Headwear

Mindaugas Gapševičius & Maria Safronova Wahlström

In collaboration with Ian Erik Stewart (neuroscience consultant), Mindaugas Miselis (electronics), Antanas Skucas (programming)

The collection of headwear has been designed to encourage the discussion on the impact of electricity on the human cortex and to experience other humans (and the umwelt) through an electrical signal. How far could electricity help in understanding the other? Is there a possibility to alter human senses by electric impulses? If our brains are affected by electric current, what happens then to the brain itself?

Headwear in use. Photo: Bon Alog

Headwear in use. Photo: Bon Alog

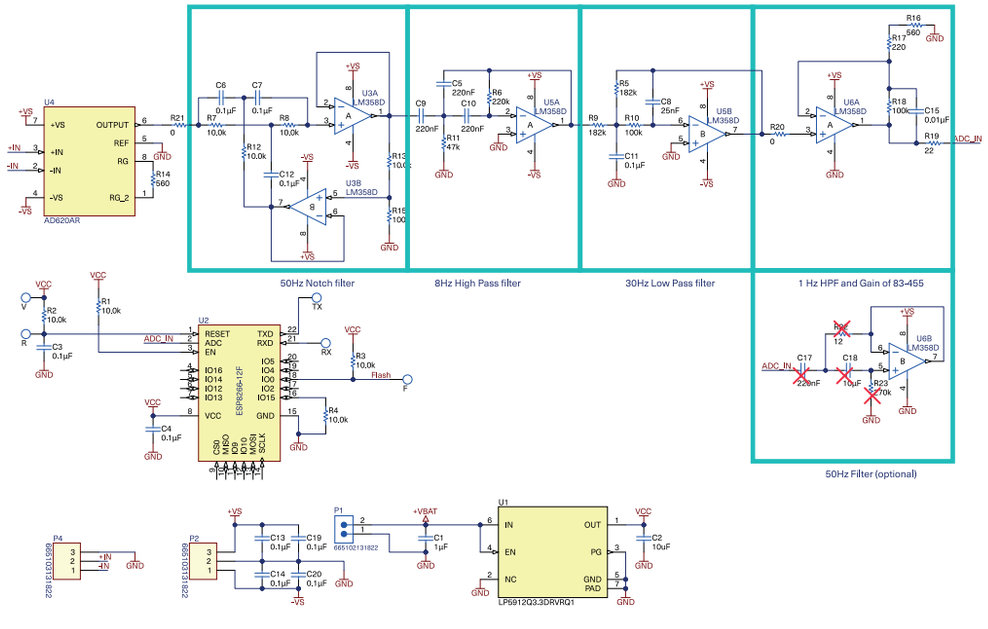
The project was inspired by research on brain-to-brain interfaces, including the study "A Brain-to-Brain Interface for Real-Time Sharing of Sensorimotor Information"[1] by Miguel Pais-Vieira et al., which introduced the transfer of sensorimotor information between the brains of two rats. Another compelling paper, "Closed-Loop Deep Brain Stimulation Is Superior in Ameliorating Parkinsonism"[2] by Boris Rosin et al., showed how the analog signal from the six recording electrodes implanted in the African green monkey brain is amplified in an electronic chip, which, in turn, delivered electric impulses back into the brain through the two stimulating electrodes. The inspirations suggested that—if used with non-invasive methods to work with the brain, such as electroencephalography (EEG) and transcranial direct current stimulation (tDCS)—we could combine the methods and implement them into a brain-to-brain interface for an artistic project.
Though the headwear was designed for humans, it is possible to imagine the interaction through the electric signals between humans and non-human animals.

1 Pais-Vieira, M., Lebedev, M., Kunicki, C. et al. "A Brain-to-Brain Interface for Real-Time Sharing of Sensorimotor Information." Scientific Repports 3, 1319 (2013). https://doi.org/10.1038/srep01319.

