Online Communication in the Digital Age

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Lecture – 56

The Future of Communication Technology

Good morning, dear friends and welcome to today's module on the future of communication technology. Rapid developments of 5G and also very soon 6G networks and the integration of augmented and virtual reality are some examples which suggest that online communication in the digital age is poised to revolutionize the way we connect and interact with each other.

Today we shall discuss some other technologies which have further revolutionized media and communication in different fields. We shall look at holographic and telepathic technologies as well as brain computer interfaces and their uses in digital communication.

As discussed in previous modules, advances in natural language processing and AI driven chatbots are enhancing human computer interactions continually. The future of technology holds immense promise with experts envisioning a world where the virtual and physical realms merge in a seamless fashion.

Metaverse related technologies like holographic displays, telepathic communication chipsets and brain computer interfaces etc. are bringing the convergence of the physical and the digital worlds closer. Let us have a look at a video first that discusses these possibilities.

We all rely on technology advances to power the communication and computing networks that help us work, play, shop and socialize.

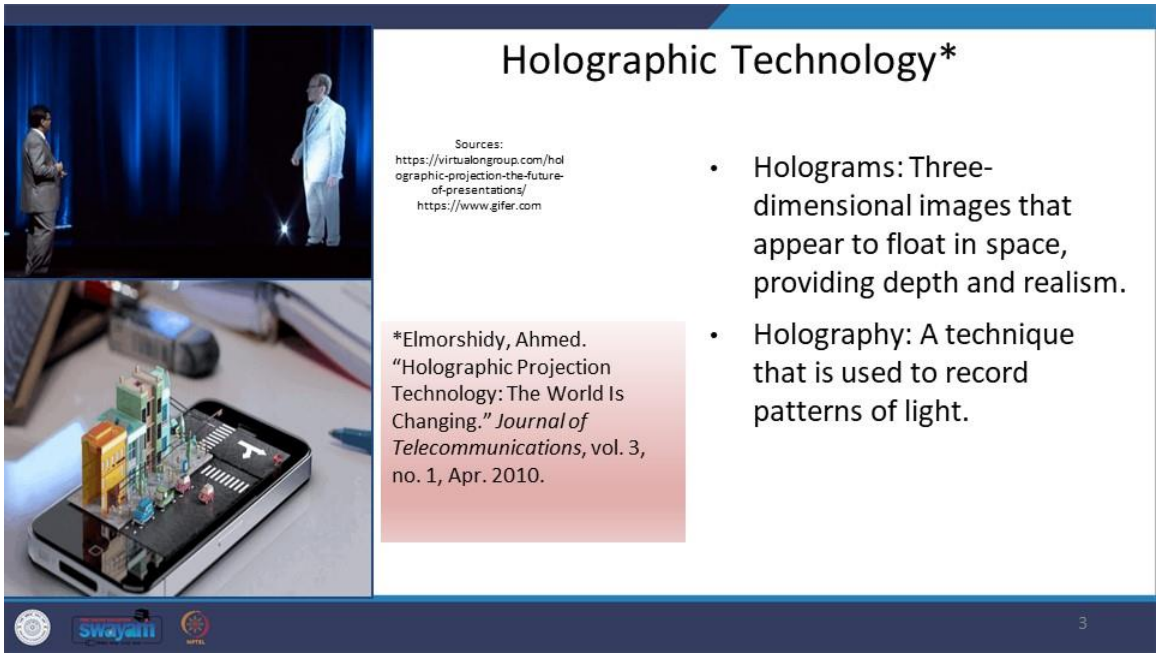
Dozens of international experts have helped us discover new technologies which could help us see, hear, touch and even smell at a distance. To create rich and personalized media experiences and for networks to deliver services faster and more consistently wherever we are. We are sharing a sample of these in our Technology Futures report and looking forward to helping their benefits to everyone. Over the next few decades we will see how the virtual and the physical worlds becomes intertwined using things like augmented and virtual reality. And people will have expectations on wireless access to be as available and reliable as the electricity grid which put a lot of effort into the people who are building these future networks.

Wireless access will also become a human right and we need to make sure that also the developing parts of the world will have very good access to it. Applications that are heavily dependent on machine learning and speech understanding, tens of thousands of satellites in low earth orbit, frequency operations up in the 90 plus gigahertz, increasing numbers of devices, internet of things in the billions. The communication technologies that I expect to have the most profound impact over the next 50 years are the ones that will allow us to become truly sustainable in terms of how we build communication systems. So these technologies relate to advances in material science, relate to how we do more with less data, to how we think about telecommunications infrastructure as a system that sits in harmony with the natural and built environment. The technologies which I think will stand out in 30, 40, 50 years time will be all around quantum computing and

quantum communications as well as around the human machine interface, our ability to tap and interact with the human brain.

Five trends in wireless connectivity in the coming decade. One is a reliable remote presence, two are open radio access systems, three is the interplay of machine learning and communications, four are the new developments in electromagnetics and quantum systems, and number five, real time data markets and extraction of economic value from wireless data.

The first concept that we discuss today is holographic technology and its uses in online communication. A hologram is a picture of a whole object showing it in three dimensions. Holographic communication thus refers to real time capturing and coding, transporting and rendering of 3D representations in the presence of certain other human beings who are physically present at that time. It offers incredible applications across various industries, in business meetings, in the fields of education, healthcare, entertainment, virtual reality, and also of course advertisements.

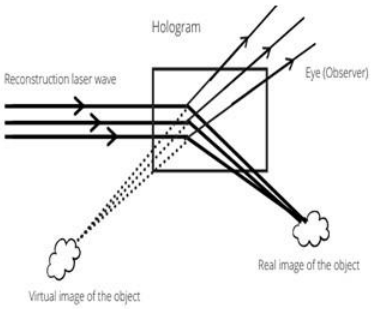


Holograms are three dimensional images that appear to float in space, providing depth and also a certain realism. Holography is a technique that is used to record patterns of light.

Unlike traditional flat images, holograms give the illusion of depth and perspective, making them appear lifelike and immersive. At its core, holography relies on the interference patterns created by coherent light sources such as lasers. These patterns are recorded on a spatial media, which then enables reconstruction of the hologram when illuminated with light of the same properties.

How Holograms Work?*

- Holograms capture and reproduce the entire light field of the object, enabling a more immersive visual experience.
- Holography utilizes the principles of light interference to create the illusion of depth and perspective in the reconstructed image.
- The hologram itself contains information about both the amplitude and phase of the light waves, resulting in a more accurate representation of the original object.



Source: https://www.physicswave.com

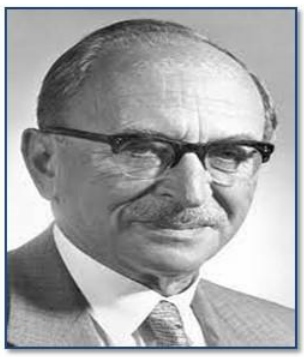
Wilson, Tracy V. "How Holograms Work." *HowStuffWorks Science*, HowStuffWorks, 30 Aug. 2023.

So how do holograms work? Holograms capture and reproduce the entire light field of the object, enabling a more immersive visual experience. They utilize the principles of light interference to create the illusion of depth and perspective to the finally reconstructed image. It contains information about both the amplitude and phase of the light waves, resulting in a more accurate representation of the original objects.

