Problem Statement

Epilepsy is a common chronic neurological disease characterized by recurrent seizures. Electroencephalogram (EEG) records cortical electrical activity and is the most widely used detection and analysis procedure for epilepsy. However, EEG systems are costly, inaccessible for less-funded institutions. Therefore, affordable EEG systems that can be rapidly and broadly deployed are in critical need. In this work, we show the development of an affordable diagnostic EEG system complete with ten channels, high temporal resolution, and a robust case.

Background

- 1 in 26 Americans develop Epilepsy.
- An EEG can help detect seizures by visualizing cortical electrical activities.
- EEG placed on scalp to detect electrical impulses from brain.
- Medical-grade EEG systems expensive, upwards \$10,000.
- Average price per patient \$200-3,000 [1].
- Competing system, OpenBCI, is 8-channels for \$2,578 [2].
- 80% of epilepsy patients live in low- and middle-income countries [3].



Figure 1: OpenBCI EEG Headset [4]

Figure 2: Example EEG signal [5]

Specifications

- Cost of ear clip, head cap, electrodes, embedded system, and case must remain under \$100
- Remain operational 3-4 years.
- Able to accommodate 10 channels.
- Head cap circumference between 50-65 cm.
- Head cap maintain landmark accuracy.
- Ear clip should score 10 or below on the Borg discomfort scale.
- Circuit samples at 1kHz with 12-bit resolution.
- Electrodes should be able to be sanitized for safety.

Hardware

<u>Ear Clip</u>

• Earclip for reference and driven right leg.

Head Cap

• Flexible off-the-shelf generic cap with cutouts for electrodes.

<u>Case</u>

- Durable for common table level drops
- Can be made from a variety of Fused **Deposition Modeling** (FDM) materials for other needs.



Figure 4: EEG Head Cap Design



Figure 3: 3D printed ear clip



Diagnostic EEG for Viral-Induced Epilepsy

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Electronics & Software















Time (s)

Figure 17: Evoked Potential from Blinking

Figure 15: Evaluation of Driven Right Leg's Efficacy





Results Continued



Figure 20: Case Drop Test

Case Drop Testing Results

- 24 Drops from varying tabletop heights
- Results show case is durable enough for common drops with minor cosmetic damage
- Future designs could improve holding the board in and holding the lid on
- Testing with completed circuitry could be considered

Conclusion

- Embedded system
- Improve noise
- Fix sample dropping
- Implement digital filters
- Analog front end
- Improve driven right leg efficacy
- Further power conditioning and decoupling
- Fine tune gain resistor values
- Test EEG monitoring on to see brain waveforms
- User guide documentation for building the system

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