UNIT-IV

What is Virtual Reality?

- VR enhances the user experience to the next level via VR headsets or other VR devices like Oculus quest 2, Hp reverb G2, etc.

- VR is a self-controlled environment where the user can control the simulated environment via a system.

- VR enhances a fictional environment by using sensors, displays, and other features like motion tracking, Movement tracking, etc.

VR stands for Virtual Reality, where users immerse themselves in a specifically designed /simulated environment for a specific purpose. For example, medical training, games, etc., which are explored without borders and boundaries in 360 degrees. VR creates a virtual, simulated environment where people interact in simulated environments using VR goggles or other devices. This tutorial on "What is Virtual Reality" will extend your boundaries to explore the world of <u>AR, VR, and AI</u> where the future ahead is!

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Types of Virtual Reality

Virtual reality has evolved into several types, each with its own unique features and applications. The following are some of the most innovative types of virtual reality that have a significant impact on the present and will shape the future:

- Non-Immersive Virtual Reality

Non-immersive virtual reality is a computer-based virtual experience in which you can control some characters or activities within the software. Still, the environment does not interact with you directly. Aside from desktop computers, you may also locate a powerful

laptop for virtual machines and on-the-go work. Because customers value mobility more and more, manufacturers design powerful systems in small packages.

For example, when you play video games like World of Warcraft, you may control characters within the game with their own movements and qualities. Technically, you interact with a virtual environment but are not the game's focus. All actions or features interact with the characters included therein.

- Fully Immersive Virtual Reality

Unlike non-immersive virtual reality, fully immersive virtual reality guarantees a realistic experience within the virtual environment. It will give you the impression that you are in that virtual environment and that everything is happening to you in real-time. This is a costly virtual reality type requiring helmets, gloves, and body connections equipped with sense detectors. These are linked to a high-powered computer.

The virtual environment detects and projects your emotions, reactions, and even a blink of an eye. You will feel as though you are in the virtual world. There is one example of this where you will be outfitted in a tiny room with the necessary hardware so you can play a virtual shooter game.

- Semi-Immersive Virtual Reality

A semi-immersive virtual reality experience combines fully immersive and non-immersive virtual reality. With a computer screen or VR box/headset, you can walk around an independent 3D area or virtual world. As a result, all actions in the virtual world are focused on you. Other than your visual perception, you have no true physical motions. On a computer, you can navigate the virtual area using the mouse, and on mobile devices, you can move around with your finger and swipe.

- Collaborative VR

Collaborative virtual reality is a type of virtual world where people in different places can talk to each other using avatars or 3D characters. It lets multiple users be in the same virtual environment at the same time, talk to each other, and work together on different tasks.

- Augmented Reality

Augmented reality (AR) refers to a technology that combines real-world environments with computer-generated content. It allows users to interact with virtual objects in a real-world environment.

- Mixed Reality

Mixed reality (MR) is a technology that creates a new environment by combining real and virtual things. It allows virtual objects to interact with the real world, creating a seamless experience.

What is the Need for Virtual Reality?

- Virtual reality allows users to create simulated, interactive, and specifically designed environments for specific use.

- It is designed for human interaction or for a specific reason to create experiences.

- Unlike other reality technologies like AR and MR, VR enhances the user experience to the next level with its fully immersive and interactive technology.

What Technology Does Virtual Reality Use?

VR technology often comprises headgear and peripherals such as controllers and motion trackers. The technology is available through a web browser and is powered by proprietary downloaded apps or web-based VR. Sensory peripherals like controllers, headphones, hand trackers, treadmills, and 3D cameras are all part of virtual reality hardware.

There are two main types of VR devices:

- Standalone - devices with all the components required to offer virtual reality experiences in the headset. Oculus Mobile SDK, produced by Oculus VR for its standalone headsets, and the Samsung Gear VR are two popular standalone VR platforms. (The SDK has been deprecated in favour of OpenXR, which will be available in July 2021.)

- Tethered - headsets that connect to another device, such as a PC or video game console, to deliver a virtual reality experience. SteamVR, part of Valve's Steam service, is a popular tethered VR platform. To support headsets from different vendors, such as HTC, Windows Mixed Reality headset manufacturers, and Valve, the SteamVR platform employs the OpenVR SDK.

VR Accessories

VR Covers

Sweating may cause skin discomfort if you use your VR headset for an extended time. In such instances, VR coverings can be a terrific way to protect your skin when playing high-intensity games like Population One, Beat Saber, or FitXR.

VR Gloves

One of the benefits of VR gloves is that they create a genuine tactile feel, making the experience more engaging and lifelike. Although a few VR gloves are on the market, most are aimed at businesses. However, there are a few that customers may utilise.