The history of holography dates back to the 1940s when Dennis Gabor, a Hungarian British physicist, first proposed the concept. However, it was not until the invention of the laser in the 1960s that holography became practical.

Origins

- The concept of holography was first proposed by Hungarian-British physicist Dennis Gabor in 1947.
- In 1971, Dennis Gabor* was awarded the Nobel Prize in Physics for his invention of holography.
- While in 1966, Lohmann and Brown** proposed and fabricated the computer-generated holography for spatial filter for the first time by introducing the sampling law and detour phase coding method.

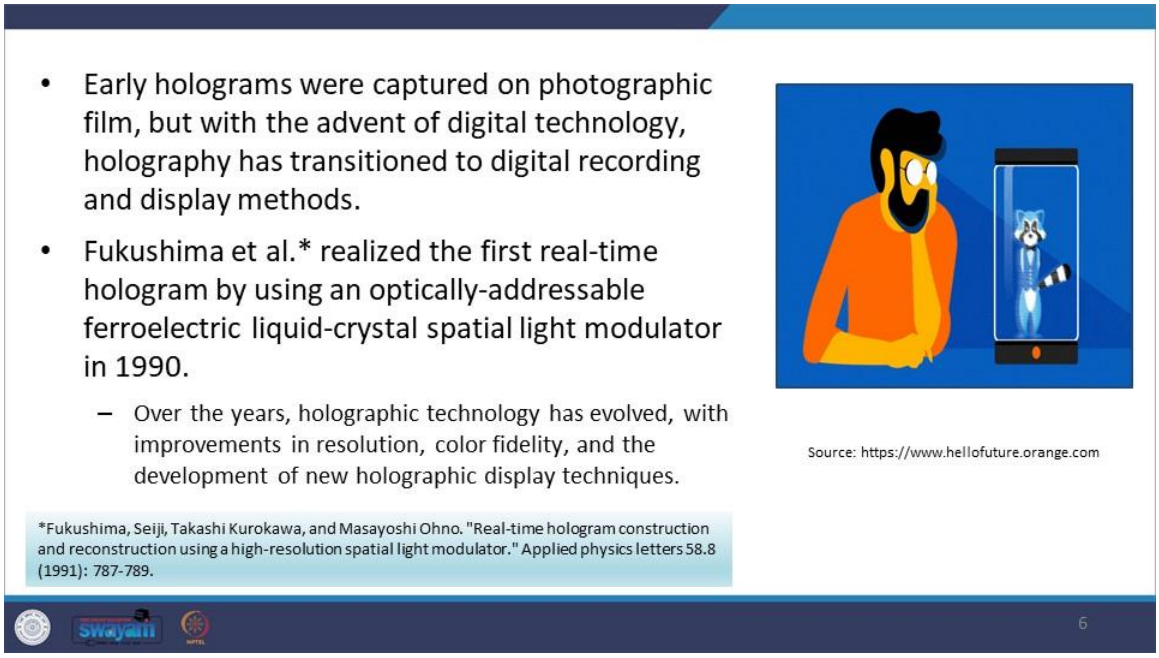


Dennis Gabor
Source: https://www.nobelprize.org

Gabor, Dennis. Holography, 1948-1971: Nobel Lecture. Nobel Foundation, 1972.

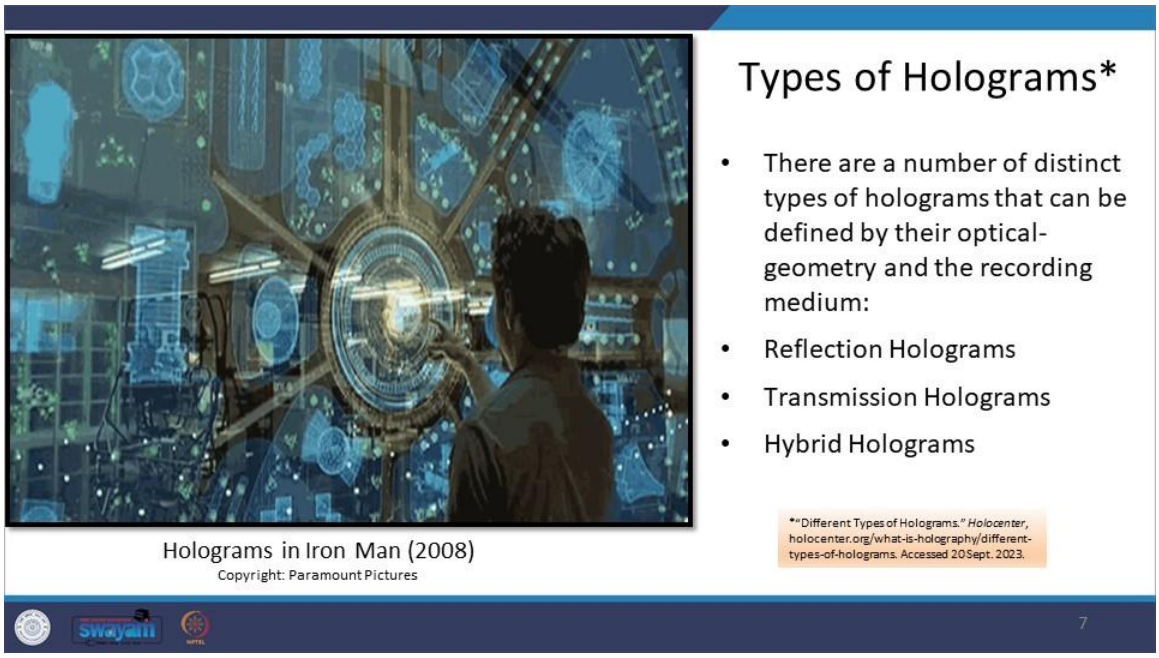
Brown, Bryon R., and Adolf W. Lohmann. "Complex spatial filtering with binary masks." Applied optics 5.6 (1966): 967-969.

Dennis Gabor was also awarded the Nobel Prize in Physics in 1971 for his invention of holography.



Early holograms were captured on photographic film, but with the advent of digital technology, holography has transitioned to digital recording and display methods. Fukushima et al. realized the first real-time hologram by using an optically addressable ferroelectric liquid crystal spatial light modulator in 1990. Over the years, we find that this technology has evolved with improvements in resolution, color fidelity, and the development of new display techniques.

These advancements have paved the way for groundbreaking applications that have the potential to revolutionize entertainment, healthcare, education, and various other fields.

