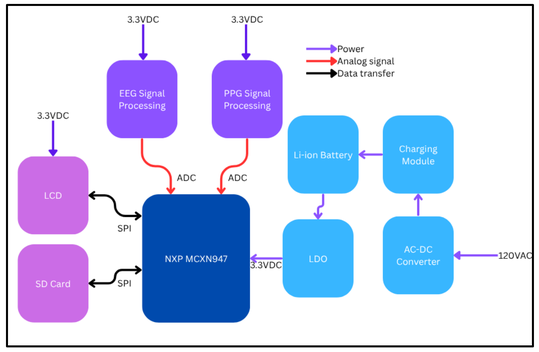

Figure 2: Hardware Block Diagram

Summary of Results

Our system successfully integrates EEG acquisition, signal processing, and LCD visualization. We validated our pipeline using sample EEG and PPG data, which was displayed on the LCD in real time. The EEG signal was also transformed using FFT and fed into a lightweight binary classifier to infer user cognitive state. While custom PCB fabrication and onboard PPG development were postponed due to hardware limitations, all core functionality is demonstrated using a development board. SD card data logging is currently in progress.

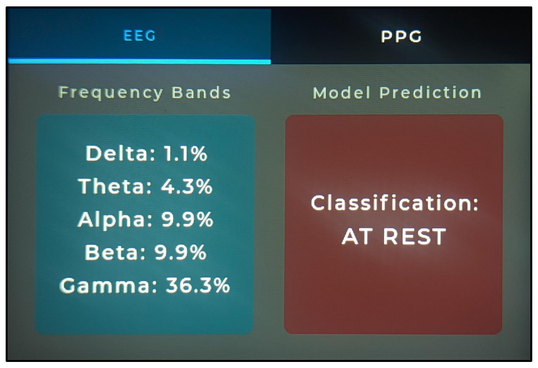

Figure 3: EEG Information on LCD

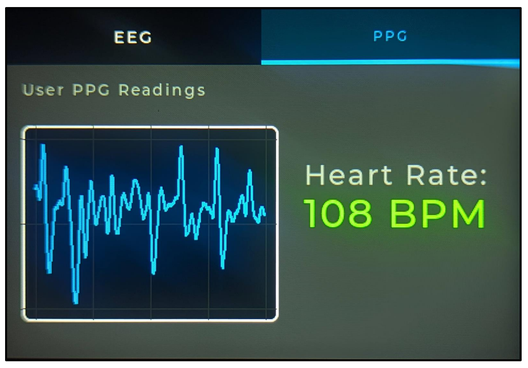

Figure 4: PPG Information on LCD

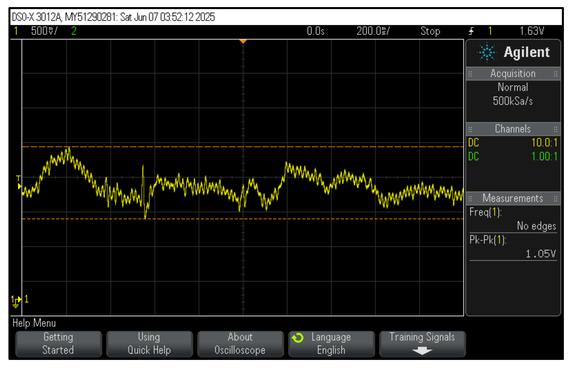

Figure 5: Measured EEG Waveform on Oscilloscope

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- Dr. Wala Saadeh – Hardware and research advice
- Dr. John Lund – Hardware and code support
- Professor Todd Morton – Code support

Conclusion

The dual monitoring system takes a valuable step toward filling a gap in the health industry by offering an affordable way to monitor mental states. While it was originally designed to include two data streams, time constraints forced us to drop the PPG and rely on the microcontroller development board. In the future, we plan to integrate photoplethysmography and transition the system to a printed circuit board.