Brain-Computer Interfacing

Notable Topics

- Methods
- What is EEG?
- Direct Cranial Stimulation and tDCS
- Initiatives within the field
- Recommended Reading

Introduction

Brain-Computer Interfacing is a subcomponent of neural engineering, which is quickly emerging as a distinct field within neuroscience. It is the gathering of neural information to use within computational systems. As can be imagined, this is a very difficult, but potentially groundbreaking field.

There are many techniques used within the field of Brain-Computer Interfacing, with varying levels of invasiveness and effectiveness. Unfortunately, it is usually the more invasive methods that are the most effective, though medical grade EEG machines can still garner reliable data about conditions such as epilepsy. A few of these techniques are:

- Electroencephalography (EEG)
- Functional magnetic resonance imaging (fMRI)
- Positron emission tomography (PET)
- Magnetoencephalography (MEG)

With many others existing as well. For hackers and hobbyists, EEG is likely your best bet, as it is one of the least invasive and cheapest methods available, though unfortunately it lacks the spatial sensitivity of methods such as fMRI.

EEG is the placement of electrodes on the scalp to receive the electrical data generated by the minute action potentials of neurons as they fire. These electrodes can either be active or passive, active meaning that these electrodes are powered as they operate. Often electroconductive gel is placed on the scalp before placement, depending on the device, as it makes the electrodes more reliable.

For creation of your own devices and tech utilizing EEG, you should educate yourself on the different devices available on the market. First off, I would like to state that a lot of those “focus” devices are complete bullshit. One electrode placed on the forehead isn’t going to be even remotely accurate, especially if it is passive and without conductive gel. A lot of the crappier headsets are actually gathering the electrical impulses of the muscles in your face, so that they can wow the audience by raising an eyebrow and moving a cube or something. Be careful about that.

NeuroSky is an example of this. It’s a neat party trick but it is not even remotely accurate. Emotiv is slightly more accurate, but again still not accurate enough for real information gathering. Another major problem with both NeuroSky and Emotiv is that by default they do not allow access to the raw

EEG data, they simply let you use the device to operate apps. You have to pay hundreds of dollars extra to get access to their proprietary EEG data, which isn't even accurate in the first place. I think that's a pretty shitty business philosophy that the hacker community shouldn't tolerate.

If you want to create your own headset and are familiar with soldering and circuitry, look into OpenEEG. It is an old project but a good starting point to create your own headset. NOTE: /cyber/ is not responsible if you harm yourself engaging in these activities. POORLY ISOLATED ACTIVE ELECTRODES PLACED ON THE SCALP CAN FRY YOUR BRAIN! If you do not know what you are doing I would buy it premade (OpenEEG has premade headsets for sale) or at least use passive electrodes to minimize the risk.

Another more recent headset is OpenBCI. It is less open than OpenEEG, as it does not give you the instructions to make the headset yourself. Also be aware that OpenBCI is funded by DARPA and by association the US government. However, OpenBCI seems to be more accurate than OpenEEG and is a good premade headset for the price. It also has Bluetooth functionality.

If you are loaded/want the best scientific results possible, you could always buy a medical EEG system. These products by Brain Products are well received within the research community: http://www.brainproducts.com/products_by_apps.php?aid=5

For analyzing the data gathered, study basic signal processing. Fast Fourier Transformations on the incoming neural data will divide the waves into frequency amplitude graphs, so you can see how much of each frequency is being generated at each electrode. 60 hz is often not included because it is generated as a byproduct of the gathering process, just something to keep in mind.

Direct Cranial Stimulation

tDCS headsets are becoming a new fad now. What they essentially do is stimulate your neurons by sending a small electric wave pulsing from a pad placed on the scalp. We clearly know that electrical stimulation is a real and significant phenomenon (remember electroconvulsive therapy?) but many of the headsets on the market have little research and send a very low charge. In fact, most of the research suggests the electrical waves don't make it through the skull, and instead stimulate, you guessed it, the muscles of the face. The exception to this rule with tDCS headsets is Thync, which seems to have a decent amount of research supporting it, and has a much higher charge than most tDCS devises due to some clever electrical engineering. However, Thync admits that its charges probably only stimulate facial muscles as well. They've just figured out how to stimulate facial muscles in an efficient manner to stimulate neurotransmitters. All Thync can stimulate, however, are calm and energetic states, and I've yet to see any tDCS device do anything but that.

Ultimately I think this technology at this point is pretty gimmicky. Thync may be worthy of investment because of the future potential it holds, and it does work for 80% of individuals, but if you were expecting mindjacking you will be sorely disappointed. Also, who the fuck needs direct brain stimulation just so they can game harder? That's a pretty lame reason.

Initiatives within the field

US: BRAIN Initiative

EU: Human Brain Project

EU: Blue Brain Project

Recommended Reading

- Brain-Computer Interfacing: An Introduction by Rajesh Rao