International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

A Review paper on
Exploring Brain Chips: The Future of Neuroscience Research

OMKAR BALAJI MADALE, Dr.Mrs.PRATIBHA ADKAR

MCA Department,PES Modern College Of Engineering Pune,India

Abstract: -Brain chips, designed to enhance human memory, aid paralyzed patients, and serve military purposes, have gained significant attention. These implantable computer chips, acting as sensors or actuators, have the potential to improve memory function, facilitate language fluency acquisition, and enable recognition of previously unfamiliar individuals. This comprehensive research paper provides an overview of brain chips, including their basic principles, manufacturing techniques, and diverse applications in various fields.

Keywords: Brain chips, Sensors, Actuators, Therapeutic devices, Electrodes, Epilepsy, Artificial intelligence, Memory enhancement, Robotics, Amplifiers

I. INTRODUCTION

The evolution and development of humankind have spanned countless millennia, shaping the intelligence and complexity of our brains. Concurrently, technology has undergone continuous advancement since the emergence of humans, with mankind playing a crucial role in its present form. However, we are now approaching a juncture where technology is poised to surpass humans in both intelligence and efficiency.

In this context, humans are faced with the challenge of keeping pace with technology. One of the recent developments in this field is the advent of brain chip implants. These innovative devices are designed to augment human memory, assist individuals with paralysis, and potentially serve military applications. Furthermore, there is a possibility that implantable computer chips acting as sensors or actuators could not only aid failing memory but also facilitate the acquisition of fluency in a new language or enable the "recognition" of previously unknown individuals.

It is evident that the concept of brain chips presents an opportunity for humans to bridge the gap between their natural abilities and the capabilities offered by advancing technology. By embracing this technology, humans can strive to enhance their cognitive capacities and achieve new levels of interaction and integration with the digital world.

Advancements in therapeutic devices, prosthetics, and computer science have demonstrated the potential for developing direct interfaces between the human brain and computers. This technology is continuously improving and becoming increasingly efficient. It is a remarkable convergence of technology with our fundamental needs, addressing two major challenges faced by humanity: the overwhelming volume of data being generated and the presence of debilitating and incurable diseases. Additionally, it aims to tackle the issue of data processing speed, which is crucial in our fast-paced world.

The exponential growth of data production in recent decades is staggering, with what used to take years now being generated within a matter of minutes. It is evident that in the coming years, this data production rate will continue to accelerate, and what currently takes minutes may soon be accomplished in mere seconds. This trend is inevitable across all fields of technology.

Humanity has reached a point where individuals are overwhelmed by the vast amount of information available, necessitating the assistance of algorithms to process and transform digital data into useful knowledge, akin to how the human brain functions. Deep learning, a prominent area of research for companies like Google and Microsoft, focuses on developing efficient methods to process and store data. Given the increasing digitization of the world, this technology has become crucial.

Brain chips play a pivotal role in this technological advancement, as they have the potential to revolutionize the fields of technology and engineering. The digital practices that dominate the modern world, such as online transactions, social media, internet access, and data downloading/uploading, generate an enormous amount of data. As humans adapt to this digital landscape, there is a pressing need for technology that can enhance our cognitive abilities and enable us to process this data effectively. Brain chip interfaces have been extensively researched to enhance brain function, particularly for individuals with neurological disorders such as paralysis, stroke, and epilepsy. Additionally, brain chips have practical applications for military personnel.

The introduction of this innovative technology opens up numerous possibilities for a better future, enabling humans to navigate the digital realm more efficiently and effectively.

Types of Brain Chips

There are two main types of brain chips: invasive and non-invasive. Invasive brain chips are surgically implanted directly into the brain, while non-invasive brain chips are worn on the outside of the body and use external stimuli to interact with the brain.

- Invasive Brain Chips:

Invasive brain chips are typically implanted using electrodes that are inserted directly into the brain. These electrodes can be used to monitor brain activity, stimulate specific areas of the brain, or record information from the brain.

- Non-invasive Brain Chips:

Non-invasive brain chips use external stimuli, such as electrical or magnetic fields, to interact with the brain. Some examples of non-invasive brain chips include transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), and electroencephalography (EEG).

Ethical Considerations:

Brain chips, although offering numerous potential benefits, also give rise to various ethical concerns, including issues of informed consent, privacy, and the potential for unauthorized access or manipulation of the brain.