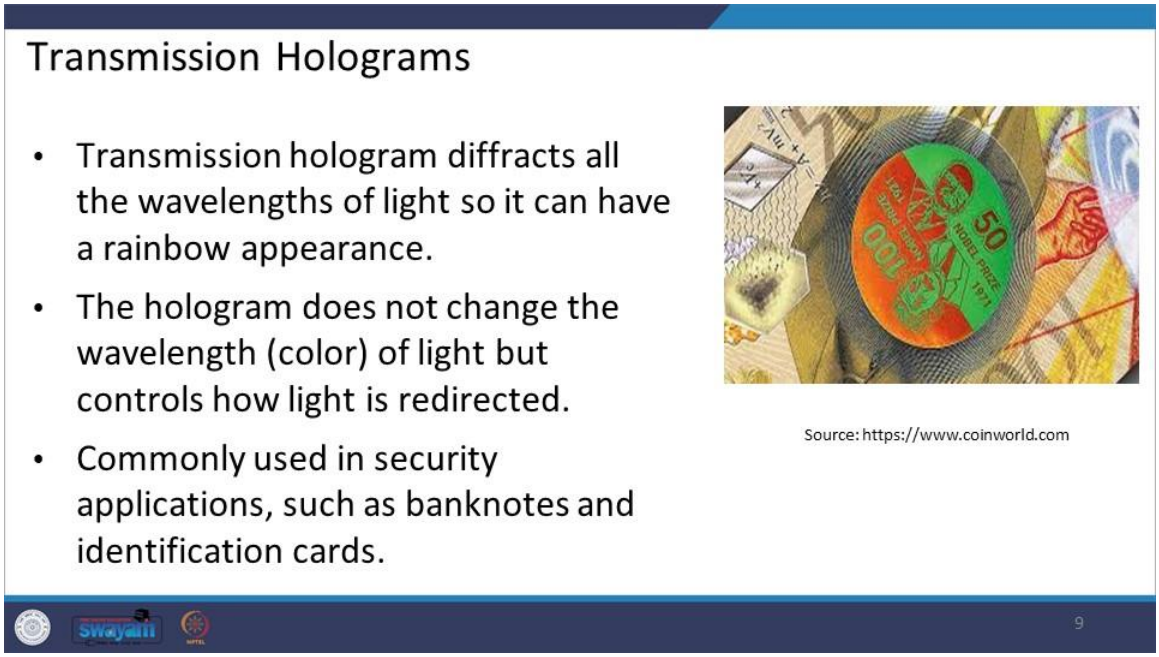


Holograms are of various types. Designed by their optical geometry and the recording medium, we will look at three types of holograms, reflection, transmission, and hybrid holograms.

Reflection holograms require laser illumination for viewing, and they are able to produce a virtual image that appears to float above the surface of the hologram. Another type of hologram is known as Dennis Gabor reflection hologram. It has been named after the originator, a Russian physicist and one of the founders of optical holography. The second type of reflection hologram is termed as Denisyuk reflection hologram, which has been

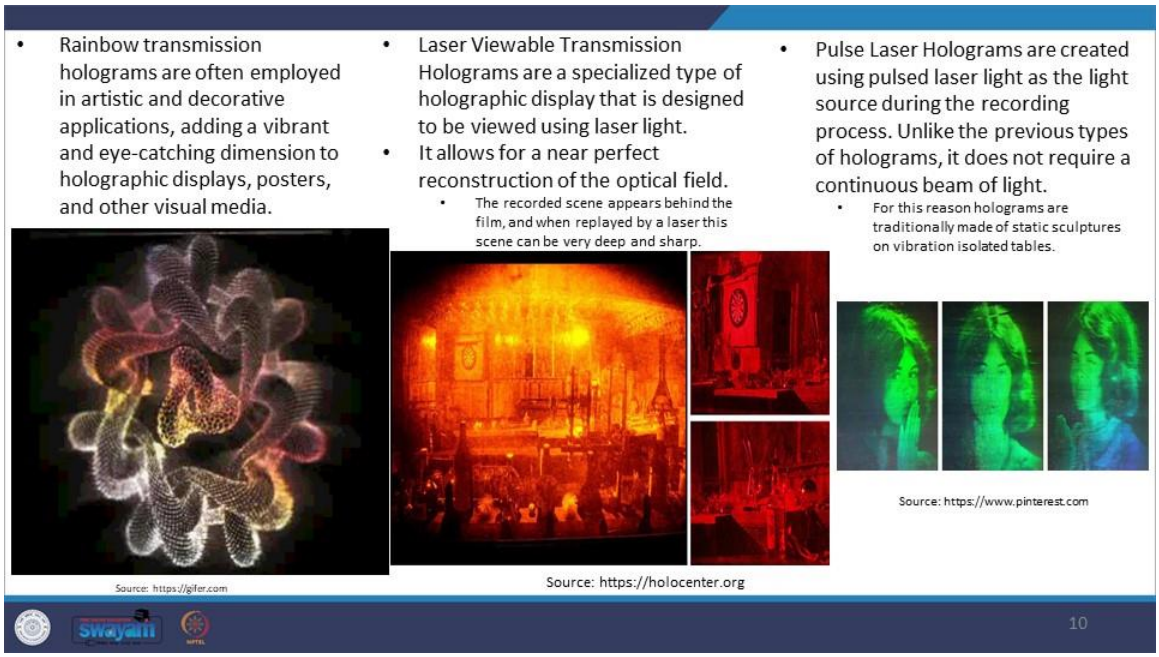
named after their originator, a Russian physicist and one of the founders of optical holography. In the points below, you would have a summary of how the technology is used. Another type of reflection holograms is known as pseudo color reflection hologram, which enhances the visual representation of an object by assigning artificial colors to different depth or intensity levels within the hologram itself.

Conversely, transmission holograms have a different visual quality, and the color is controlled by geometry rather than chemistry.



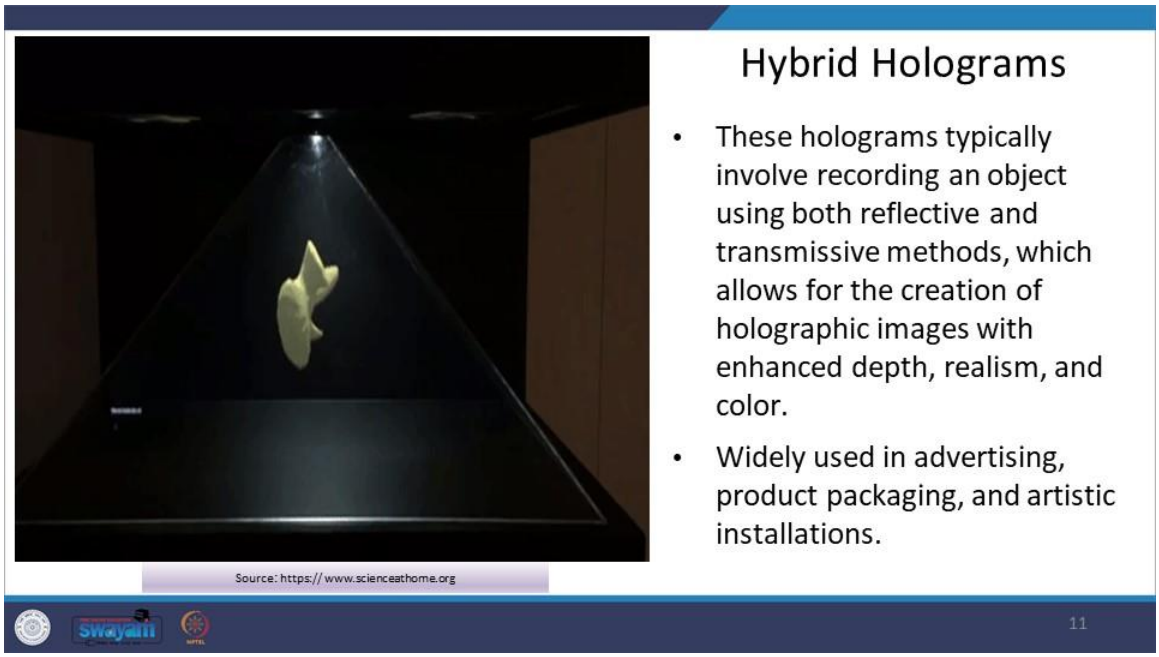
Transmission holograms are commonly used in security applications, such as banknotes and identification cards. They defect all the wavelengths of light, so it can have a rainbow presence. And this type of a hologram does not change the wavelength of light, but rather controls how light is redirected.