Tracker for The Entire Body

The Full Body Tracker, like VR Gloves, delivers a high degree of immersion and engagement. Although most full-body VR trackers are marketed as a training tool, there are a few low-cost solutions if you want to fully immerse yourself in the virtual world and experience an adrenaline rush.

VR Lenses

They protect the lens of your headset from small scratches and fingerprints while also filtering out harmful light to alleviate eye strain. The lens guard is simple to instal. For a secure fit, place the VR lens over each of your VR headset lenses.

Motion Controllers

These add-ons enable users to interact with mixed reality. Because controllers have a specific position in space, they enable fine-grained interaction with digital objects.

Omnidirectional Treadmills (ODTs)

This auxiliary equipment allows users to move physically in any direction. ODTs allow users to move freely in VR surroundings, providing a completely immersive experience.

Features of VR

The Virtual World

A fictional space that exists apart from the real world. Of course, the medium employed to construct this area is a simulation comprised of visual components generated with computer graphics. The creator's rules establish the relationships and interactions between these pieces.

Immersion

The users are put in a virtual area that is physically separated from the actual world. VR headsets do this by filling the entire field of view, whilst headphones accomplish the same outcomes with sounds, immersing users in another universe.

Sensory Input

VR headsets track users' location inside a specific environment, allowing the computer to depict changes in position. Users who move their heads or bodies will feel they are moving in the virtual environment. The input is as near to reality as possible; to move around, users do not touch a button but rather move about.

Interactivity

Simulated worlds must have virtual components with which to interact, such as picking up and dropping items, swinging swords to kill goblins, smashing mugs, and pressing buttons on planes.

Applications of Virtual Reality

1. VR creates opportunities to conduct activities virtually, for example creating virtual excursions or field trips towards education.

2. Virtual reality has a huge influence on the Healthcare industry. The FDA authorised the prescription-use EaseVRx for pain reduction in adults in November 2021. Cognitive behavioral therapy as well as other behavioural concepts like attention-shifting, interoceptive awareness, and deep relaxation are used in this system to aid in decreasing chronic pain.

3. VR for tourism advances have enabled people to check out vacations before they buy them in the post-Covid age. Thomas Cook debuted their 'Try Before You Fly' VR experience in 2015, where potential vacationers may visit stores in different locations to experience the vacation in VR before booking it. Consequently, once customers sampled the 5-minute VR version of the trip, there was a 190% increase in New York excursion bookings.

4. In entertainment, Realtime experience of fictional characters or sci-fi movies, animations, and motions can be experienced by all using VR.

5. Prototyping helps the automotive industry avoid multiple designs and reduce resources by creating virtual designs using VR.

6. In terms of Defense, VR helps our brave men experience the battlefield environments in real-time to avoid unconditional situations in Reality.

Advantages and Disadvantages of VR

Virtual Reality (VR) technology has its advantages and disadvantages. On the one hand, VR has made it possible to achieve impossible goals that might not be possible in the real world. On the other hand, current VR systems have limited functionality compared to what is possible in the real world. Let's take a closer look at the advantages and disadvantages of VR.

Advantages

- *Enhanced Customer Engagement*

Virtual reality gives customers a realistic 3D product experience that lets them see all the features and decide which ones are best for them. This immersive experience enhances customer engagement and fosters brand loyalty.

- *Improved Customer Retention*

Brands that offer VR-enabled technology stand out from those that engage in push marketing tactics. VR creates a lasting impression, improving customer retention rates and boosting the brand's reputation.

- *Streamlined Product Designs*

With virtual reality software, designers can mix and match different design elements in a virtual space to figure out which vector goes where. This helps streamline product designs and reduces the time taken for prototyping.

- *Optimized Return on Investment (ROI)*

Although implementing VR can take some time, it can significantly optimize every value chain. This leads to a steady flow of customers and deals, leading to an increased ROI.

- *Reduced Costs*

In a virtual world, virtual reality can get rid of the need for expensive training methods like bringing new employees on board, evaluating their performance, and holding appraisal meetings. This cost-effective approach helps companies save time and resources.

- *Remote Connectivity*

VR headsets can map different environments in space, which lets people connect and work together in a virtual world. This feature is particularly useful for remote teams that work together but are physically located in different parts of the world.

Disadvantages

- *High Cost*

The cost of exploring virtual reality can be expensive, as VR equipment can be costly, making it less accessible to some people. This can be a significant disadvantage of VR, particularly for small businesses and individuals.

- *Compatibility Issues with Advancing Technology*

VR gear might not work on all devices and operating systems, which limits who can use it. Also, VR equipment needs powerful computers or other special hardware to work, which can make it hard to get.

