Evaluating the Feasibility of Augmented Reality Brain-Machine Interfaces

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Can We?

EEG (electroencephalogram) devices can non-invasively measure small voltages from the brain. These measurements can be used to detect focus and attention.

However, EEG measurements are susceptible to noise from motion artifacts and external computing near the sensors. Using AR (Augmented Reality) technology alongside EEG has many applications, but we must ensure that the electrical noise generated by an AR headset will not obscure the EEG measurements in frequencies of interest.

32 channel
Enobio EEG

Magic Leap
ML1 Headset

Lab Streaming Layer (LSL)

EEG

Eye Tracking

Environment Information

AR Events

Analysis Pipeline

State Classifier

AR Controller

Paradigm for oddball task

standard / target / standard / standard

For each frame, the stimulus is visible for 500 ms. and then off for 500 ms.

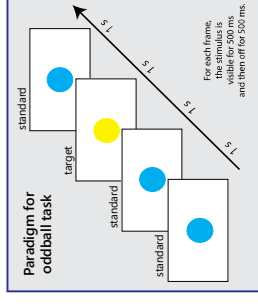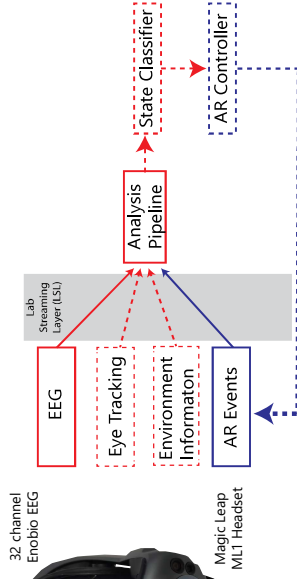## Investigating Frequency Domain Noise Caused by AR Headset

When people close their eyes for a sustained period of time, we expect to observe an increase in power at ~10 Hz.

We compared the power spectral density of the EEG signal from the brain while a participant sat with their eyes closed when:
the headset was powered on and presenting unobserved stimuli and worn by the participant [Headset Powered On],
the headset was powered off but worn by the participant [Headset Powered Off], and
the headset was powered off and NOT worn by the participant [Headset Removed].
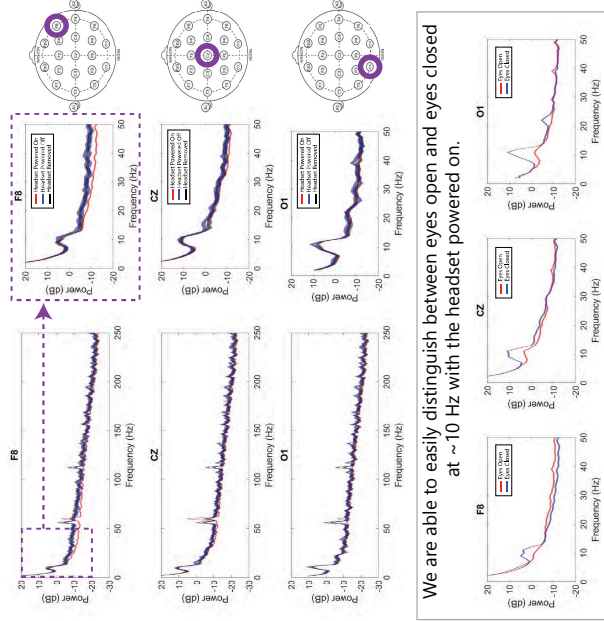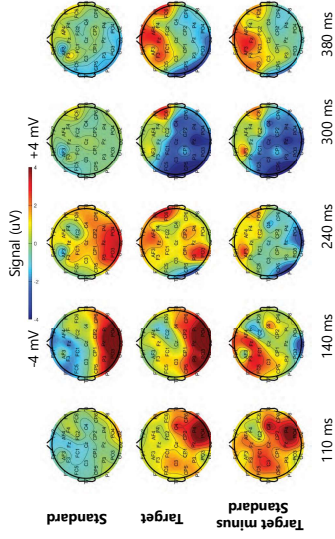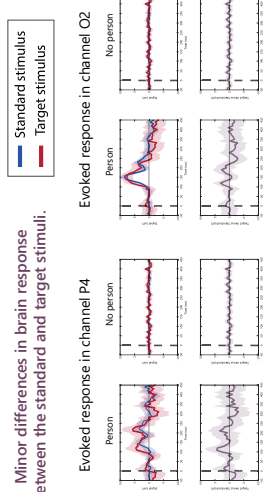

We are able to easily distinguish between eyes open and eyes closed at ~ 10 Hz with the headset powered on.

Detecting Event-Related Potentials in the Oddball Task

The presentation of the stimulus evokes a response in the brain, but does not evoke a response when only measuring the AR headset.

Stimulus Onset

Person wearing headset
Only AR headset

Minor differences in brain response between the standard and target stimuli.

Evoked response in channel P4

Person / No person

Evoked response in channel O2

Person / No person

Standard stimulus
Target stimulus

Standard

Target

Target minus Standard

Signal (uV)
-4 mV   0   +4 mV

110 ms   140 ms   240 ms   300 ms   380 ms

No person   Person

Signal (uV)
-4 mV   +4 mV

0 ms   150 ms   230 ms   500 ms   660 ms

Should We?

If it is possible to build robust EEG and AR applications, there are important questions to consider regarding the nature of the data collected and the potential use cases of this data.

Please share your thoughts below on how likely (in the next ten years, assuming that it is technically feasible) these applications are and how comfortable you are with them.

🔴 Drivers of non-autonomous trucks are required to wear wakefulness-monitoring devices.

🟢 Students' attention levels in the classroom are monitored, and teachers have access to data for each student.

🔵 Consumers using a streaming platform are required to pay attention when viewing advertising content and the platform validates that they do so.

Likely in ≤ 10 years

Uncomfortable

Comfortable

Unlikely in ≤ 10 years
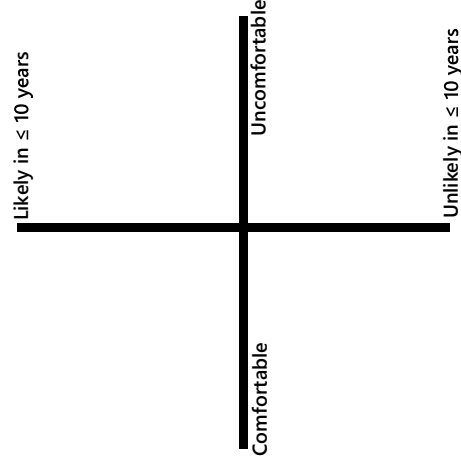
What are the potential applications that would make this technology worth pursuing?