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Neuralink: Spearheading the Point of Interaction among Brain and Machine

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Abstract: ***This examination paper gives an expansive outline of Neuralink Enterprise and its weighty work in the domain of neurotechnology, particularly in the production of implantable mind machine interface (BMI) advances, regularly alluded to as cerebrum chips or brain inserts. Neuralink, an organization established by Elon Musk in 2016, looks to make direct lines of correspondence between the human mind and outside mechanical gadgets, with potential applications going from clinical mediations to mental upgrades. This paper investigates the innovative angles, applications, challenges, and moral contemplations related with Neuralink's cerebrum chip innovation.***

Keywords: Neuralink Corporation, Neurotechnology Brain-Machine Interface (BMI), Medical interventions, Cognitive enhancements

1. Introduction

Is Artificial Intelligence (A.I.) mankind's most prominent development or its most noteworthy danger? In the words of Elon Musk, “If AI has a goal and humanity just happens to be in the way, it will destroy humanity as a matter of course without even thinking about it…It’s just like, if we’re building a road and an anthill just happens to be in the way, we don’t hate ants, we’re just building a road.” [1] It is impossible for human beings to keep up with Artificial Intelligence.

The only way for humans to be at par with Artificial Intelligence is to merge with it. This is one of the main reasons why Elon Musk and a team of seven scientists and engineers founded the company Neuralink.

Neuralink is an American neurotechnology company that is developing implantable brain–computer interfaces (BCIs), commonly known as brain chips. The company's main purpose for developing implantable neural interface is to facilitate bidirectional communication between brains and computers.

1) History of Neuralink

Founded by Elon Musk and a team of seven scientists and engineers, Neuralink was launched in 2016 and was first publicly reported in March 2017.

Jared John Birchall, the wealth manager of Elon Musk was made the President, CFO AND CEO OF Neuralink in 2018.

By July 2019, the company had a received a funding of $158 million, of which $100 million was from musk himself.[2] As of 2020, the company was located in the Mission District of San Francisco where it shared its headquarters with OpenAI, another company co- founded by Elon Musk.

2) The N1 Chip

The N1 chip is the original cerebrum chip being created by Neuralink. This chip, which is roughly the size of a coin, alongside 1024 terminals dispersed across 64 strings in the mind can perform activities which were viewed as unimaginable until now.[4] For example, having this chip embedded in the cerebrum can assist a visually impaired individual with seeing interestingly. This is one of the numerous capacities of this chip. The chip is fixed in a biocompatible nook that can endure states of being which are a lot more extreme than the human body. The embed is controlled by a little battery which can be charged remotely from an external perspective with an inductive charger.

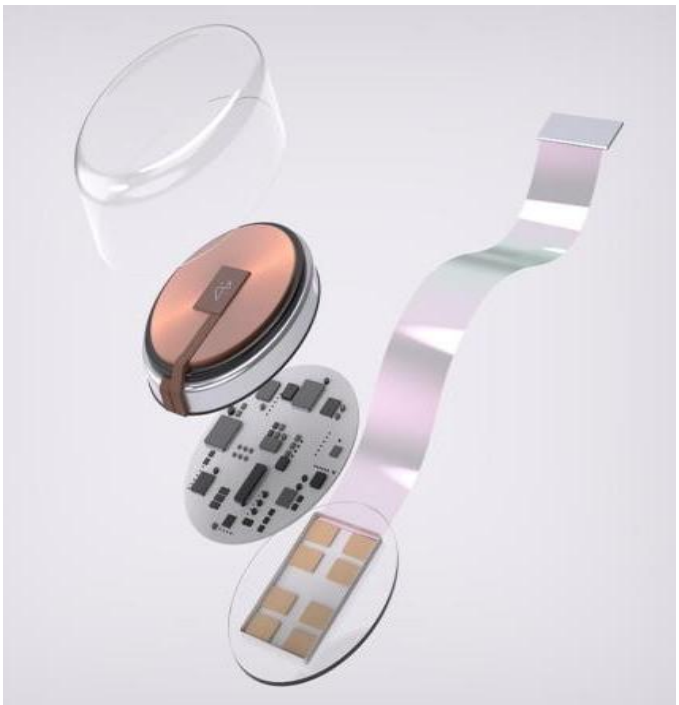

Figure 1: N1 Implant

3) Working with N1 Implant

The working of the embed depends on the way that our mind is a normally happening electrical gadget. Each activity that is completed in our body is finished by the transmission of electrical signs from the cerebrum to various body parts through the sensory system. In this way, by adding terminals into our cerebrum, which can both record and convey