- *Limited Content Availability*

VR content is hard to make because it takes special skills and money to produce. This means that there isn't much VR content out there. This can make it hard for VR users to find a lot of different things to do, which is one of the biggest problems with this technology.

- *Health Concerns*

Some VR experiences might cause motion sickness or other physical discomforts. Long-term use of VR equipment can also hurt your eyesight and sense of balance, which can be scary.

- *Negative Effects of Isolation and Dependence on VR*

VR can be a lonely experience, especially if the person using the equipment shuts them off from the real world. Using VR too much to avoid reality can lead to social isolation and other bad things.

What is the Difference Between VR and AR?

Factors	VR	AR
Virtuality	VR is completely virtual	AR uses a real-world entity to enhance digital content
Control	VR users are controlled by the system	AR users can control their presence in real world
Compatibility	VR requires compatible devices like a headset device	AR needs no specific device
Environment	VR only enhances a fictional reality	AR enhances both virtual and real-world entities
Freedom	VR is composed of cables and can be inaccessible over a specified distance.	AR is free from cables and free to move without any hindrances like distance.

Future of Virtual Reality

As VR is in its early stage or towards its second generation in its advancement future of VR lies on

- Developing virtual reality headsets which can support up to 8K with much more powerful processors.

- Integration of Artificial Intelligence in VR.

- 5G can also provide interesting scenarios for the evolution of VR.

- Virtual shopping in a 3D view

- Better geo-location system via indoor mapping etc.

Grid Computing

Grid Computing comes under the evolution of cloud computing which includes all the nodes that are located in different locations. It has heterogeneous nodes that are located in a different company. Some nodes are set ideal and these nodes can be combined to perform any one task. It is highly preferable to perform complex activities as there are many computers or nodes involved in the same network.

Features of Grid Computing

The reason behind the usage of grid computing is −

- **Reduced Cost** − A separate setup for grid computing is not needed and it can be installed in the existing computers. For data storage purposes cloud services can be used.
- **Efficiency** − When a large task is given, it can be broken down into pieces and each small task can be assigned to each node thus making the process faster and more efficient.
- **Flexible** − Its function is not limited to the building or a region, the computers can be implemented anywhere around the world and can be accessed through the network.

Applications of Grid Computing

- **Computational Biology** − Using grid computing, we can create a model of the human brain and also use it for mapping human genomes.
- **Cost of Applications** − After the introduction of grid computing, it greatly decreased the cost of applications that are used to design a model in the Field of Engineering.
- **Resource Sharing** − When an institute needs a central hub with the resources and is capable of sharing with the persons, then grid computing can be used that act like a single virtual organization.

- **Movie Industry** − It is particularly used by the production of the movie industry, to add the effects to the scenes and helps in producing the movie faster.

Working of Grid Computing

The computer or node raises a request for the resources and then the control node will be used to provide access to the users to choose the resources in the network. The node can be in user mode when resources are available or switch to provider mode when the resources are not available. The tasks are performed in grid computing using the three primary grid nodes namely,

User node

The user node or the computer requests for the need of resources and then gets them from other nodes of the computer. It simply uses the resources available in the network.

Provider node

It is a node or computer that shares its resources with the user nodes based on the request. When a request is received from the user node, some sort of task is performed by the nodes like forecasting the stocks needed in the future.

Control node

It is a computer with a server or group of servers that serve as an administrator and manages both the user and provider node.

Types of Grid Computing

Based on the performance, grid computing is divided into three major categories,

1. Computational grid

This type of grid computing is highly powerful and extensively used by researchers for their research purpose. Because highly powerful computers can be combined to perform any task at high speed and with accuracy.

2. Scavenging Grid

This grid helps search the resources that are available in the network and is also known as CPU scavenging.

3. Data Grid

The nodes or computer's structure can be resized and to deal with large data, multiple computers can be attached according to the need. When the user is on the local machine, the data can be accessed at any time.

Advantages of Grid Computing

- It does not deal with central servers but rather only the control node which will switch the nodes between the user and provider node based on the resources.
- The System with different operating systems and located anywhere can also use grid computing using the heterogeneous nodes.
- The Cost of installation and usage is zero and allows the concurrent performance of tasks.

Disadvantages of Grid Computing

- Grid computing is one of the evolution steps of cloud computing and it still needs some update.
- As multiple computers in different places can be used, there will be licensing issues for the software.
- The Control node can sometimes behave abnormally and pushes the entire network down.