Rainbow transmission holograms are also known as Benton holograms, and they are a type of transmission holographic display that produces a strikingly colorful three-dimensional image.



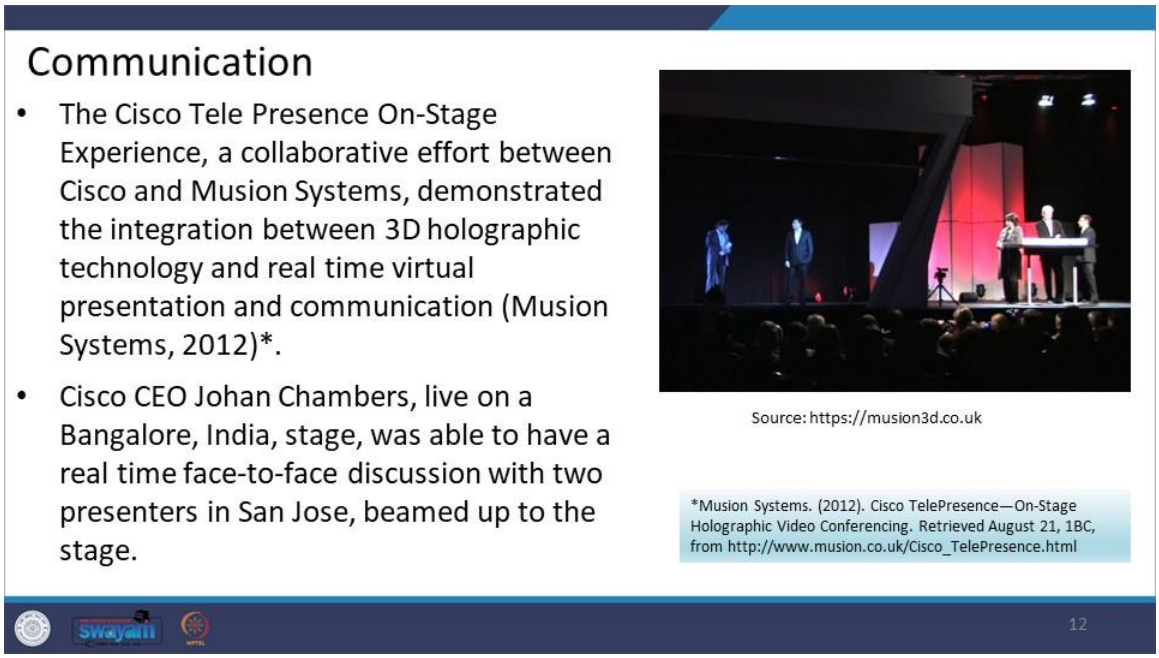
Rainbow transmission holograms are often employed in artistic and decorative applications. Another type is known as laser viewable transmission allows for a near perfect reconstruction of the optical field. It is a specialized type of holographic display that is designed to be viewed using laser light. The third variety is known as the pulsed laser holograms, which are created using pulsed laser light as the light source during the recording process. Unlike the previous types of holograms, it does not require a continuous beam of light, but rather in pulses.

And finally, hybrid holograms combine elements of both transmission and reflection holography. They offer flexibility in creating holographic effects with different viewing conditions.

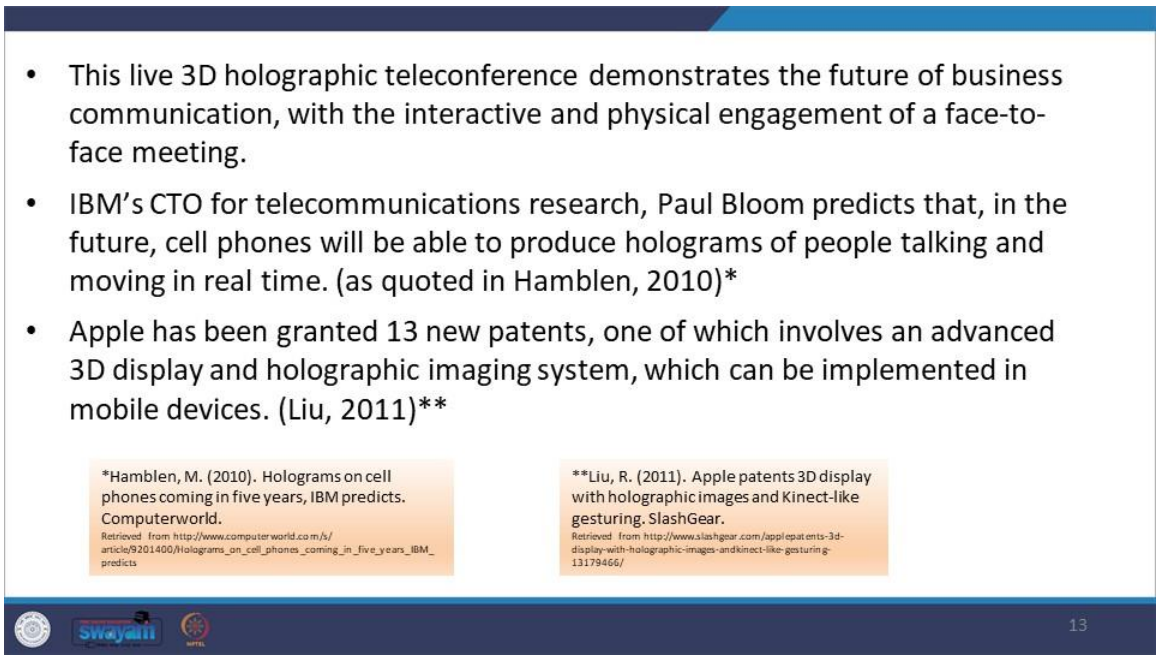


These holograms typically involve recording an object using both reflective and transmissive methods which allows for the creation of holographic images with enhanced depth, realism, and also color. It is widely used in advertising, product packaging, and artistic installations.

Let us now take a look at the significant developments in 3D holographic technology in the last couple of decades.



In the field of communication, its impact can already be realized. We can refer to the Cisco telepresence on-stage experience, which was a collaborative effort between Cisco and Museums Systems. It demonstrated the integration between 3D holographic technology and real-time virtual presentation and communication. Cisco CEO, Johan Chambers, live on a Bangalore stage, was able to have a real-time, face-to-face discussion with two presenters in Sanjos beamed up to the stage. On the right-hand side of this slide, we have a representation of this event.