messages, and interfacing those cathodes to a chip, we can physically move data to and from the mind. This helps in restoring and enhancing the normal functions of a human body. The implant can convert the data from electronic devices to brain signals, allowing the brain to be directly connected to any electronic device and allowing us to control that particular device with our mind. This concept can be used to cure blindness, deafness and aphasia by using external electronic devices.

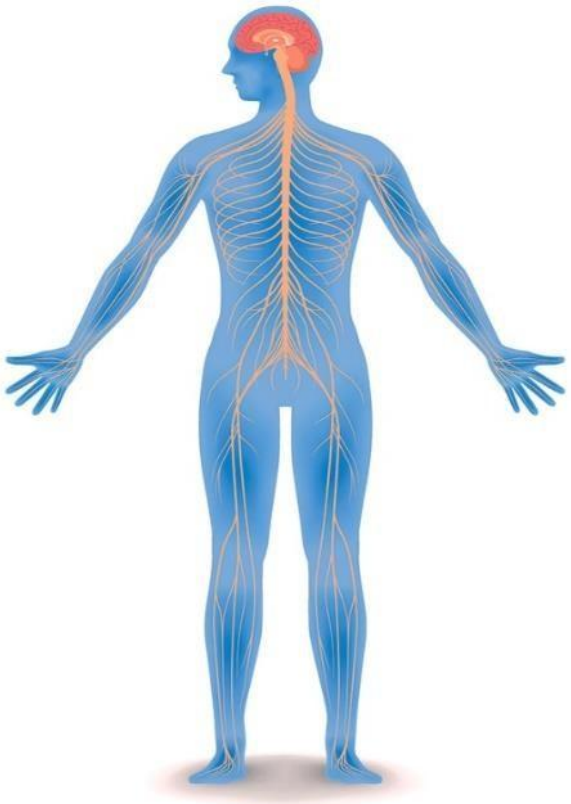

Figure 2: Transfer of Electrical Impulses through the Nervous System

4) Implanting the chip

Since the terminals, which are embedded in the cerebrum are so meager (almost 4-6 micrometers) that they can't be set inside the mind physically. In this way, to establish the cathodes unequivocally inside the cortex of the cerebrum, a careful robot, called the R1 was fabricated. The only task of the R1 is to ensure that the electrodes are planted properly inside the brain with complete precision while ensuring that the brain is not even slightly harmed during the surgery. The chip is not directly attached to the brain but rather it is attached to a part of the skull and it is connected to the electrodes through wires which are approximately 20 times thinner than human hair. In this way, the chip is completely invisible from the outside.

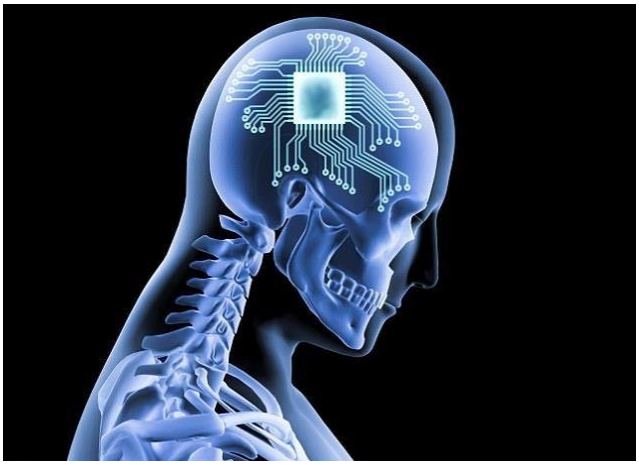

Figure 3: Implantation of the chip

5) Structure of the R1 Robot

The Base Structure; As the name suggests, the base structure is the supporting structure of the entire robot. When combined with the motion stage, it provides the structural platform for the head of the robot and the primary linear motion of the robot in three axis which is used to position the robot head and needle precisely while keeping in mind that the brain is a living entity that keeps continuously moving.