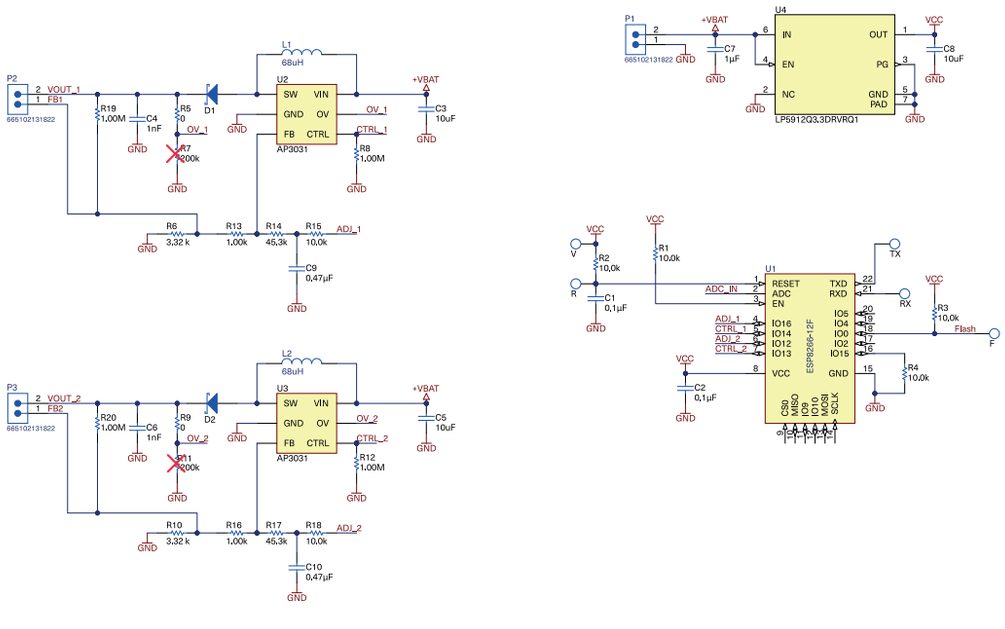
2 Rosin, B. (2011). "Closed-Loop Deep Brain Stimulation Is Superior in Ameliorating Parkinsonism" in Neuron, 72, 370–384, October 20. Available at https://www.cell.com/neuron/pdf/S0896-6273(11)00776-8.pdf

The headwear uses medical strategies based on brain cell communication: the electrical impulses are detected on the scalp while using electroencephalography, and brain stimulation is triggered by passing DC current through electrodes, a noninvasive method to treat depressive disorder, increase empathic abilities, or decrease antisocial behavior in violent offenders.
The headwear pieces have Wi-Fi modules, which allow the audience to connect different headwear pieces to each other and control them through tablets or cellphones. While the data is transmitted over Wi-Fi, the location is defined through the GPS data. If the GPS signal is too weak (which is often the case in exhibition spaces) or if only one piece of headwear is set up, the audience can experience their own brain activity while connecting their own headwear through a tablet or a cellphone. In this case the EEG signal is picked up on an individual cortex and transmitted through the same cortex, making a feedback loop between the EEG and tDCS modules and the cortex.

The collection of headwear that questions the boundaries of empathy and the intertwining of brain and umwelt is part of a larger project, *You and I, You and Me*, which explores the possibilities of communication through electricity.



Circuits of the EEG module.



Circuits of the tDCS module.

Usage instructions

- Attach batteries and the circuit boards to the snap buttons on the headwear.

- Launch the app "You and I, You and Me" on a tablet or smartphone.

- Pair your app with the headwear.

- Look for peers with other headwear.

- Connect to peers by tapping an IP in the augmented reality interface.

- Use the slider at the bottom of the screen to control the intensity of electricity passed: left side—no electric current; right side—100 uA.

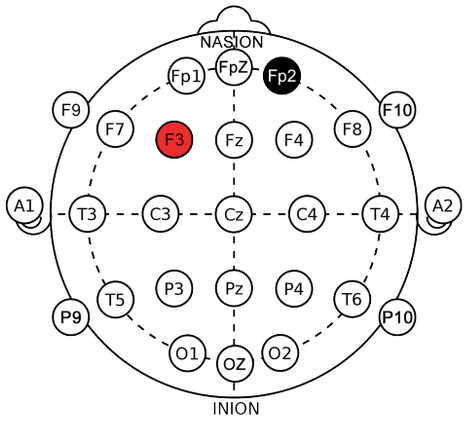
For more information, see http://triple-double-u.com/you-and-i-you-and-me/.