This live 3D holographic teleconference demonstrates the future of business communication with the interactive and physical engagement of a face-to-face meeting. IBM CTO for telecommunications research, Paul Bloom, predicts that in the future, cell phones would also be able to produce holograms of people talking and moving in real-time. Apple has already been granted 13 new patents, one of which involves an advanced 3D display and holographic imaging system, which can be implemented in mobile devices.

Holographs have found their use in military communications as well.

Military Training

- Hologram technology finds applications in various military domains, including training and education, mission planning, intelligence analysis, virtual simulations, and augmented reality overlays.
  - The Defense Advanced Research Projects Agency completed a five-year program called "Urban Photonic Sandtable Display" that creates a real-time, color, 360-degree 3D holographic display to assist battle planners, allowing them to view a large-format, interactive 3D display without having to wear 3D glasses (DARPA, 2011).
  - In addition to its 3D holographic quality, the program allows multiples users to view and interact with the image simultaneously, assisting team-based planning.

Source: https://www.defensenews.com/digital-show-dailies/itsec/2019/12/02/whats-the-point-of-virtual-training-if-it-doesnt-feel-real-the-us-army-is-tackling-the-problem/

*DARPA (2011). DARPA Successfully Completes 3D Holographic Display Technology Demonstration Program.
Retrieved from http://www.darpa.mil/NewsEvents/Releases/2011/2011/03/24_DARPA_Successfully_Completes_3D_Holographic_Display_Technology_Demonstration_Program.aspx

In various military domains, including training and education, mission planning, intelligence analysis, virtual simulations, and augmented reality overlays, we find that the technology is already in use. The points below illustrate a program called Urban Photonics Standable Display that creates a real-time color 360-degree 3D holographic display to assist battle planners, and it also allows them to view a large-format interactive 3D display without having to wear 3D glasses. This program also allows multiple users to view and interact with the image, simultaneously assisting team-based planning.

Furthermore, in addition to the explosion of 3D animated films, the entertainment industry seems to fully embrace 3D holographic technology.

Entertainment

- In 2012, the deceased Tupac Shakur's 3D life-size and life-like moving hologram appeared on stage, performing alongside other artists.
- Alive Gallery, opened in Seoul in 2007, brings 62 world-renowned masterpieces of Western art to life, from Michelangelo to Andy Warhol, and combines "art history, technology, and imaginative—but fact-based—stories, offering a compelling multimedia cultural and entertainment experience." (Cho, 2008)*

Tupac Shakur as a hologram
Source: https://tenor.com

*Cho, J. (2008). Talking to Mona Lisa & Michaelangelo. abcNEWS. Seoul, South Korea. Retrieved from http://abcnews.go.com/International/Travel/story?id=5241276&page=1#.T5MRhO0vQrh

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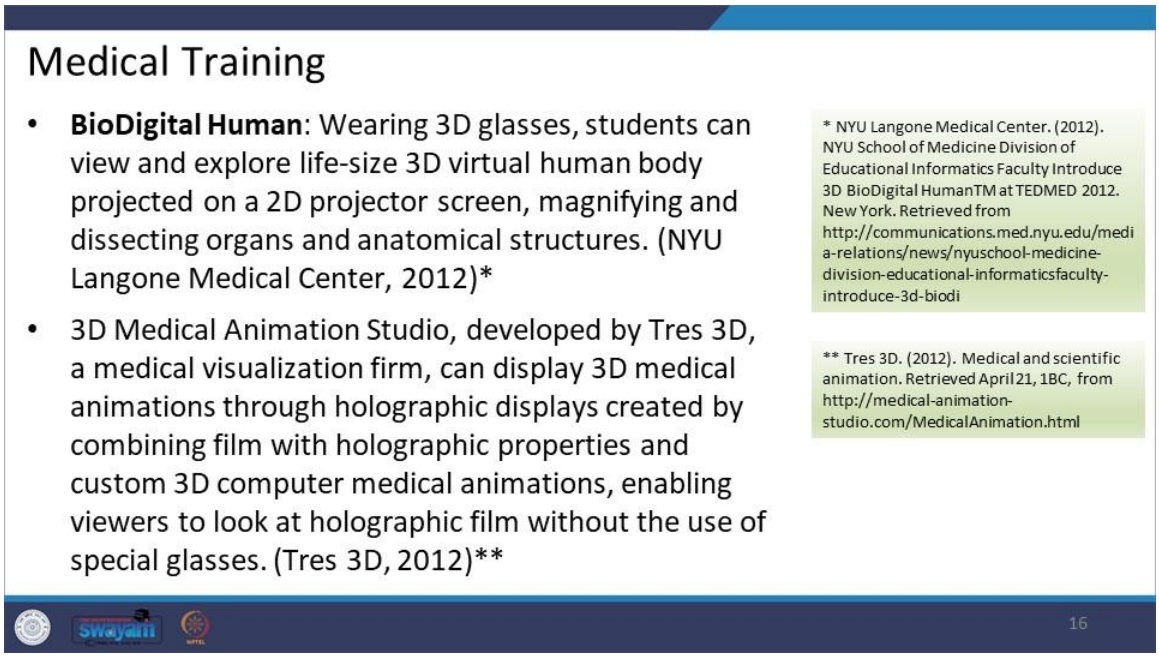
In 2012, the disease Tupac Shakur's 3D life-size and life-like moving hologram appeared on stage, performing alongside other artists. Alive Gallery opened in Seoul in 2007, brings 62 world-renowned masterpieces of Western art to life, from Michelangelo to Andy Warhol, and combines art history, technology, and imaginative, but fact-based stories offering a compelling multimedia, cultural, and entertaining experience.

Holograms revolutionized medical training by offering immersive and interactive simulations, and they enable healthcare professionals to practice procedures, anatomy, and diagnostics in a realistic risk-free environment, enhancing skill development, and also the patient care.



The slide illustrates two examples. The first is bio-digital human, where wearing 3D glasses, students can view and explore life-size 3D virtual human body, which is projected on a 2D projector screen, magnifying and dissecting organs and anatomical structures. 3D medical animation studio, which is developed by Tres 3D, a medical visualization firm, can display 3D medical animations through holographic displays created by combining film with holographic properties and custom 3D computer medical animations, enabling viewers to look at holographic film without the use of special glasses.

Another futuristic digital communication technology we shall discuss now is telepathic technology. It envisions a future where thoughts, emotions, and experiences can be shared and understood without the need for verbal or written communication.