II EVOLUTION TOWARDS IMPLANTABLE BRAIN CHIPS

Brain chip implants have become a prominent aspect of modern society. One notable invention in the field of human brain research is the Electro Encephalography (EEG) device, developed by Hans Berger in 1929. The EEG device revolutionized the recording of human brain signals. Another influential figure in this domain is Jose Delgado, who conducted research involving the implantation of electrodes in animal brains, connected to a device called a Stimoceiver.

A significant milestone occurred in 1998 when researcher Philp Kennedy successfully implanted the first brain chip in a human brain to record brain activity. Subsequent advancements include the development of the Brain Gate system by John Donoughue and his team at Brown University in 2001, the invention of the EEG cap by Jonathan Wolpaw and his researchers at New York State in 2004, and the creation of a wireless Brain Chip Interface by IBM. The wireless Brain Chip Interface is a small chip measuring 4mm in size and contains 5.4 billion interconnected transistors, capable of stimulating 1 million neurons and establishing 256 million neural connections. Notably, DARPA, the secretive research arm of the Department of Defense, has plans to implant Brain-Computer Interfaces (BCIs) in soldiers for various applications.

The latest phase of evolution in implantable brain chips involves the integration of advancements in prosthetic technology with developments in computer science. By combining smaller, lighter, and more powerful computer systems with radio technologies, individuals can access information and communicate anytime and anywhere. This progress in miniaturization has led to the creation of wearable systems that are inconspicuous, allowing users to move about and interact freely. Additionally, through networking capabilities, users can share experiences with others. The wearable computer project envisions users accessing a communal data source known as the Remembrance Agent.

III ELEMENTARY PARTS OF BRAIN CHIPS INTERGFACE

- The Pedestal with a chip:

The pedestal is 2 cm in which a 4mm micro electrode array (brain chip) is connected to it. Here the image is of the pedestal with a chip. It records all the electric pulses of brain nerve cells and transfers it to a signal amplifier.

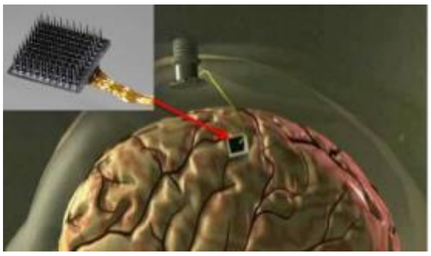

Fig 3.1.1 The Pedestal with a chip

- Neural Signal Interpreter:

The brain chip converts the analog brain signals into digital signals, which are then transmitted to a computer. The computer, equipped with a neural signal interpreter, is capable of learning and identifying the unique patterns created by nerve cells during specific activities performed by the human brain. This learning process is facilitated by the digital signals received from the neural signal interpreter.

Fig 3.1.2 Neural Signal Interpreter

- The computer:

The computer learns and recognizes the distinct patterns generated by nerve cells during various activities performed by the human brain. It achieves this by analyzing the digital signals provided by the neural signal interpreter.

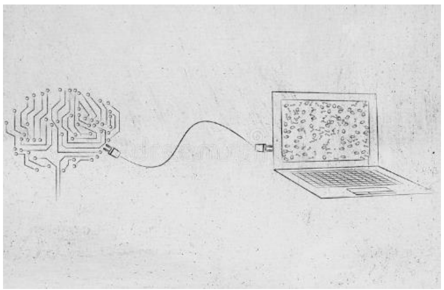

Fig 3.1.3 The computer

IV. APPLICATIONS OF BRAIN CHIPS ON VARIOUS SECTORS

- Medical implants: Brain chips have the potential to assist individuals suffering from neurological disorders, including Parkinson's disease, epilepsy, and chronic pain. They offer a means to manage symptoms effectively and enhance the overall quality of life for patients.

- Brain-computer interfaces (BCIs): Brain chips can be utilized to develop BCIs, enabling individuals to control computers or other devices through their thoughts. This innovative technology holds immense potential in assisting individuals with disabilities, such as paralysis, to communicate and engage with the world around them.

- Cognitive enhancement: Brain chips have the potential to enhance cognitive abilities, including memory and attention. Nevertheless, the ethical considerations surrounding this application are currently under discussion and subject to debate.

- Artificial intelligence: Brain chips have the capability to enable the development of intelligent machines that possess the ability to learn and adapt, similar to humans. This advancement in technology has the potential to bring about revolutionary changes in fields such as robotics and autonomous vehicles.