Green Computing

The objectives of green computing are comparable to those of chemical synthesis: decrease the use of dangerous chemicals, maximize energy efficiency throughout the product's lifecycle. The maximize recyclability or biodegradability of obsolete manufacturing and production garbage. Green computing is critical for all systems, from personal computers to large-scale information centers. Underneath the idea of "Green Computing" has also defined its role in helping to save the ecosystem. Green computing uses machines and their assets in an environmentally conscious and eco-friendly manner. In a general context, it's the research of how to build, develop, manufacture, use, and dispose of computing systems in a way that has a minimal environmental impact. Green Computing, also called *Green Technology* or *Green IT,* has rapidly risen to technology acceptance rankings.

What are the Environmental Benefits of Green Computing?

In its most primitive sense, Green Computing reduces technology's environmental effects. This entails conserving energy, minimizing losses, and fostering long-term viability. Green computing aims to lower the carbon emissions of the Information Systems and Systems industry and its connected businesses. Green computing includes two primary techniques: Energy efficiency and Electronic-waste. Reduced resource usage and energy efficiency (CPUs), servers, and peripherals are all energy efficient. The correct dumping of electronic trash is known as e-waste.

Strategies of Green Computing

A green computing program must address these aspects because an advanced IT system depends on diverse races, connections, and technology. When developing a solution, end-user experience, leadership reorganization, regulatory requirements, and investment return (ROI) may be factors to consider. There are also significant financial incentives for businesses to seize command of their own energy usage. Of the several power control techniques available, one of the most effective may still be basic, plain idiotic.

1. Durability of Substance

According to Gartner, the PC production method consumes 70% of the natural resources needed during the PC's entire lifecycle. Fujitsu recently published a (lifecycle assessment) LCA of a computer that revealed that production and finished account for most of the desktop's environmental footprint. As a result, the major influence on green computing generally extends the tool's life. "Consider for product lifespan, emphasizing expandability and adaptability," according to another Gartner research. Producing a new PC, for example, has a much larger environmental impact than producing a new RAM component to improve an older one.

2. Designing a Datacenter

Datacenter infrastructures are power guzzlers, contributing between 1.1 and 1.5 percent of total global energy consumption in 2010. Datacenter infrastructures, according to the US Department of Energy, use 100 to 200 times more powerful than ordinary commercial properties.

From the IT infrastructure to the heating, ventilation, and air conditioning (HVAC) equipment to the precise destination, layout, and construction phase, an efficient information center design should handle all of the power use issues contained in a data center.

The US Department of Energy has identified five major sectors where power-efficient information center architecture best practices should be focused:

- Networks of information technology (IT)
- Situational circumstances
- Air quality control
- Refrigeration systems
- Systems involving electricity

On-site power production and thermal exhaust reuse are two more energy-efficient design options recommended by the US Ministry of Power. Datacenter architecture that is power efficient should help to effectively utilize a data center's area while also increasing productivity and effectiveness.

Three new US patents issued in 2018 make utilization of facility designs that employ internal and external excess heat to refrigerate and generate electrical energy concurrently. The three designs use a silo structure to encourage the utilization of excess internal heat while chilling the silo's computing units using recirculated air.

3. Optimization of Equipment and Distribution

o **Effectiveness of algorithms:** The quantity of desktop resources needed for any particular computing function is affected by technique performance, and there are various efficiency trade-offs when creating programs. Moving from a slower (e.g., linear) search method to a rapid (e.g., hashed or indexed) search algorithm can minimize resource utilization for a particular activity from significant to near-zero. According to a Harvard physicist's research from 2009, the average Google search emits 7 grams of carbon dioxide (CO_2). On the other hand, Google contested this statistic, claiming that an average search created only 0.2 grams of CO_2.

o **Allocation of the resources:** Information can also be sent to information centers with lower power costs using algorithms. Experts from MIT, Carnegie Mellon University, and Akamai have thoroughly tested a power algorithm that calculates site traffic with the lowest energy expenditures. The experts calculated that energy expenses would be cut by 40% if their proposed methodology is implemented. This strategy, however, does not truly decrease the amount of energy utilized; rather, it decreases the price to the corporation that uses it. However, an equivalent method may be used to manage traffic to use the power that is more ecologically friendly or effective. A similar strategy has been used to reduce power consumption by diverting traffic away from network infrastructure that is suffering hot weather, allowing systems to be turned down and cooling systems to be avoided. Huge server centers are occasionally built-in areas where electricity and area are cheap and plentiful. Local renewable power sources could influence green location options. This temperature permits external air to be used for refrigeration or situating them where the heating they create can be used for other reasons. Strategies to substantially reduce network device power usage through appropriate system management methods are examined. The study classifies the techniques into four main tactics, which are as follows:

  i. Adaptive Link Rate (ALR)

  ii. Interface Proxying

  iii. Energy-Conscious Infrastructure

  iv. Maximum Energy-Conscious Applications

  v. Vrtualizing

What is Big Data Analytics?

