Team Axon Mobile Sponsorship Packet for Altium

Overview:

Team Axon Mobile is Aidan Curtis, Sophie D'Amico, Andres Gomez, Benjamin Klimko, and Irene Zhang, all electrical and computer engineering students at Rice University in Houston, Texas. We are working with Dr. Nitin Tandon of UTHealth to develop a system capable of recording and wirelessly transmitting data from implanted brain electrodes in patients suffering from intractable epilepsy. Due to the large amount of data produced, we plan to implement novel data compression and analysis techniques in our system; we hope to also allow the system's use for neuroscience research in animal models (e.g. using neural spike data as compared to the LFP data typically analyzed in clinical settings).

Mission Statement

Problem Statement

According to the World Health Organization, up to 50 million people in the world have epilepsy. Of these 50 million, 30% do not respond to medication to keep their seizures under control. These patients are said to have intractable epilepsy, and one of the most effective ways of treating these patients is to record patient EEG data in order to determine the source of the seizures, and then remove the specific part of the brain that is causing the seizures. This process of recording data is invasive and requires implanting electrodes into the brain. These electrodes are wired from inside the brain to a stationary external source that collects the data. The presence of wires causes two main problems: 1) the patients have limited mobility throughout the duration of the data recording and must remain in the hospital for days or even weeks, and 2) the wires are a potential source of infection.

Remaining in the hospital for an extended period of time is extremely expensive, and if the wires were to cause an infection, that cost would only go up. The estimated cost for this procedure is about $10,000 a day. Additionally, being unable to move about unrestricted is detrimental to the patient's general well-being.

We aim to design a device that can be implanted into a patient's brain and transmit EEG data wirelessly. Such a device can decrease hospital stay with the possibility of the patient going home for the duration of the recording process, and will drastically decrease the cost of the process. Additionally, even if the patient must remain in the hospital, our device will allow the patient to move about the room freely, which will greatly improve their quality of life. Lastly, our device will also implement novel data compression techniques prior to transmission, which sets our product apart from existing solutions.

Project Scope

We will build a fully functioning wireless neural recording system that uses data compression to efficiently transmit local field potentials and/or single unit action potential data from patients to a nearby data collection device.

It will contain four major subsystems: (1) A power management system; (2) Frontend interface chip that does signal conditioning; (3) A wireless link to a receiver; (4) A novel data compression implementation

With a budget of $2,500 and working between August 29, 2018 and April 11, 2019 we must meet or exceed a minimum set of requirements:

- 48 electrode channels consisting of 6 probes with 8 electrodes each

- A battery life 24 hours or greater
- An ADC resolution of at least 8 bits
- Ability to wirelessly transmit data at least 1 meter
- A Sampling rate of at least 1000 Hz
- Range of wireless functionality: 1 meter
- Sampling rate: $\geq$1000 Hz

(Preliminary) Project Timeline

System-Level Design	September 2018
Working Compression and/or LFP Algorithm in Python	October 2018
First-Iteration Board Design of Probe/Intan Chip Interface	October 2018
First-Iteration Wireless RF Interface	October 2018
Initial Power System Design	November 2018
Altium Diagram for Complete Working System	November 2018
Test Intan Chip, Wireless Interface, and Power Prototype Boards	November 2018
First-Iteration Working Full-System Prototype for One Probe (Without Compression)	December 2018
Meet with Sponsor to Review Progress and Next Steps	January 2019
Test Second Prototype (at proper form factor)	February 2019
Meet with Sponsor to Review Progress and Next Steps, Pt. II	February 2019
Compression Algorithm Fully Functioning in C	March 2019
Power System Measurement/Verification	March 2019
Implantation/Animal Testing	March 2019
Final Product/Presentation	April 11th, 2019

Events:

All Rice senior design teams are required to participate in a school-wide Engineering Design Showcase competition on April 11, 2019. Additionally, we are required to participate in at least one external competition and we are currently considering the following as options:

- Johns Hopkins Healthcare Design Competition
- VentureWell BMEidea
- ZPower Battery Bowl Design Challenge
- Design by Biomedical Undergraduate Teams challenge sponsored by the National Institute of Biomedical Imaging and Bioengineering

Depending on the progress we make our team may also try to submit a paper to a peer-reviewed journal.

Team Contributions:

All classes at Rice that focus on PCB design currently use Autodesk EAGLE. As part of our sponsorship agreement our team could talk with the professors of these courses to try to switch the software taught to Altium products. Similarly, our engineering design facility does not have Altium products installed on computers so we could also talk to the facility administrators about getting licenses so Rice students are introduced to these tools while still in school.