Telepathic Technology

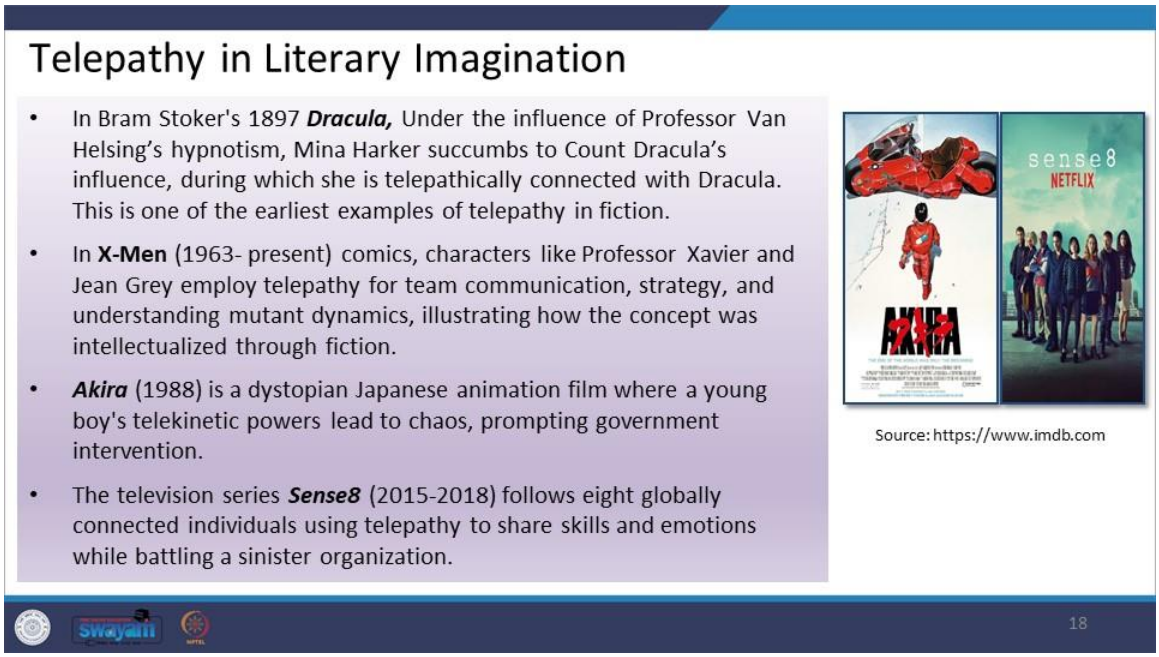
- Telepathic technology refers to the ability to transmit or communicate information directly from one mind to another, bypassing traditional sensory channels.
- It aims to facilitate direct communication by decoding and interpreting neural signals.
- It relies on advancements in neurosciences, brain-computer interfaces, and neural engineering to bridge the gap between individuals' thoughts.
- It is important to note that telepathic technology is still in its early stages of development.

Source: https://www.freepik.com

As all of us can understand by the name of this technology itself, it refers to the ability to transmit or communicate information directly from one mind to another by passing traditional sensory channels. It aims to facilitate direct communication by decoding and interpreting neural signals. It relies on advancements in neurosciences, brain-computer interfaces, and neural engineering to bridge the gap between the thoughts of different individuals. However, it is important to note that telepathic technology is still in very early stages of its development.

The current focus is on understanding the complexities of the human brain, deciphering neural patterns, and creating reliable and accurate methods for capturing and transmitting brain activity.

Telepathy, however, is a prevalent theme in fiction, also in science fiction genre. Various characters, including extraterrestrials, superheroes, and supervillains also often possess telepathic powers.



The first popular reference is available in 1897 novel Dracula by Bram Stoker. Under the influence of Professor Van Halssen's hypnotism, Mina Harker succumbs to Count Dracula's influence during which she is able to telepathically connect with Dracula. This is one of the earliest examples of telepathy in fiction.

In the 1963 to present Axeman comics, characters like Professor Xavier and Jean Grey employed telepathy for team communications, strategy planning, and understanding mutant dynamics.

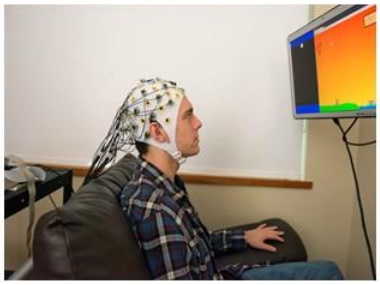
The 1988 Akira is a dystopian Japanese animation film where a young boy's telekinetic powers lead to chaos, prompting a government intervention.

The television series Sense8, which was televised between 2015 to 2018, follows eight globally connected individuals using telepathy to share skills and emotions while battling a sinister organization.

Fiction's portrayal of telepathic abilities in characters like Charles Xavier of Marvel Comics has sparked interest in real-world brain-computer interfaces and telepathic communication technology, inspiring innovation and research. This form of communication heavily relies on the use of brain-computer interfaces, popularly known as BCIs, that allow direct communication between the human brain and the external device.

Brain-Computer Interface

- A brain-computer interface (BCI), also known as a brain-machine interface (BMI) or *smartbrain*, establishes a direct communication link between the electrical activity of the brain and an external device, typically a computer or a robotic limb.
- BCIs are primarily employed for purposes such as investigating, mapping, enhancing, or restoring various human cognitive or sensory-motor functions. (Krucoff et al., 2016)*



Source: https://www.vox.com

*Krucoff, Max O et al. "Enhancing Nervous System Recovery through Neurobiologics, Neural Interface Training, and Neurorehabilitation." Frontiers in neuroscience vol. 10 584. 27 Dec. 2016.

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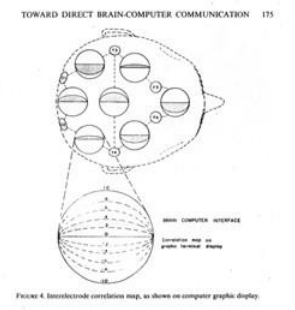
BCI is also known as a brain-machine interface or BMI or a smart brain. It establishes a direct connection link between the electrical activity of the brain and an external device, typically a computer or a robotic limb. BCIs are primarily being employed for purposes such as investigating, mapping, enhancing, or restoring various human cognitive or sensory motor functions.

BCIs have emerged from decades of research at the intersection of neuroscience and engineering. They originated as a means to restore communication and mobility for individuals with severe disabilities, eventually evolving into a field with broad implications for both medical as well as non-medical applications.

Background

- In the 1970s, Jacques Vidal initiated research on BCIs at the University of California, Los Angeles (UCLA), with initial funding from the National Science Foundation and subsequent support from Defense Advanced Research Projects Agency (DARPA).
- The term "brain-computer interface" made its debut in scientific literature in Vidal's 1973 paper titled “Toward direct brain-computer communication”*.



Source: https://historyofinformation.com

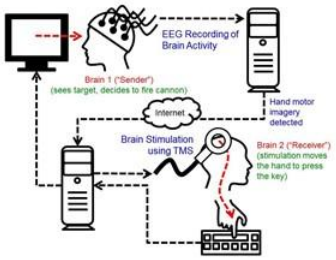
*Vidal, Jacques J. "Toward direct brain-computer communication." Annual review of Biophysics and Bioengineering 2.1 (1973): 157-180.

Such research was initiated in the 1970s. The primary name which we can refer to in this context is Jix Vidal of the University of California. The term brain-computer interface was used for the first time in scientific literature in Jix Vidal's 1973 paper.

By decoding and transmitting brain signals, BCIs hold the potential to revolutionize communication by bridging minds across distances.