Big Data analytics is a process used to extract meaningful insights, such as hidden patterns, unknown correlations, market trends, and customer preferences. Big Data analytics provides various advantages—it can be used for better decision making, preventing fraudulent activities, among other things.

What is Big Data?

Big Data is a massive amount of data sets that cannot be stored, processed, or analyzed using traditional tools.

Today, there are millions of data sources that generate data at a very rapid rate. These data sources are present across the world. Some of the largest sources of data are social media platforms and networks. Let's use Facebook as an example—it generates more than 500 terabytes of data every day. This data includes pictures, videos, messages, and more.

Uses and Examples of Big Data Analytics

There are many different ways that Big Data analytics can be used in order to improve businesses and organizations. Here are some examples:

- Using analytics to understand customer behavior in order to optimize the customer experience

- Predicting future trends in order to make better business decisions

- Improving marketing campaigns by understanding what works and what doesn't

- Increasing operational efficiency by understanding where bottlenecks are and how to fix them

- Detecting fraud and other forms of misuse sooner

Benefits and Advantages of Big Data Analytics

1. Risk Management

Use Case: Banco de Oro, a Phillippine banking company, uses Big Data analytics to identify fraudulent activities and discrepancies. The organization leverages it to narrow down a list of suspects or root causes of problems.

2. Product Development and Innovations

Use Case: Rolls-Royce, one of the largest manufacturers of jet engines for airlines and armed forces across the globe, uses Big Data analytics to analyze how efficient the engine designs are and if there is any need for improvements.

3. Quicker and Better Decision Making Within Organizations

Use Case: Starbucks uses Big Data analytics to make strategic decisions. For example, the company leverages it to decide if a particular location would be suitable for a new outlet or not. They will analyze several different factors, such as population, demographics, accessibility of the location, and more.

4. Improve Customer Experience

Use Case: Delta Air Lines uses Big Data analysis to improve customer experiences. They monitor tweets to find out their customers' experience regarding their journeys, delays, and so on. The airline identifies negative tweets and does what's necessary to remedy the situation. By publicly addressing these issues and offering solutions, it helps the airline build good customer relations

The Lifecycle Phases of Big Data Analytics

Now, let's review how Big Data analytics works:

- Stage 1 - Business case evaluation - The Big Data analytics lifecycle begins with a business case, which defines the reason and goal behind the analysis.

- Stage 2 - Identification of data - Here, a broad variety of data sources are identified.

- Stage 3 - Data filtering - All of the identified data from the previous stage is filtered here to remove corrupt data.

- Stage 4 - Data extraction - Data that is not compatible with the tool is extracted and then transformed into a compatible form.

- Stage 5 - Data aggregation - In this stage, data with the same fields across different datasets are integrated.

- Stage 6 - Data analysis - Data is evaluated using analytical and statistical tools to discover useful information.

- Stage 7 - Visualization of data - With tools like Tableau, Power BI, and QlikView, Big Data analysts can produce graphic visualizations of the analysis.

- Stage 8 - Final analysis result - This is the last step of the Big Data analytics lifecycle, where the final results of the analysis are made available to business stakeholders who will take action

Different Types of Big Data Analytics

Here are the four types of Big Data analytics:

1. Descriptive Analytics

This summarizes past data into a form that people can easily read. This helps in creating reports, like a company's revenue, profit, sales, and so on. Also, it helps in the tabulation of social media metrics.

Use Case: The Dow Chemical Company analyzed its past data to increase facility utilization across its office and lab space. Using descriptive analytics, Dow was able to identify underutilized space. This space consolidation helped the company save nearly US $4 million annually.

2. Diagnostic Analytics

This is done to understand what caused a problem in the first place. Techniques like drill-down, data mining, and data recovery are all examples. Organizations use diagnostic analytics because they provide an in-depth insight into a particular problem.

Use Case: An e-commerce company's report shows that their sales have gone down, although customers are adding products to their carts. This can be due to various reasons like the form didn't load correctly, the shipping fee is too high, or there are not enough payment options available. This is where you can use diagnostic analytics to find the reason.

3. Predictive Analytics

This type of analytics looks into the historical and present data to make predictions of the future. Predictive analytics uses data mining, AI, and machine learning to analyze current data and make predictions about the future. It works on predicting customer trends, market

trends, and so on.

Use Case: PayPal determines what kind of precautions they have to take to protect their clients against fraudulent transactions. Using predictive analytics, the company uses all the historical payment data and user behavior data and builds an algorithm that predicts fraudulent activities.

4. Prescriptive Analytics

This type of analytics prescribes the solution to a particular problem. Perspective analytics works with both descriptive and predictive analytics. Most of the time, it relies on AI and machine learning.

