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BRAIN-MACHINE INTERFACES OVERVIEW

Annotation. Brain-machine interfaces contains from a variety of other systems and technologies that packed together in one box – neural implant – are able to change a life of millions of people. Indeed, assuming progress of constant enhancement in computational hardware and continuation of miniaturization of electronic devices, we are getting ready to see this state-of-the-art technology in a marketplace.

Keywords: neural interface, brain-machine interface, brain-computer interface, Neuralink.

INTRODUCTION

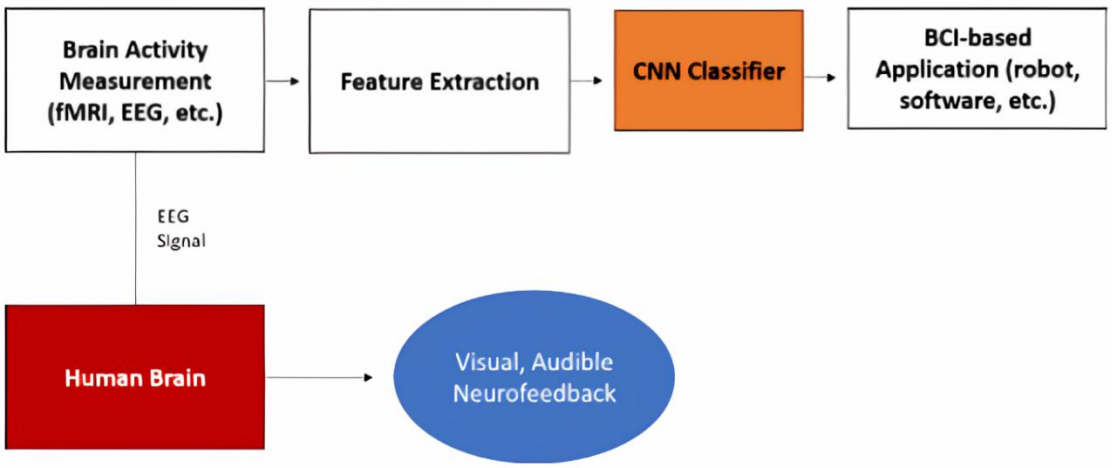
Despite a futuristic nomination, neural interfaces, or speaking in a common way, brain-machine interfaces, weren't developed in the last decade - experiments on animals' brains are being done from the beginning of the second half of XX century.

As a 60 years ago, a baseline of brain interface - thin electrodes that are able to detect the smallest potential`s deviations, inserted right to brain. However, modern science is able to produce noninvasive approaches, this method lags far away from invasive one - brain signals that are coming through a human skull are very distorted and nonspecific. However, in order to complete the path to the technical devices that will be controlled by the mind, humanity had to make a huge scientific breakthrough [1], for example, new microprocessor technologies, computing hardware and software containing modern neural algorithms that allow for the preprocessing of raw brain data. An overview of these technologies will be the main purpose of this article.

THE NOMINATION OF BRAIN-MACHINE INTERFACES

Brain-Machine Interface (BMI) - system of direct communication between brain and a digital device. BMI development is targeted on renewing human`s sensory-motor functions and enhancing cognitive skills or sensory-motor function that is called augmenting. BMI is able to receive signals from the brain as well as send it to it [2].

BMI, in a common way, is a very complicated system that contains several specific parts, described on (picture 1). One of the newest parts is a neural decoder which is ordinary built based on open-source architectures.



Picture 1. Standard pipeline of using brain-machine interface

THE TIMELINE OF BRAIN-MACHINE INTERFACE EVOLUTION

In the 1970s in The University of California a group of scientists began a research directed to understanding human recovery after damage of sight, hearing and losing motor functions in cause of injuries or diseases. That research led to creation of the nomination Brain-Computer Interface.

