Maratha Vidya Prasarak Samaj's
Karmaveer Adv. Baburao Ganapatrao Thakare College Of Engineering Nashik-13.
(NAAC ACCREDITED INSTITUTE WITH 'A++' GRADE)

DEPARTMENT OF ELECTRONICS &TELECOMMUNICATION ENGG.

Departmental TeChronicle Month: -August 2025

Vol. - 07, Issue – 2

Department Vision:-

To be recognized as an excellent department offering competent technical education to create competent electronics & telecommunication engineers for the benefit of the common masses.

Department Mission:-

Committed to serve the needs of society through innovative teaching learning processes, promoting industry-institute interaction to provide competent and cultured electronics and telecommunication engineers.

Program Educational Objectives:-

1. *To impart state of art technical education in the Electronics & Telecommunication Engineering.*
2. *To promote society beneficial projects and activities.*
3. *To develop soft skill, team work, professional ethics and multidisciplinary approach for the carrier enhancement.*
4. *To bridge the gap between Industry-Institute through collaboration with Industries, Institutions and Universities.*
5. *To provide suitable infrastructure and facilities in tuned with advancing technological evaluation.*

Greeting,

*Department of **Electronics and Telecommunication Engineering** is celebrating **"MVP Samaj Din"** by unveiling technical newsletter "TeChronicle" VOL7, ISSUE-2 on 19th August 2025.*

*The day is celebrated to remember all **Karmaveer of M.V.P. Samaj**, it is also birthday of **Karmaveer Raosaheb Thorath**.*

❖ Role of AI in Interpreting Neural Data for BCIs

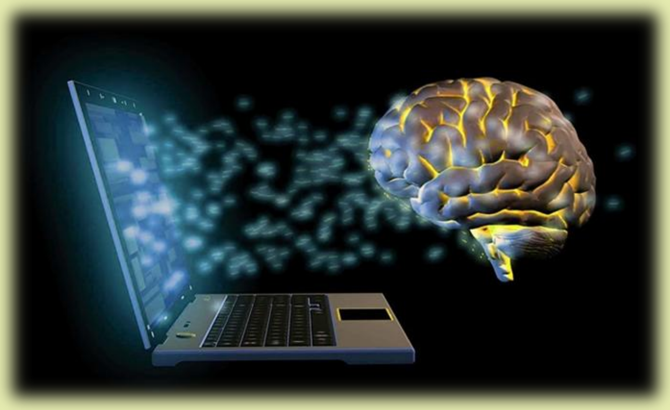
[Yukta Sonawane (3rd year) E&TC]

Brain-Computer Interfaces (BCIs) are no longer confined to the realm of science fiction. They are rapidly becoming a reality, with promising pplications in medicine, communication, gaming, and even everyday life. At the core of this revolutionary technology lies an essential enabler: **Artificial Intelligence (AI)**.

Without AI, interpreting the complex and often noisy data produced by the human brain would be nearly impossible. This article explores how AI is transforming BCIs, making them smarter, faster, and more adaptable to human needs.

What Is a Brain-Computer Interface?

A Brain-Computer Interface is a system that allows direct communication between the brain and an external device—typically a computer or machine. It bypasses traditional methods of communication such as speech or physical movement, offering an interface where thoughts can potentially control actions.Imagine being able to control a computer, a wheelchair, or even a robotic arm—just by thinking. No mouse, no keyboard, no spoken command—just the pure, silent force of your brain's electrical impulses. This futuristic vision is becoming a reality thanks to the fascinating and fast-evolving field of Brain-Computer Interfaces (BCIs**)**. At the heart of this transformation lies another groundbreaking technology: Artificial Intelligence (AI)**.**Together, AI and BCIs are changing how we interact with the world, not through touch or voice, but through thought.