Big Data Analytics Tools

Here are some of the key big data analytics tools :

- Hadoop - helps in storing and analyzing data

- MongoDB - used on datasets that change frequently

- Talend - used for data integration and management

- Cassandra - a distributed database used to handle chunks of data

- Spark - used for real-time processing and analyzing large amounts of data

- STORM - an open-source real-time computational system

- Kafka - a distributed streaming platform that is used for fault-tolerant storage

Big Data Industry Applications

Here are some of the sectors where Big Data is actively used:

- Ecommerce - Predicting customer trends and optimizing prices are a few of the ways e-commerce uses Big Data analytics

- Marketing - Big Data analytics helps to drive high ROI marketing campaigns, which result in improved sales

- Education - Used to develop new and improve existing courses based on market requirements

- Healthcare - With the help of a patient's medical history, Big Data analytics is used to predict how likely they are to have health issues

- Media and entertainment - Used to understand the demand of shows, movies, songs, and more to deliver a personalized recommendation list to its users

- Banking - Customer income and spending patterns help to predict the likelihood of choosing various banking offers, like loans and credit cards

- Telecommunications - Used to forecast network capacity and improve customer experience

- Government - Big Data analytics helps governments in law enforcement, among other things

What Is Quantum Computing?

Quantum computing is an area of computer science that uses the principles of quantum theory. Quantum theory explains the behavior of energy and material on the atomic and subatomic levels.

Quantum computing uses subatomic particles, such as electrons or photons. Quantum bits, or qubits, allow these particles to exist in more than one state (i.e., 1 and 0) at the same time.

KEY TAKEAWAYS

- Quantum computing uses phenomena in quantum physics to create new ways of computing.
- Quantum computing involves qubits.
- Unlike a normal computer bit, which can be either 0 or 1, a qubit can exist in a multidimensional state.
- The power of quantum computers grows exponentially with more qubits.
- Classical computers that add more bits can increase power only linearly.

Uses and Benefits of Quantum Computing

Quantum computing could contribute greatly to the fields of security, finance, military affairs and intelligence, drug design and discovery, aerospace designing, utilities (nuclear fusion), polymer design, machine learning, artificial intelligence (AI), Big Data search, and digital manufacturing.

Quantum computers could be used to improve the secure sharing of information. Or to improve radars and their ability to detect missiles and aircraft. Another area where quantum computing is expected to help is the environment and keeping water clean with chemical sensors.4

Here are some potential benefits of quantum computing:5

- Financial institutions may be able to use quantum computing to design more effective and efficient investment portfolios for retail and institutional clients. They could focus on creating better trading simulators and improve fraud detection.
- The healthcare industry could use quantum computing to develop new drugs and genetically-targeted medical care. It could also power more advanced DNA research.
- For stronger online security, quantum computing can help design better data encryption and ways to use light signals to detect intruders in the system.
- Quantum computing can be used to design more efficient, safer aircraft and traffic planning systems.

Features of Quantum Computing

Superposition and entanglement are two features of quantum physics on which quantum computing is based. They empower quantum computers to handle operations at speeds exponentially higher than conventional computers and with much less energy consumption.

Superposition
According to IBM, it's what a qubit can do rather than what it is that's remarkable. A qubit places the quantum information that it contains into a state of superposition. This refers to a combination of all possible configurations of the qubit. "Groups of qubits in superposition can create complex, multidimensional computational spaces. Complex problems can be represented in new ways in these spaces."6

Entanglement
Entanglement is integral to quantum computing power. Pairs of qubits can be made to become entangled. This means that the two qubits then exist in a single state. In such a state, changing one qubit directly affects the other in a manner that's predictable.

Quantum algorithms are designed to take advantage of this relationship to solve complex problems. While doubling the number of bits in a classical computer doubles its processing power, adding qubits results in an exponential upswing in computing power and ability.7

Decoherence
Decoherence occurs when the quantum behavior of qubits decays. The quantum state can be disturbed instantly by vibrations or temperature changes. This can cause qubits to fall out of superposition and cause errors to appear in computing.

It's important that qubits be protected from such interference by, for instance, supercooled refridgerators, insulation, and vacuum chambers.57

Limitations of Quantum Computing

Quantum computing offers enormous potential for developments and problem-solving in many industries. However, currently, it has its limitations.