- Research: Brain chips have the potential to be employed in neuroscience research for the purpose of studying the brain and its intricate functions. They offer valuable insights into understanding the workings of the brain and exploring novel approaches for the treatment of neurological disorders.

V. COMPONENT OF BRAIN CHIPS

- The Chip

A silicon chip measuring four millimetres in square size is implanted in the primary motor cortex of the brain. This chip is equipped with 100 micro electrodes, each as thin as a strand of hair. These micro electrodes function as sensors, detecting minuscule electrical signals that are produced when a user engages in imagination or mental processes.

Fig 6.1.1 The Chip

- The Connector

The signal originating from the brain is transmitted through a pedestal plug that is connected to the skull.

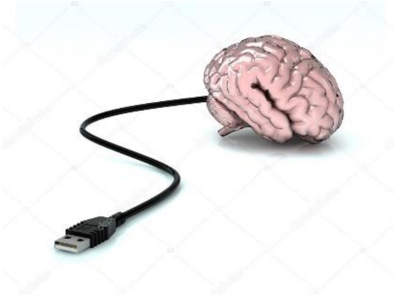

Fig 6.1.2 The Connector

- Convertor

The signal is then directed to an amplifier, where it undergoes conversion into optical data. This optical data is then transmitted through a fiber-optic cable, allowing it to be transmitted to a computer.

Fig 6.1.3 The Converter

- Computer

The brain-computer interface utilizes electrophysiological signals from the brain to control remote devices. In the case of invasive interfaces, such as the preferred Brain Computer Interface (BCI), electrodes are used to capture the brain's electrical activity, measuring it at the microvolt level, and transmitting it to amplifiers.

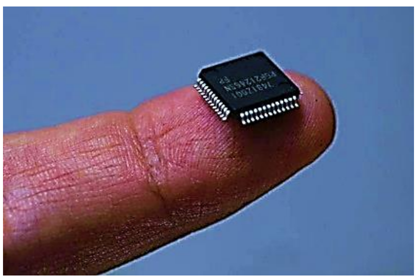

Fig 6.1.4 The Computer

VI. BENEFITS OF IMPLANTABLE BRAIN CHIPS

In the future, we may witness a convergence of science fiction and reality, where individuals form intimate and occasionally essential connections with machines, turning into cyborgs. It is highly probable that implantable computer chips, functioning as sensors or actuators, will soon aid not only in combating memory decline but also in facilitating fluency in new languages and enabling the "recognition" of unfamiliar individuals. The advancements made in therapeutic devices, prosthetics, and computer science strongly suggest that the development of direct interfaces between the brain and computers is within reach.

According to computer scientists' predictions, in the coming two decades, neural interfaces are expected to be developed that can expand the range of human senses, improve memory, and enable "cyberthink" - a form of communication that is invisible to others. This innovative technology will provide seamless and continuous access to information precisely when and where it is required.

Advancements in radio technologies will allow individuals to access information and communicate from any location and at any time. Through the miniaturization of components, wearable systems have been developed that are discreet and nearly imperceptible. These wearable devices, integrated with personal information structures, enable individuals to freely move around and interact with their surroundings. Additionally, by leveraging networking capabilities, users can share experiences with others. The concept of the wearable computer project involves users accessing a communal data source known as the Remembrance Agent.

Implantable chips, functioning as intelligence or sensory amplifiers, offer several benefits:

• They can expand the dynamic range of senses, allowing individuals to perceive infrared (IR), ultraviolet (UV), and chemical spectra.

• They have the potential to enhance memory capabilities.

• They enable consistent and immediate access to information whenever and wherever it is needed.

These enhancements can significantly improve quality of life, increase survivability, and enhance job performance for many individuals. The development of prototype devices for these enhancements is expected within five years, with military prototypes following within ten years and prototypes for information workers within fifteen years. However, it may take approximately twenty to thirty years for widespread adoption. The brain chip is anticipated to function as a prosthetic cortical implant, stimulating the user's visual cortex either based on visual input captured by a camera or through an artificial "window" interface.

VII. CHALLENGES OF IMPALNTABLE BRAIN CHIPS

According to Rahmi Aktepe, the head of the Informatics Association of Turkey, there are concerns regarding the security of implantable brain chips. Aktepe warns that if these chips become widespread, there is a risk of them being hacked and used for malicious purposes, potentially turning users into "killing machines" against their will. He emphasizes that all computer-based systems, including Neuralink's brain chip, can be vulnerable to cyber-attacks and misuse.