The Problem: The Brain Speaks in Code

The human brain is a symphony of electrical activity—billions of neurons firing at once, creating a chaotic, beautiful, and incredibly complex flow of signals. These signals don't come with a built-in decoder ring. They're noisy. They're messy. And they're unique to every individual.When a BCI captures these signals through sensors—whether implanted in the brain or worn like a headset—it's essentially receiving an encrypted message with no clear key.That's where AI steps in—not just as a tool, but as a translator, a listener, a learner.AI: The Mind's Interpreter

Artificial Intelligence, particularly machine learning and deep learning**,** plays the role of a digital linguist—learning to understand the brain's silent language and turning it into real-world action**.** Real-World Applications of AI-Powered BCIs

Medical Rehabilitation: -Patients with paralysis or neurological injuries are now able to move robotic limbs, control wheelchairs, or even communicate via thought using AI-driven BCIs. Systems trained on their brain signals enable them to type or speak without moving a muscle.

Neurogaming and Immersive Entertainment: - Games and virtual reality experiences can now adapt to a player's emotional or cognitive state. For example, a game may become more challenging if the AI detects increased concentration or relaxation.

Mental Health Monitoring: AI can detect patterns associated with stress, anxiety, or depression. Combined with wearable EEG devices, this can lead to real-time mental health tracking and personalized interventions.

Cognitive Enhancement and Education: By analyzing attention and engagement levels, AI-enabled BCIs can help create adaptive learning environments, customizing teaching methods to suit each learner's brain state.

REFERENCES

- https://www.researchgate.net/publication/229059733_Brain-Computer_Interfaces_Beyond_Medical_Applications
- https://pmc.ncbi.nlm.nih.gov/articles/PMC3497935/

❖ Brain interface computer

[Shreyasi Pawar (2nd year) E&TC]

What if you could control a machine with your mind? In 2025, this is no longer just a dream. Brain-computer interfaces (BCIs) are devices that create a direct communication pathway between a brain's electrical activity and an external output. Their sensors capture electrophysiological signals transmitted between the brain's neurons and relay that information to an external source, like a computer, mobile device or robotic limb, which essentially lets a person turn their thoughts into actions. BCIs are set to change how humans interact with technology. With companies like Neuralink starting human trials, the future of brain- machine connection is already here.

What is a Brain computer interface?

A brain-computer interface (BCI) is a device that lets the human brain communicate with and control external software or hardware, like a computer, mobile device or robotic limb. With BCI technology, scientists envision a day when patients with paralysis, muscle atrophy and other conditions could regain motor functions. Rehabilitation services could also adopt BCIs to accelerate recovery from injuries. Ramses Alcaide, CEO of neurotech startup Neurable which develops non-invasive braincomputer interfaces in the form of headphones, sees potential for BCI-enhanced devices to become an everyday item for the average person.

How does it work?

Brain-computer interfaces capture and analyze brain activity to convert it into control commands for computers. The measurement of electrical brain activity is done using electrodes. Subsequently, specialized algorithms process the captured signals to recognize patterns that correlate with specific thoughts and mental images. In the next step, the brain-computer interface translates these patterns into commands that machines can understand. Researchers use machine learning and artificial intelligence to recognize and analyze signals due to the complexity of the data.

Brain activity can be recorded either using manually applied and removable BCIs or through surgically implanted BCIs:

1. **Invasive BCIs**
   - Surgically implanted in brain tissue.
   - High signal accuracy.
   - Used for medical needs (e.g. paralysis, spinal injury).
   - Carries surgical risks.
2. **Non-Invasive BCIs**
   - External devices (like EEG headsets).
   - Lower signal strength, but no surgery.
   - Best for AR/VR, gaming, robotics control.

Challenges:

Technical and user challenges. Each person generates unique brain signals, which are difficult to measure clearly. Also, learning to use a BCI can require substantial training.

Ethical framework. BCIs may raise questions about what constitutes consent and about potential unfair advantages conferred by certain human enhancements.

Security and privacy. BCIs could be vulnerable to cyberattacks that expose brain data or interfere with a device's function.