- Decoherence, or decay, can be caused by the slightest disturbance in the qubit environment. This results in the collapse of computations or errors to them. As noted above, a quantum computer must be protected from all external interference during the computing stage.
- Error correction during the computing stage hasn't been perfected. That makes computations potentially unreliable. Since qubits aren't digital bits of data, they can't benefit from conventional error correction solutions used by classical computers.
- Retrieving computational results can corrupt the data. Developments such as a particular database search algorithm that ensures that the act of measurement will cause the quantum state to decohere into the correct answer hold promise.8
- Security and quantum cryptography is not yet fully developed.
- A lack of qubits prevents quantum computers from living up to their potential for impactful use. Researchers have yet to produce more than 128

Advantages:

Speed: Quantum computers can perform certain calculations much faster than classical computers, making them well-suited for tasks that involve a large amount of data or complex mathematical calculations.
Parallelism: Quantum computing allows for the parallel processing of information, which means that multiple computations can be performed simultaneously. This can significantly speed up certain tasks, such as searching large databases.
Cryptography: Quantum computing has the potential to break many of the encryption methods currently used to secure data. However, it also has the potential to develop new and more secure encryption methods, which could be more resistant to attacks by hackers.
Chemistry: Quantum computing can simulate the behavior of molecules at a level of detail that is not possible with classical computing. This could lead to new discoveries in drug design, materials science, and other areas.
Disadvantages of Quantum Computers
Quantum computers have the potential to revolutionize the field of computing, but they also come with a number of disadvantages. Some of the main challenges and limitations of quantum computing include:

1. **Noise and decoherence:** One of the biggest challenges in building a quantum computer is the problem of noise and decoherence. Quantum systems are extremely sensitive to their environment, and any noise or disturbance can cause errors in the computation. This makes it difficult to maintain the delicate quantum state of the qubits and to perform accurate and reliable computations.
2. **Scalability**: Another major challenge is scalability. Building a large-scale quantum computer with a large number of qubits is extremely difficult, as it requires the precise control of a large number of quantum systems. Currently, the number of qubits that can be controlled and manipulated in a laboratory setting is still quite small, which limits the potential of quantum computing.
3. **Error correction**: Error correction is another major challenge in quantum computing. In classical computing, errors can be corrected using error-correcting codes, but in quantum computing, the errors are much more difficult to detect and correct, due to the nature of quantum systems.
4. **Lack of robust quantum algorithms**: Even though some quantum algorithms have been developed, their number is still limited, and many problems that can be solved using classical computers have no known quantum algorithm.
5. **High cost**: Building and maintaining a quantum computer is extremely expensive, due to the need for specialized equipment and highly trained personnel. The cost of building a large-scale quantum computer is also likely to be quite high, which could limit the availability of quantum computing to certain groups or organizations.
6. **Power consumption**: Quantum computers are extremely power-hungry, due to the need to maintain the delicate quantum state of the qubits. This makes it difficult to scale up quantum computing to larger systems, as the power requirements become prohibitively high.
7. **Comparison between classical and quantum computers**

Properties	Classical Computers	Quantum Computers
Basic Unit	Bits (0 or 1)	Qubits (0, 1 or both)
Superposition	Not possible	Qubits can exist in multiple superpositions
Entanglement	Not possible	Qubits can become entangled
Processing	Perform tasks one by one	Can perform multiple calculations simultaneously
Speed	Limited by Moore's Law and physical limitations	Faster and more efficient for certain problems

Algorithms	Classical algorithms	Quantum algorithms
Applications	Various industries and fields	Cryptography, optimization, chemistry, etc.

Brain Computer Interface

Brain-Computer Interface (BCI): *devices that enable its users to interact with computers by mean of brain-activity only, this activity being generally measured by ElectroEncephaloGraphy (EEG).*

Electroencephalography (EEG): *physiological method of choice to record the electrical activity generated by the brain via electrodes placed on the scalp surface.*

A BCI can also be called a brain-machine interface, a neural-control interface, a mind-machine interface or a direct neural interface. A BCI allows for direct communication between the brain and an external device, often to control its activity. BCIs read signals from the brain and use machine learning algorithms to translate the signals into an external action.

Brain-Computer Interfaces (BCI) publishes high quality, original research articles encompassing analysis of theoretical and practical advances in brain-computer interface (BCI) technology. Articles should expand upon novel and innovative research where the methods, analysis and conclusions are robust and of the highest standard.

A BCI measures brain activity and translates it into a form that can allow machines to compensate for lost or damaged brain functions, provide supplementary or augmented functions, or entrain lasting improvements in existing functions. The Journal recognizes that the field of BCI research is highly multi-disciplinary, and strives to integrate a range of perspectives from various disciplines in order to deepen understanding of the issues, challenges and solutions in the field. *Brain-Computer Interfaces* will be of interest to experts within the following fields:

- biomedical engineering
- computer science and engineering
- electrical engineering
- human factors
- industrial and systems engineering
- machine learning
- mechanical engineering
- neuroscience
- neurosurgery
- psychology

- rehabilitation engineering

Brain-computer Interfaces in Neurological Rehabilitation

Brain-computer interfaces can help individuals who don't have use of their limbs, require assistive devices, or are unable to speak. The use of brain-computer interfaces in neurological rehabilitation (the doctor-aided process that aims to help individuals with nervous system disorders, injuries or diseases) can help improve an individual's ability to navigate through day-to-day experiences. BCIs are often used for rehabilitation after stroke or injury. In the future, we may see BCI medical products used in surgery or other medical operations.

