ABET Addendum

Jose Castillo-Valdovinos

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Desired Needs

- **Low input impedance**: The main aim of the hydrogel electrode is to achieve an input impedance within 40 kΩ, outperforming many existing dry EEG systems.
- **Low-cost manufacturing**: Many EEG systems cost upwards of $10,000. Using 3D-printable components seeks to drive the production cost down as much as possible.

Constraints

- **Safety Affairs:** The device interfaces with the scalp and includes electrical components, so our headset must minimize electrical shock risk, skin irritation, pressure injury, and biological contamination. Constraints include limited time and resources available for safety testing.
- **Manufacturability**: Constraints included cost (staying within budget), fabrication time, and access to resources.
- **Quality Control/Marketability:** Quality control is constrained by time, as it would require repeated impedance testing and mechanical testing of connectors.

Engineering Standards

- **ISO 10993-1** → Guides biological evaluation of medical devices and is relevant because the hydrogel and electrode tips contact the user's scalp.
- **ISO 14971** → Supports risk management and connects directly to the team's FMEA process for identifying and reducing user hazards
- **IEC 60601-1** → Applies to basic safety and essential performance of medical electrical equipment, especially because the system includes electrical components near the user.

Concerns

- User safety is the primary concern due to electrical shock risk.
- The hydrogel must not irritate the scalp or expose users to unsafe chemicals.
- The electrode teeth and headstrap must also avoid excessive pressure, especially during longer recordings.
- Data privacy: any applications should have informed consent and secure data storage.

Teamwork

- In our design group, we had two subprojects: the hydrogel electrode and the adjustable headset. There was constant collaboration between members of each subteam, and leadership on tasks was delegated fairly.
- To meet all expected deadlines, we maintained open communication and were adaptable; this was important during setbacks and during prototyping.

Motivation

I led the PCB design and development for this project, taking ownership of the circuit architecture. I wanted to deepen my knowledge of electrical design and gain hands-on experience debugging and troubleshooting hardware systems. I am committed to building a career in PCB design and integration with physiological signals, and this project provided invaluable foundational experience in that specialty.

Innovation

- Our most innovative idea was the "semi-dry" hydrogel electrode with a comb-like structure. This combines the usability of wet and dry electrodes without the drawbacks

- Our design can be reproduced at a cheaper cost than many other existing EEG headsets because the majority of the headset is 3D printed.