How BCIs are used in Telepathic Technology

- BCIs establish a direct communication pathway between the brain and an external device or computer system.
- They record, analyze, and interpret brain signals to facilitate control, communication, or feedback.
- BCIs can utilize various methods for signal acquisition, such as electroencephalography (EEG), invasive neural implants, or functional magnetic resonance imaging (fMRI).
- Signal processing algorithms and machine learning techniques are employed to decode and translate brain signals into meaningful commands or outputs. (Bird et al., 2018)*

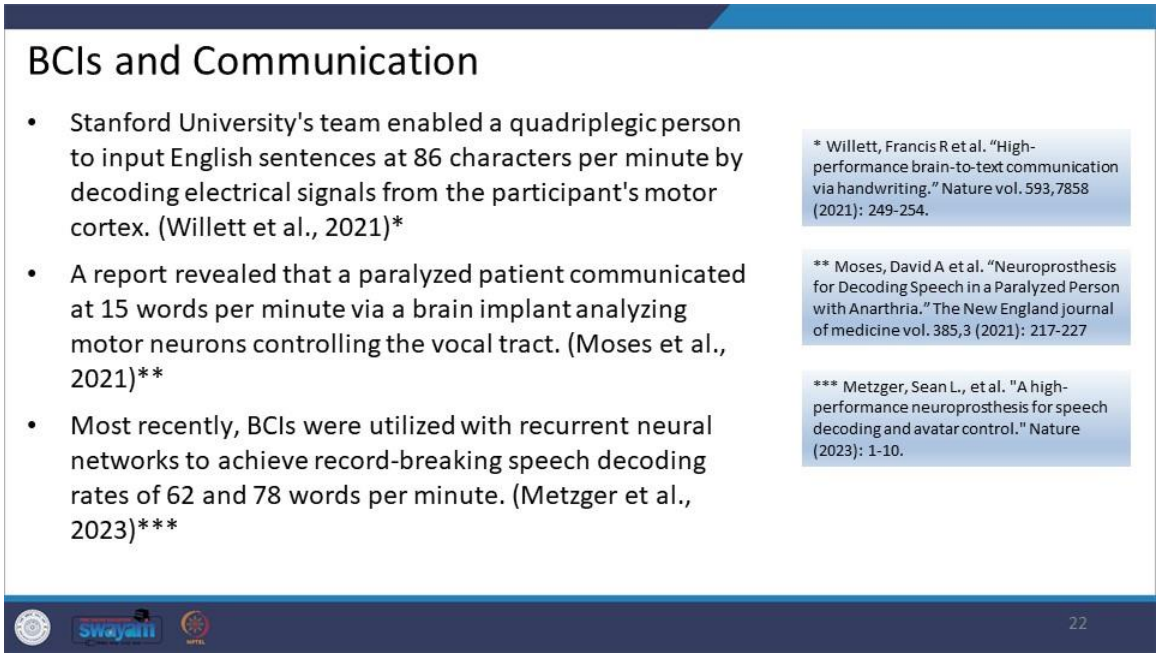


Source: https://www.vox.com

*Bird, Jordan J., et al. "A study on mental state classification using eeg-based brain-machine interface." 2018 international conference on intelligent systems (IS). IEEE, 2018.

BCIs establish a direct communication pathway between the brain and an external device or a computer system. They record, analyze, and interpret brain signals to facilitate controlled communication or feedback. And they can utilize various methods for acquiring the signal such as EEG, Invasive Neural Implants, or fMRI, that is Functional Magnetic Resonance Imaging. Signal processing algorithms and machine learning techniques are employed to decode and translate brain signals into meaningful commands or outputs.

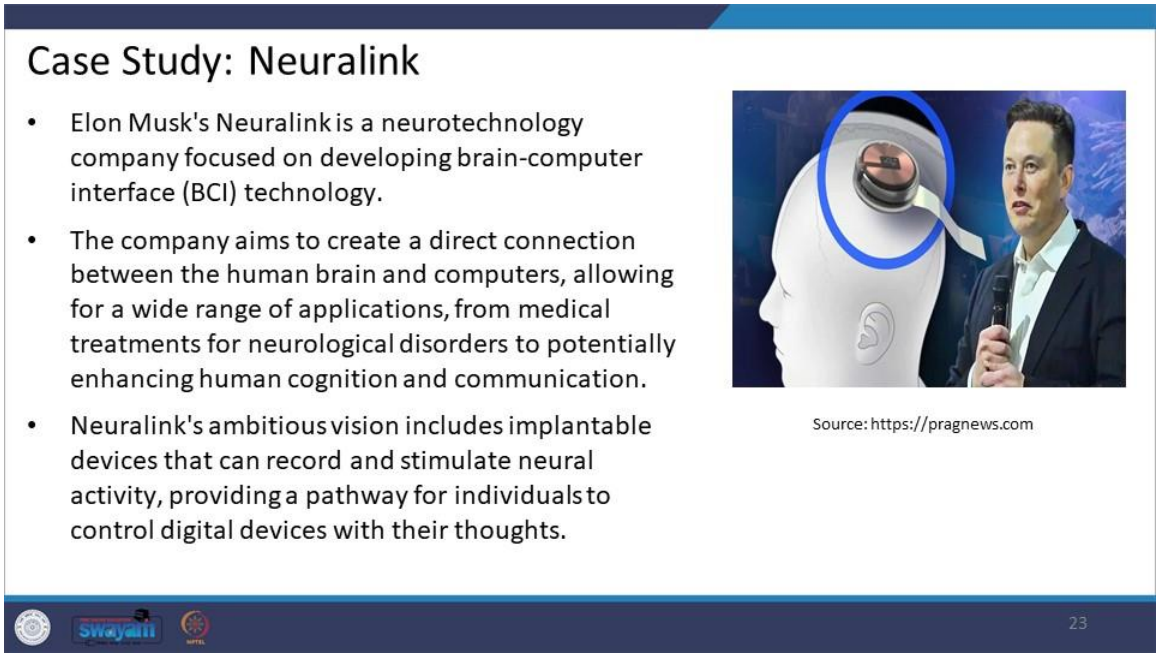
Cutting edge research in BCIs is expanding the frontiers of communication by harnessing neural signals. It promises breakthroughs in accessibility, human-machine interaction, and even restorative communication for severe disabilities.



Certain examples of such breakthrough communicative technologies are illustrated here. They are primarily from the field of medical advancement, but very soon we find that such implications would also be available in business and professional fields of communication. The first example is that of a Stanford University's team, which enabled a quadriplegic person to input English sentences at 86 characters per minute by decoding electrical signals from the participant's motor cortex. A report revealed that a paralyzed patient communicated at 15 words per minute via a brain implant, analyzing motor neurons controlling the vocal tract. And most recently, BCIs were utilized with recurrent neural networks to achieve record-breaking speech decoding rates of 62 and 78 words per minute.