The Robot Head: The robot head is the part of the robot where all the processing takes place. It contains the optics and sensors of 5 camera systems and the optics for an optical coherence tomography (OCT) system.

The Needle: The needle is the only part of the R1 robot which comes in direct contact with the brain. It is thinner than a human hair and is used to grasp, insert, and release the threads which are embedded with electrodes.

Figure 4: The R1 Robot

6) Test on Living Organism

Animal Tests

Since 2017, Neuralink has been testing the N1 chip by planting it in the brains of monkeys, pigs and other animals. From 2017 to 2020, Neuralink carried out these experiments in partnership with University of California, Davis (commonly known as UC DAVIS).

Twenty-three monkeys were experimented on, out of which seven were transferred by the university to Neuralink at the end of their partnership. The initial success of these experiments was publicly confirmed in April 2021 when

Elon Musk posted a video of a nine-year- old macaque monkey named Pager playing the video game Pong with its mind, with the help of the brain implant.

They made this progress by compensating Pager with a banana smoothie at whatever point it finished a progression of undertakings in the game [5]. Then, at that point, the joysticks were detached, however Pager's psyche actually continued to convey similar messages to accept its prize i.e., the smoothie. These signs sent by the cerebrum permitted Pager to play the game through the mind chip, with next to no joysticks. In July 2023, Musk affirmed that these monkeys are currently fit for playing more perplexing computer games like Minecraft through their psyches. However, there is no video evidence of this yet. Experimentation has also been done on pigs. Electrodes were implanted in a pig's spinal cord which allowed the engineers to control the movement of the pig's limbs showing that the chip can be used to cure full body paralysis.

Criticism and the Ethical Issues of these tests Neuralink's experiments have been criticized many animal rights and safety organizations including the People for the Ethical Treatment of Animals which is more commonly referred to as PETA [6]. In 2022, the Physicians Committee for Responsible Medicine (PCRM) claimed that Neuralink and UC Davis had mistreated a number of monkeys, putting them through mental anguish, excruciating pain, and chronic infections as a result of surgery. PCRM believes that the fifteen monkeys which were not transferred to Neuralink were killed during the experimentation. In December 2022, Neuralink was reportedly the subject of a government inquiry by the United States Department of Agriculture (USDA) on possible breaches of Animal Welfare.[7] A report also states that the employees were rushed due to Elon Musk's demands of fast reports which caused a lot of unnecessary harm and pain to these animals. Neuralink denied all these claims by stating that all the monkeys that passed away died after the experimentation was over, and not during the experimentation.

Figure 5: Pager Playing Pong with its Mind

7) Human Trials

Initially, in 2022, the application for clinical human trials of the chip was rejected by The United States Food and Drug Administration (FDA) due to its incomplete information on the implant's effect on the human body. However, in June 2023, The FDA approved clinical human trials. "The FDA acknowledges and understands that Neuralink has announced that its investigational device exemption for its implant/R1 robot was approved by the FDA and that it may now begin conducting human clinical trials for its device," said an agency pokesperson.[8]

8) The Future of Neuralink

As of now, no human trial has been conducted but everything indicates that one will be conducted very soon. For now, these implants are only available for U.S. citizens above the age of 18 who have at least one of the following conditions: quadriplegia, paraplegia, visual impairment or blindness, aphasia or the inability to speak, or hearing impairment or deafness [4].