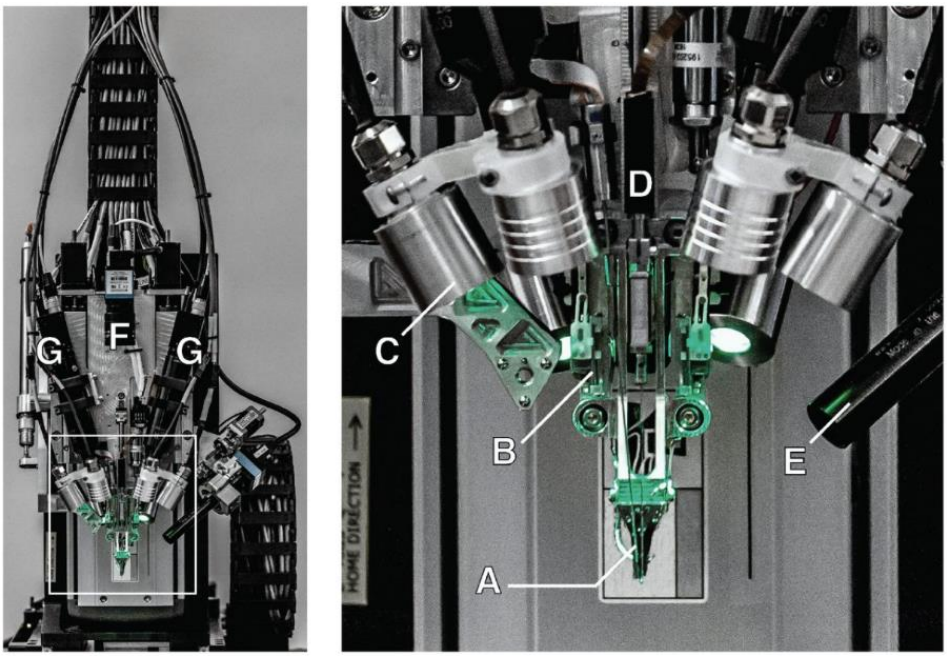
In the middle of 1990s science approach in the area of human augmentation was able to create the first neural prosthesis for humans. However, accuracy of BMI in case of recording neural signals wasn't that precise to modern one, but they already were well precise to manually, using advanced mathematics decode output signal from the brain to interpret it and make decisions from it.

In June of 2004 American Matthew Nagle became the first man in the world who got a neural implant. Implant was produced by the lead American company BrainGate.

In December of 2004 Jonathan Wolpaw and his research team released a scientific article in which was demonstrating the ability to control a pointer on a computer screen using a brain-machine interface. To be able to do that, a patient had to wear a specific kind of hat with electrodes within it and hardly concentrate on wish to move that pointer. That research made a huge public response [3].

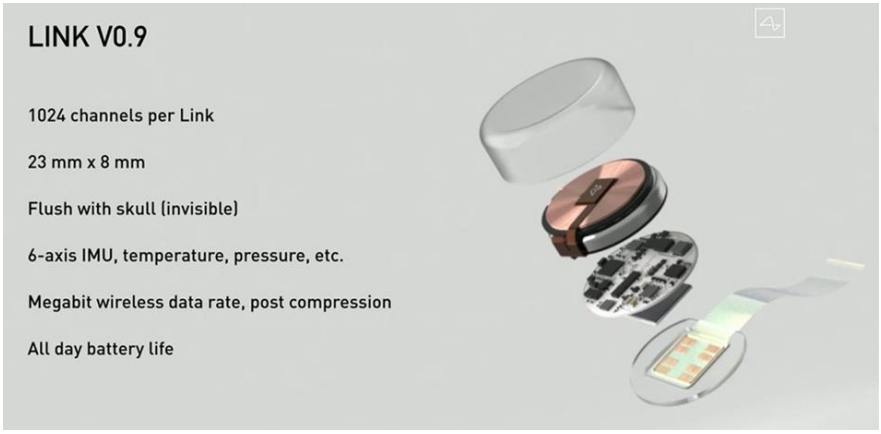
ELON MUSK`S NEURALINK

Brain-machine interfaces (BMIs) have a strong potential to help people with a wide range of clinical issues – mental or physical disorders, however clinical BMIs aren`t that effective as needed – they are strong limited by modest channel counts. Neuralink has break this limit by using 3072 electrodes, distributed in 96 threads. Each thread is individually implanting using specialized robot (picture 2), without any human`s intervention.



Picture 2. The robotic electrode inserter. A. Loaded needle pincher cartridge. B. Low-force contact brain position sensor. C. Light modules with multiple independent wavelengths. D. Needle motor. E. One of four cameras focused on the needle during insertion. F. Camera with wide angle view of surgical field. G. Stereoscopic cameras.

The array of electrodes is packaged into a miniaturized implantable device (picture 3) with built-in accumulator that is capable to keep it's charge daylong. After that it can be recharged using an induction charger. That implantable device (chip) is able to detect neural activity with low latency and is very durable to keep implanted forever if needed [4].



Picture 3. The miniaturized durable implantable device with induction charger

CONCLUSION

Brain-machine interface is one of the most perspective and promising state of technology for the current time [4, 5]. According to that, many companies, startups and scientists are concentrating their resources on BMI development and research. However, only few of them are able to show state-of-the-art products. This direction that combines neurobiology and micromechanics in itself keeps it place in the top charts in the list of the technologies that going to be able most precipitously change the world.

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