A great example of this application is Neuralink, which is a pioneering neurotechnology company founded by entrepreneur and tech visionary Elon Musk. It represents a

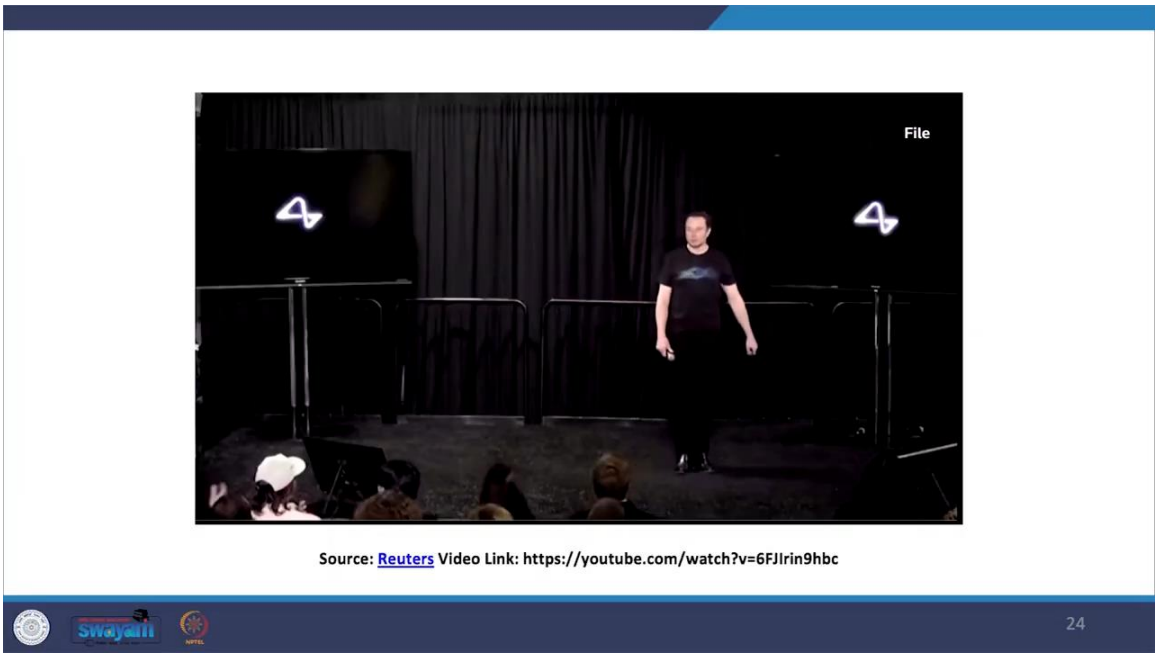
groundbreaking effort to bridge the gap between the human brain and the artificial intelligence or the AI through the development of advanced BCI technology.



Musk's company Neuralink aims to create a direct connection between the human brain and computers, allowing for a wide range of applications from medical treatments for neurological disorders to potentially enhancing human cognition and communication. Neuralink's ambitious vision includes implantable devices that can record and stimulate neural activity providing a pathway for individuals to control digital devices only with the help of their thoughts.

While the technology is still in its very early stages, Neuralink has generated significant interest and investment, raising questions about the ethical and societal implications of merging the human brain with artificial intelligence.

Let us look at a video that talks about the latest developments in Neuralink's endeavors.

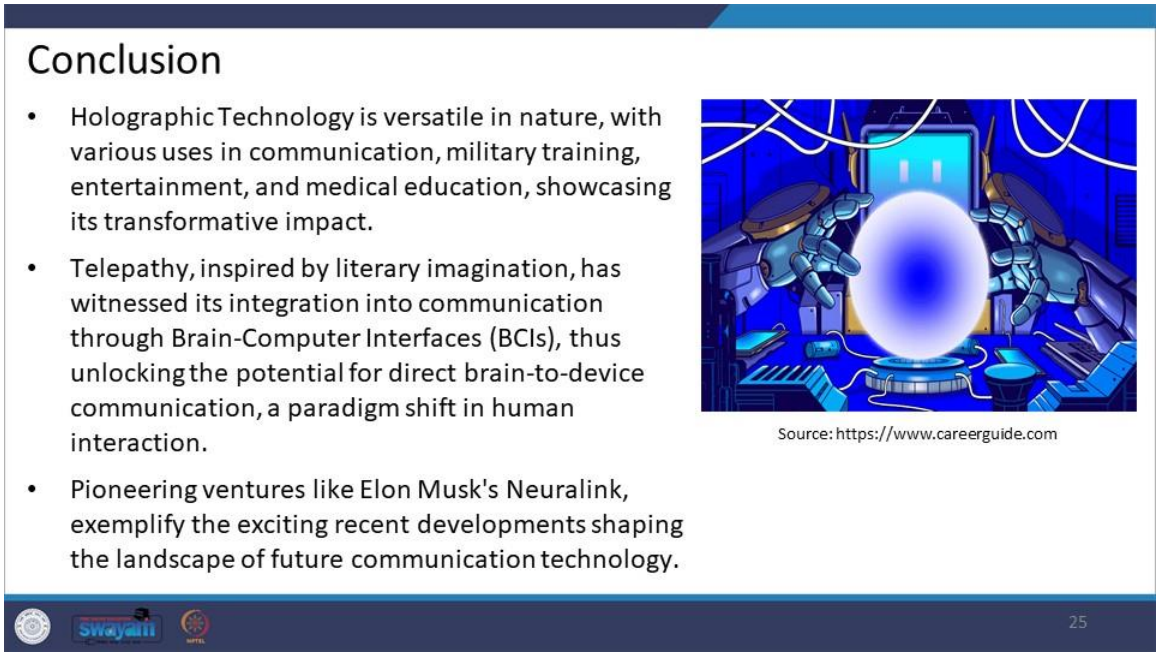


Elon Musk's brain implant company Neuralink said on Thursday it had been given a green light from the US FDA to kick-start its first in-human clinical study. It's a critical milestone for Neuralink after earlier struggles to gain approval. We're confident that it is possible to restore full-body functionality. On at least four occasions since 2019, Musk has said his medical device company would begin human trials for brain implant to treat severe conditions such as paralysis and blindness.

Yet the company only sought Food and Drug Administration approval in early 2022, and the agency rejected the application, sources linked to the company told Reuters in March. The sources said the FDA had pointed out several concerns to Neuralink that needed to be addressed before sanctioning human trials. They include the device's battery as well as safety issues surrounding its wires and the protection of brain tissue. Thursday's FDA approval comes as US lawmakers are urging regulators to investigate the oversight of animal testing at Neuralink. The company has already been the subject of federal probes, including at least one linked to animal testing and treatment.

In a tweet on Thursday, Neuralink said it was excited to share the news of the approval, but that it's not yet recruiting for a clinical trial. Over the years, Musk has publicly outlined an ambitious plan for Neuralink. He envisions its devices to cure a range of conditions from obesity, autism, depression, schizophrenia, to enabling web browsing and even telepathy. And that both disabled and healthy individuals would be swiftly getting surgical implants at local centres. Neuralink and the FDA did not immediately respond to a Reuters request for comment.

Neuralink's FDA approval for its human clinical study in Musk's ambitious vision for brain implants. The video has talked about the latest development in Neuralink's endeavours. The future of online communication is thus an exciting and rapidly evolving landscape. We have explored some aspects of it today.



Holographic technology is versatile in nature as we have seen with various uses in communication and other aspects like military training, entertainment, medical education, etc. It has a transformative impact on the manner in which we interact for different professional needs. Telepathy, which is inspired by literary imagination, has witnessed its gradual integration into communication through BCIs, thus unlocking the potential for direct brain-to-device communication, which would be a paradigm shift in human interaction. Pioneering ventures like Musk's Neuralink exemplify this exciting recent development shaping the landscape of future communication technology.

These innovations promise to make communication more immersive, efficient and accessible than ever before. The future will undoubtedly be marked by greater connectivity, innovative platforms and novel ways to interact bridging geographical distances and enhancing human connections.

Thank you.