Aktepe acknowledges that the primary purpose of brain-computer interface (BCI) studies is to understand the human brain and develop treatments for conditions such as memory loss, hearing loss, and depression. However, he cautions that it is impossible to guarantee that these technologies will not be exploited for controlling people in the future. He raises concerns about the hidden agenda behind such chips, describing it as a "project of creating smart people versus smart robots."

Chips can damage mental, physical health

According to Rahmi Aktepe, the purpose of implantable brain chips is to transfer brain signals between humans and smart robots, potentially turning individuals into robots or allowing robots to mimic human behavior. However, Aktepe emphasizes the importance of ethical frameworks in the use of these chips. He believes that if used ethically and supported by artificial intelligence, the chips can help individuals make faster and more accurate decisions.

Aktepe also raises concerns about the potential creation of new viruses that could affect the brain chips and lead users to act unethically or suffer mental and physical damage. He warns that if a computer virus were to enter a chip, it could potentially harm not only the user's brain but other functions as well.

Elon Musk, the founder of Neuralink, has described the brain chip as being about the size of a large coin and fully embeddable in the skull without causing harm to the brain over time. The chip is designed to have an all-day battery life and can be wirelessly charged via an induction coil. Musk has expressed the goal of using these devices to solve important spine and brain problems, although he has not provided specific details on how they would cure neurological conditions or a precise release schedule for the chips.

- Safety Concerns

Ensuring the safety of implantable brain chips is a significant challenge due to the intricate and sensitive nature of the brain. The potential consequences of any damage to the brain emphasize the importance of careful design and extensive testing of these devices to minimize risks and ensure user safety. Extensive precautions must be taken to mitigate the possibility of harm and to prioritize the well-being of individuals who receive implantable brain chips.

- Privacy and Security

Safeguarding the privacy and security of the data collected and transmitted by implantable brain chips is a crucial challenge. Brain-computer interfaces have the capability to capture and transmit extensive data related to an individual's thoughts, emotions, and physical condition. It is imperative to implement robust measures to ensure that this information remains confidential and protected from unauthorized access, preventing any misuse or exploitation for malicious intentions. Stricter security protocols and encryption techniques need to be employed to safeguard the privacy and integrity of the data collected by these devices.

- Technical Challenges

Ensuring the privacy and security of the data collected and transmitted by implantable brain chips is a significant challenge. These devices have the capability to record and transmit extensive data related to a person's thoughts, emotions, and physical state. Protecting this information from unauthorized access is crucial to prevent its misuse or exploitation.

- Cost and Accessibility

Addressing the challenge of making implantable brain chips accessible and affordable to the general public is crucial. These devices have the potential to be expensive, which could restrict their availability to only the wealthiest individuals, exacerbating socioeconomic disparities. Furthermore, insurance coverage for such advanced technologies may be limited initially, further hindering accessibility.

VIII. CONCLUSION

Brain-like chips, inspired by biological structures such as the human brain, have the potential to revolutionize computation. They can optimize interactions with the environment through unsupervised learning rules. Establishing a general learning platform and utilizing nanotechnology can enhance the chips' capabilities, making them smaller, more efficient, and reliable. This technology has various advantages, including parallel task handling, restoring limb function, and improving rehabilitation for patients. In summary, brain-like chips offer endless possibilities and numerous benefits for a wide range of applications.

IX. REFERENCES

1.Efron, B., and R. J. Tibshirani (1993). An Introduction to the Bootstrap, New York, Chapman and Hall.

[1] Dr. Shruti Sneha Das Rourkela, Odisha, India shrutisnehadas[at]gmail.com, International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2022): 7.942 Volume 11 Issue 3, March 2022 www.ijsr.net Licensed Under Creative Commons Attribution CC BY Brain Chips Technology

Websites:-

[2] Brain Chips | PDF | Brain | Retina (scribd.com)

[3] The Future Technology Brain Chip Interference (ijert.org)

[4] The Future Technology Brain Chip Interference – IJERT

[5] 20th WCP: Ethical Assessment of Implantable Brain Chips (bu.edu)

[6] Brain chips ppt (slideshare.net)

[7] Brain chips seminar ppt (slideshare.net)

[8] Brain Chips | Seminar Report, PPT, PDF for ECE Students (seminarsonly.com)

[9] IT expert issues warning on computer brain chips (aa.com.tr)

[10] (PDF) A history of development in brain chips in present and future (researchgate.net)