But the implants will be available for everyone around the world in the long term. In 2021, Elon musk tweeted, "First Neuralink product will enable someone with paralysis to use a smartphone with their mind faster than someone using thumbs."[9]

This seemed quite impossible at that time but now it is very likely that this will happen in the near future. In an interview on July 19, 2023, Musk stated that Neuralink could collaborate with his car company, Tesla in the future.[10] Tesla has built a humanoid robot called the

Tesla Bot or ***Optimus***.

Since this bot is built by Tesla almost entirely from scratch, it can allow the scientists and the engineers to customize the highly advanced prosthetic devices in order to connect these devices to the Neuralink implant. This will help amputees to replace the amputated part of their body with a prosthetic part which can be controlled directly from their brain as if it was just a normal body part.

The next step for Neuralink, after fixing the functioning of the body is brain enhancement. Elon Musk has hypothesized that with time, when these implants become more advanced and the number of electrodes implanted in the brain increase, they will one day be able to digitally resurrect their user after death by taking digital snapshots of the brain and storing it in a database which can then just be put in a new body.

The implants can allow us to do everything we do on smart devices in our brain. This includes any kind of digital communication, listening to music, watching movies and shows, consuming content on YouTube, reading a book or an article etc. with these implants, there will be no limit to our knowledge or physical abilities.

Downsides of the implant

While the implant has many positive attributes, it is not without its downsides.

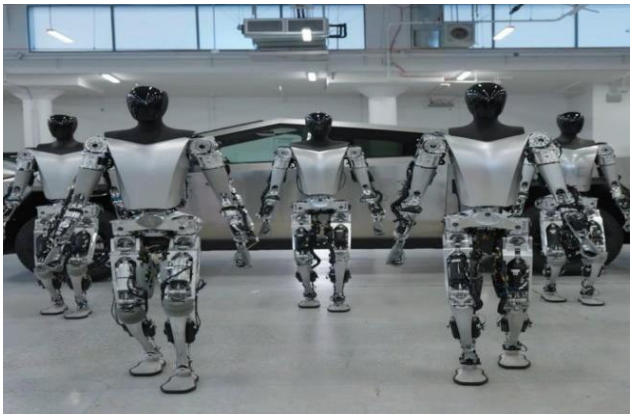

Figure 6: Tesla's Optimus bot

Killing of animals
One of the main downsides of the implant is the killing of animals during testing. Leaked documents showed that nearly 1,500 animals were killed during the testing of the implant.

Loss of humanity
If these chips do become as advanced as Elon Musk claims, our reliability on the machines will keep on increasing. The more reliable on the chip we become, the less human are.

Viruses and bugs
There is a chance of the implant getting a virus or a bug which could lead to slowing down of processing of brain and body functions. How will these viruses or bugs be removed without harming the brain?

Feeling of Inferiority
What if someone does not want an implant? If the implant does turn out to be successful, the people with the implant will have more physical and mental abilities. This will create a feeling of inferiority among the people without implants. There will also be a bias against these people.

Hacking
The most prominent and dangerous threat of the brain chips is hacking. Any smart gadget can be hacked by people with the ability to do so.

But, the hacking of the brain chip will be nothing like the hacking of a smart gadget like a laptop or a phone. If a normal smart gadget is hacked, the hacker only gets access to the information and files present in that particular device. However, if a brain chip does get hacked, the hacker would have access to your brain which in turn gives access to the entire body. The hacker would be able to control the entire body functioning, allowing the hacker to make functions of the organs faster, slow them down or even stop them entirely.

Along with this, the hacker would have access to and could alter or delete any thoughts, emotions, memories. This can allow the hacker to control the actions of the person including what the person sees, hears, smells, thinks, feels.

2. Conclusion

Companies like Apple and Meta are trying to keep up with Neuralink by creating virtual and augmented reality headsets. However, these headsets, as advanced as they might be, they are nowhere close to Neuralink's brain chip which is another level of technology which was earlier considered to be impossible. Just like everything in our world, these implants have both their pros and cons. But, in the case of these implants it is very not clear whether the pros outweigh the cons or vice-versa. The only thing that is certain is that the success of these implants will determine the future of our species. If these implants do become successful, they would surely be the killer of all other smart devices.

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