App

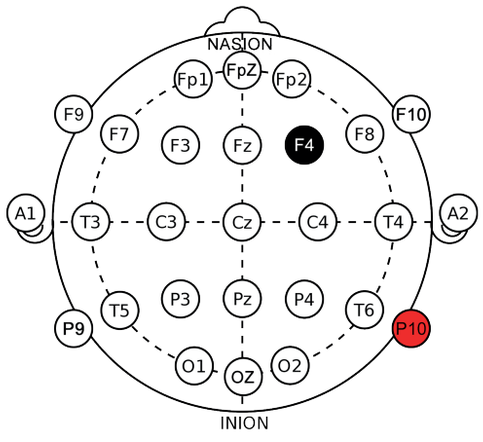
The software uses an augmented reality setting to control headwear and connect with other headwear on the local network over the Wi-Fi protocol. To function properly, the app must be connected to the custom-built electronic devices embedded in the headwear.

The Unity AR Foundation-based app to be installed on an iPhone or an iPad is accessible through the Apple Store, https://apps.apple.com/cz/app/you-and-i-you-and-me/id1581665872.

Augmented reality setting to control headwear. Video still



Montage of electrode patches for the treatment of depression. Source: https://www.tdcs.com/depression-treatment (accessed: 31 January 2022)



Montage of electrode patches for the increase of awareness. Source: https://www.tdcs.com/increased-awareness

Network setup

Wi-Fi is configured to be used within the local network named “You and I” (password “You and Me”) in the range 192.168.0.1–255. This network is then divided into a static IP range between 1 and 99 and a DHCP range between 100 and 254. The static IP range is reserved for the devices using EEG (1–49) and tDCS (50–59). The DHCP network is reserved for cell phones used during participation in the event and/or for testing purposes.
The app uses the camera, the GPS system, and the OSC protocol. The camera is used to locate other people in the area, the GPS system helps locate audience members wearing headwear, and the OSC protocol is used to send data over the network between audience members wearing headwear. The app helps the audience to connect to their own headwear (locate “Pair ...”), to other audience members with headwear (tap visible IP addresses), and to control the electric current flowing through the scalp (touch and move slider on the bottom of the screen).

Technical implementation of the headwear

The bridge between the EEG and tDCS is established while connecting additional modules to the techniques used. These include a module for signal transduction, an ATmega328P/Arduino microcontroller, a Wi-Fi signal transmission module ESP8266, and a Unity AR Foundation-based user interface. While there are quite a few commercial initiatives in the market, and local initiatives to use EEG technologies, our choice was a DIY EEG circuit and a DIY tDCS circuit we located on the Instructables.com website. These circuits gave us maximum flexibility in integrating ESP8266 microcontrollers for the Wi-Fi access between both circuits within the local network.
For the communication between the two circuits, we have chosen to work with OSC protocol. Technically the communication works as follows: Dry electrodes on the headwear that are connected to the EEG module pick up an electromagnetic signal from the cortex and send it to the ESP8266 microcontroller, which converts it to OSC protocol and broadcasts the digital data to the local network. Then the ESP8266 microcontroller on the DIY tDCS module picks up the OSC data from the local network, analyses it, and converts it to the electric current using PWM modulation. It is then passed onto the brain cortex through the integrated dry electrodes located in the headwear. The dry electrodes pass 0.1 mA, much less then is passed for the medical treatments, which suggest 1 to 2 mA. On the other hand, medical treatments use electrode patches instead of dry electrodes. Therefore, the current being passed on the scalp is also much more distributed as in the collection of headwear.
In the project, we have used a tDCS montage guide from an independent source for tDCS related news. For more information, see https://www.tdcs.com/montage-guide. Two montage uses are to be taken into account: depression treatment and the increase of awareness . The current passed depends on two states of brain activity: aroused and calm. The reference is being calculated in real time depending on the individual brain activity.

Participant’s consent form

Participants who wish to experience headwear created by artists Mindaugas Gapševičius and Maria Safronova Wahlström are required to sign this consent form.
The headwear uses medical strategies based on brain cell communication: the electrical impulses are detected while using electroencephalography (EEG), and brain stimulation is triggered by passing DC current through electrodes (tDCS), a noninvasive method to treat depressive disorder, increase empathic abilities, or decrease antisocial behavior in violent offenders.

The participant assumes all responsibility and risk for using the headwear. Artists and everyone involved in the organization of the event *You and I, You and Me* do not accept liability or responsibility to any person as a consequence of technological error that could affect a participant’s health.
Your participation in the event *You and I, You and Me* is voluntary. You may refuse to participate or discontinue participation at any time.
The information you provide is confidential and will not be disclosed.

The project is supported by the Lithuanian Council for Culture, and the Nordic Council of Ministers.

Graphic Design - Mantas Rimkus

laparello
folding

Front
when folded

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