Applications of BCIs

1. **Medical & Neurorehabilitation**
   - Paralysis treatment: Control robotic limbs or wheelchairs using thought.
   - Stroke recovery: Aid in motor function rehabilitation.
2. **Human-Computer Interaction**
   - Hands-free control: Operate computers, drones, or smart device using brain signals.
   - Augmented & Virtual Reality (AR/VR): Enhance immersive experiences with thought-based interaction.
3. **Gaming & Entertainment**
   - Neurogaming: Control game elements directly with your mind.
   - Personalized content: Games or media adapt in real time to your emotional or cognitive state.

Conclusion:

As brain-computer interfaces evolve from labs to everyday life, they promise to reshape how we connect with technology — and even with each other. Whether used to help patients regain movement or to play a game with just a thought, BCIs are a leap forward in human-machine integration. But with this power comes responsibility: we must navigate ethical concerns, protect brain data, and ensure that these tools are developed for everyone's benefit. In short, BCIs are no longer science fiction — they're science in action.

REFERENCES

- https://www.gao.gov/products/gao-22-106118
- https://builtin.com/hardware/brain-computer-interface-bci

❖ Artificial Intelligence in Brain–Computer Interfaces (BCIs)

[Shrushti Naphade (3rd year)E&TC]

Introduction

The rapid advancement of technology has given rise to systems that connect the human brain directly with computers. This innovation, known as a Brain–Computer Interface (BCI), establishes a communication pathway that bypasses traditional input devices such as keyboards, mice, or touchscreens. However, brain signals are highly complex and often difficult to interpret. To address this challenge, Artificial Intelligence (AI) has become an integral part of modern BCIs. Through the application of machine learning and deep learning techniques, AI enhances the accuracy, speed, and adaptability of these

Role of AI in BCIs

Artificial Intelligence provides the computational intelligence required to process and understand brain activity. The primary roles of AI within BCIs include:

Signal Preprocessing – AI algorithms filter out noise and artifacts from raw brain signals, ensuring clean and reliable data for further analysis.

Feature Extraction – Machine learning models identify essential patterns in brain activity, such as specific frequency bands or event-related potentials.

Classification and Prediction – AI translates neural signals into commands by recognizing patterns associated with user intentions. Techniques such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) are commonly employed.

Adaptive Learning – AI enables BCIs to continuously adapt to individual users, thereby improving performance over time.

Application

AI-powered Brain–Computer Interfaces (BCIs) are increasingly being used in real-time applications where immediate interpretation of brain signals is critical. In healthcare, for instance, patients with paralysis or spinal cord injuries can control robotic prosthetic limbs or wheelchairs in real time using their thoughts, allowing natural and instantaneous movement. Similarly, real-time BCI systems enable communication for individuals with severe speech impairments, such as those with ALS, by converting neural activity directly into text or speech as they think. In gaming and virtual reality, BCIs allow players to control in-game actions or navigate immersive environments instantly, creating highly responsive and interactive experiences. Real-time monitoring of mental states, such as detecting fatigue, stress, or attention levels, is also used in safety-critical fields like aviation, driving, and workplace management, where immediate feedback can prevent accidents and enhance performance. These applications demonstrate how AI-powered BCIs can bridge the gap between thought and action in real time, offering practical and life-changing benefits.

Future Prospects

The future of AI in BCIs is highly promising. As computational power increases and AI algorithms become more advanced, BCIs are expected to:

- Offer seamless interaction between humans and digital systems.
- Enable thought-driven communication for individuals with severe speech or movement impairments.
- Provide enhanced rehabilitation tools that accelerate recovery after strokes or injuries.
- Support cognitive enhancement, where AI-powered BCIs may boost memory, learning, and attention.
- Facilitate brain-to-brain communication and even integration with advanced AI systems, potentially leading to new forms of human–machine collaboration.

REFERENCES

- https://www.frontiersin.org/articles/10.3389/fnhum.2023.1320536/full
- https://neuralink.com

Website: www.kbtcoe.org
Email Id: techronicle.etc@gmail.com