Emerging Technology- Brain-Computer Interfaces

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Overview and Slide List

What are brain-computer interfaces?

BCI systems use a person's brain signals to control a device. These can be implanted or worn externally, and could be used to control drones, robotic limbs, or other computers.

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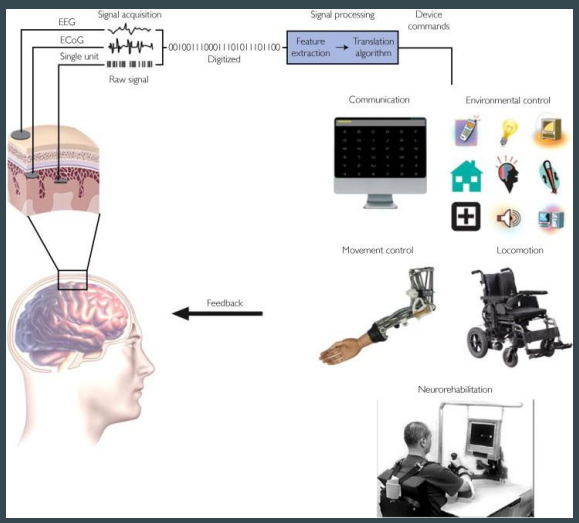
History

- ➔ The first human EEG was measured in 1924
- ➔ “Brain-Computer Interface” term coined in 1973
- ➔ P300-Speller proposed in 1988, the spark for assistive technology through BCIs
- ➔ Neurofeedback and SMR used to control objects in 90s
- ➔ Brain wave measurement also used to perform simple choices

PDF with more detail

Hans Berger recorded the first human brainwaves in 1924 with his invention and use of electroencephalography, or EEG. With this, he discovered that brain waves differ in different activity states.
The coining of the term BCI by Jacques J Vidal also brought new ideas on how BCIs could be used to control external devices, especially prothstetics, and communicating with computers.
The P300-speller created by Farwell and Donchin, where a patient focuses on one letter they want and checks for how many times it is flashed on a screen, eventually spelling out a word, sparked ideas for using BCIs to help disabled people communicate.
Neurofeedback allowed people to be purposeful about their brainwaves, and SMR was a measurement of that that was used to control devices.
This relates to other types of brain waves measured over the next decade, used by trained individuals to control other devices with purposeful thinking and management of their brain waves.

History, continued



- SSVEP used to control left/right motion of a plane in a simulator
- First international BCI meeting in 1999 in the US
- Invasive BCIs tested in primates around 2000 to control an arm
- Consumer-grade external BCIs are somewhat available now
- Continued research is looking very promising

PDF with more detail

SSVEP, which uses flickering lights linked to oscillations of brain waves, allowed test subjects to choose between left and right motion in a flight simulator, done in around 1995.
The first international meeting allowed researchers in the BCI field to learn from each other and better collaborate.
Experiments with invasive BCIs in primates showed potential for human patients to control more advanced external devices.
Commercial used of BCIs are very, very limited and still rather impractical, so the technology can't be considered all that developed.
Research in the field of BCIs currently is promising, with new ways to record brain activity being discovered and better ways to implement and link that with devices also being worked on.

Plan and Implementation- Medicine

Disabled or crippled people are affected the most; BCIs can help with communication and restoring lost movement.

Monitoring and understanding brain waves can supplement therapy for patients with disorders like ADHD or people prone to seizures.

Invasive BCI technology is in need of more advancement for medicine. To help the disabled or crippled by connecting their brain either to a robotic limb or manually back to their normal one, more advanced technology to read and interpret brain signals is needed in order to perform the fine motor functions necessary. Once developed, this technology would allow patients to control robotic limbs or wheelchairs to name some examples.

Neurofeedback is a part of BCIs where patients are able to see their brain activity through non-invasive BCIs and actively try to control it. This can help with disorders such as depression, ADD/ADHD, OCD, and others. This can already be used somewhat, but this type of therapy can become even more advanced and work even better as technology progresses.

Plan and Implementation- Business

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Non-invasive BCIs have vast applications.

