EEG Alarm Project Change Proposal

At the center of our project is the idea of improving healthcare by allowing for relatively inexpensive, at-home monitoring of biological data. Initially, the proposed project was monitoring electrical activity in the brain called electroencephalography (EEG) in order to track a user's sleep and be able to provide a biologically data-driven alarm that would wake up the user during a stage of light sleep to avoid sleep inertia. In addition to this, it would provide information about a user's sleep that would allow a trained professional to gain insight into the user's sleep health at home without the user having to sleep in a laboratory.

The analog front-end design of the EEG uses an instrumentation amplifier with a high CMRR and large gain to try and measure small voltage changes on the user's scalp. After much testing and trying out different configurations, it has been found that the possibility of creating a working EEG in the time frame of this semester's senior design course is not feasible. First of all, the SNR for EEG measurements is extremely low. Even amplification of over 5000 V/V, there is imperceptible brain-wave activity, as it is being drowned out in noise. The primary source of noise is at 60Hz from power lines, and filtering out this frequency poses significant problems. The signals that we want to measure are up to around 30-40Hz, and after spectrum analysis, the peak power that any frequency was at in this low-frequency range was approximately -60dBm while the 60Hz noise was at -50dBm. The possibility of being able to accurately detect the shift in brain-wave activity on the order of 2-5Hz with our current inexpensive equipment and constrained time-frame is unlikely. Even if we were able to completely remove the 60Hz noise, there is still the problem of the brain-wave signal itself. The signal is proving to be broad in the frequency domain between 0.1-30Hz without any noticeable shifts in signal when relaxed vs. alert. Although arousal state does not seem to be feasible, we are able to detect when the user blinks each eye and when they open or close their eye – maybe we could do something with this instead?

Keeping in line with the initial goal of designing a product that can be used for at-home health monitoring, we would like to propose a major change to our design that we now believe is more feasible for this course. Instead of creating an EEG alarm, we would like to design a wireless electrocardiogram (ECG) system where the user will wear the electronics on a band around the abdomen, and it will have three leads coming out of it to connect to the patient for ECG sensing. In addition, we will have an SpO2 subsystem that can monitor the patient's blood-oxygen saturation. Just like with clinical grade at-home ECGs that are beginning to hit the market, the device will record a sample a few seconds in length whenever the user presses a button when he or she is feeling angina or any other cardiac symptom. This data will then be streamed over Wi-Fi to the user's device where he or she can access this data, have the ECG displayed on a graph with heart rate & SpO2 data also presented. Keeping in line with the previous project focused around sleep, we can have the device take measurements periodically while the user is asleep to gain more valuable information. After collecting a day or so worth of data, the user can then show the ECG traces to his or her physician for diagnostic purposes.

Please let us know what you think about this change or perhaps a way we can stay with the original project but be able to not use real user data such as if we had a simulated signal

because I do not believe it is feasible to get the EEG circuit working well enough to make a consistent product at the end.