BCI enables subjects with motor disabilities to use their brain activity to control objects in their environment and communicate. Brain-computer interfaces using EEG signals can help them control a prosthetic limb or computer interface.

Brain-computer Interface Gaming

BCI software can "translate" mental commands from EEG data into commands in a video game. In [brain-computer interface gaming](), subjects wear an EEG headset while playing VR games designed to control virtual objects. In BCI gaming, instead of using a traditional game controller, the subject uses mental commands to enable movement-based actions in the game — such as "push," "pull" or "jump." The BCI processes mental commands from the EEG and triggers the corresponding action in the VR game (direct neural interface virtual reality).

How Can Brain-computer Interfaces Change Our Lives?

BCIs represent life-changing possibilities for subjects with motor impairments, because they allow them to perform physical actions they otherwise couldn't. BCI translates brain signals into command outcomes using artificial intelligence algorithms. These commands can be used to control wheelchairs, prosthetic limbs or other assistive technologies.

BCI technology has the potential to make everyday tasks easier for individuals of all ability levels. For example, BCIs can eliminate the need to type or give voice commands — subjects could issue navigational and input commands to a computer through brain activity.

Brain-computer Interface Ethical Issues

With the life-changing possibilities of BCI technology comes ethical implications. As the field of brain-computer interface research grows and the technology in brain-computer interface applications continues to improve, a number of brain-computer interface ethical issues have been raised.

BCI Security Issues

A BCI is a software application, and like any software that sends information to an external device, the transmitted data is capable of being extracted for nefarious purposes. Security is especially critical in BCI technology, because BCI captures signals directly from a subject's nervous system. While BCI cannot currently be used to extract a user's intentions, private thoughts or what they're reading or viewing, combining BCI data with specific stimuli can one day make that possible. BCI could be used to determine a user's health status or familiarity with certain events, which presents a significant privacy risk.

BCI Privacy Issues

Likewise, privacy is an important issue in BCI ethics, since the captured neural signals can be used to gain access to a user's private information. Ethicists have raised concerns about how BCI data is stored and protected. For example, should BCI data be treated as medical data, or as commercial data? Should BCI data be anonymized? How do users know if their BCI data has been used for commercial purposes? While much of the discussion around brain-computer interface ethical issues is still being shaped, privacy and security issues remain premier concerns.

BCI Use Cases

Here are some of the most common brain-computer interface examples in use today:

- Neuroscience
- Military
- Medicine
- Rescue/Disaster Management
- Security
- Education
- Rehabilitation

What Is Augmented Reality (AR)?

Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli and delivered via technology. It is a growing trend among companies involved in the metaverse in mobile computing and business applications in particular.

- Augmented reality (AR) involves overlaying visual, auditory, or other sensory information onto the real world to enhance one's experience.
- Retailers and other companies can use augmented reality to promote products or services, launch novel marketing campaigns, and collect unique user data.
- Unlike virtual reality, which creates its own cyber environment, augmented reality adds to the existing world as it is.

Examples of Augmented Reality

Some early adopters in the retail sector have developed AR technologies designed to enhance the consumer shopping experience. Augmented reality has been incorporated into store catalog apps, which allows consumers to visualize what different products would look like in different environments. For example, when buying furniture, shoppers point the camera to the appropriate room and the product will appear in the foreground.

Augmented Reality vs. Virtual Reality

Augmented reality and virtual reality are often confused, so let's clarify. Augmented reality uses the existing real-world environment and puts virtual information—or even a virtual world—on top of it to enhance the experience. For example, think of Pokémon Go, where users are searching in their real-life neighborhoods for animated characters that pop up on their phone or tablet. In the NFL, broadcasters use AR technology to better analyze plays.

In contrast, virtual reality immerses users into an entirely different environment, typically a virtual one created and rendered by computers. For example, virtual reality users may be immersed in an animated scene or a digital environment. Virtual reality can also be used to photograph an actual local location and embed it in a VR app. Through a virtual reality headset, someone can walk around Italy as if they were actually there.

What Is Augmented Reality Used for?

Augmented reality either makes visual changes to a natural environment or enhances that environment through adding new information. It can be used for a variety of purposes, including gaming, product visualization, marketing campaigns, architecture and home design, education, and industrial manufacturing, among others.