- Monitoring employee productivity and focus
- Checking for drowsiness in surgeons, pilots, heavy machinery operators, drivers
- Preparing a memo with thoughts
- Adaptive work and home environments if connected to smart devices

More ideas on this website

Employee activity can be monitored with BCIs, like if employees are paying attention during meetings or to help them know if they need to focus a bit more. Possibilities of managers monitoring brainwaves and adjusting workloads, pay, or rewards accordingly are also there. Adaptive workplaces can work with BCIs, like changing light or music based on stress levels. BCIs can be used to check for drowsiness before someone performs a high-risk task such as a surgery, or operates heavy machinery like a plane or car. Direct interaction with computers in the future can help people write out their papers or perform work tasks easier. There's also potential for businesses to use information from external BCIs to help decide who to advertise to and when, like at a company conference. Further research would likely start allowing BCIs to tell what people are actually thinking about or focused on, not just if they're focused at all. Smart homes can also link up with BCIs, much like with businesses, to change the environment to better fit your mood or to feel more relaxing if you're stressed.

Pros

- Help disabled people regain movement with robotic limbs
- Uses for communication, both for disabled and healthy people
- Operation of remote technology in high risk situations
- Neurofeedback to better learning and paying attention
- Brainwave-based passwords

Health is one of the most heavily researched parts of BCI technology. Not only can it help people control external things like a robotic arm, it can also reconnect their nerves and arms so that they don't have to use a prothstetic. People with locked-in syndrome are able to communicate with BCIs, and future advancements mean that they might be able to reconnect with the rest of their body using BCIs. These can also help people with psychological disorders such as ADD and ADHD understand thinking patterns and better their efforts to improve their conditions using neurofeedback, where people see what their own brain activity is. High risk situations can be handled remotely with BCIs, like having someone operate a drone in battle or in disaster rescue efforts, by using the technology without having to go to the area itself. Everyone's brain waves are unique, so passwords that are much more secure can be used with BCIs. This would be like the memory of someone's favorite song, which will be unique to them.

Cons

- Less privacy; personal brain data becoming a market, data being abused for blackmail, control, etc.
- BCIs can be hacked
- Invasive BCIs can cause scarring and health problems
- Overall, BCIs are a highly invasive technology

In the age of data collection and personalization that we live in, companies that deal with that would be more than happy to know our thoughts and moods so they can sell more stuff. Hackers would be overjoyed to be able to steal that information to sell it or use it as blackmail. This sort of thing would be a huge breach of privacy if used commercially, and is also hard to regulate.
More advanced BCIs will likely require direct implants into the brain for better readings, and these implants can cause scarring to the brain and surrounding areas, cause further neurological disease even if they're meant to help, and procedures have a long recovery process. The sheer physical invasive of this is also not to be ignored.

Summary

Brain-Computer Interfaces can do a lot of good, especially in the medical field like with helping neurological patients.

Commercial uses such as productivity, smart-home integration, personalization, and more can be useful but are also highly invasive both physically and with privacy.

Medicine is one of the biggest areas of BCI study, and has the potential to help a lot of people with neurological conditions.
Something like this is also a company's dream, because they can monitor how hard their employees work and focus and keep them on task, and implementation in smart homes or the Internet of Things can make a lot of money. However, this brings up a lot of privacy concerns that would need to be addressed.

What do I think?

My take on this is that BCIs should continue development, especially in the medical field, however, they shouldn't be used in business or connected to the internet.

BCIs have a lot of potential to help a lot of people, especially with medicine to reconnect people with their bodies after spinal cord damage, nerve damage, etc. Their ability to reconnect people with locked-in syndrome to the outside world is miraculous. Even some commercial use, like keeping workplace safe by preventing people from working when drowsy can be enormously helpful. However, the thought of companies knowing your thoughts and feelings, leveraging those against you and to make money off of you with personalization sounds like something out of a dystopian sci-fi book. That's not to mention potential hackers using the BCIs as well. If the BCIs stay relatively clean-cut, used only to help people and not connected to the internet so that tech companies don't abuse them, they are definitely a good thing. But if they get too overused, massive issues start to come up and I'm against that.

References

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