

The border between the virtual and real world continues to break down, providing breathtaking experiences that, a short time ago, could only be found in the imagination of sci-fi writers.

Virtual Reality (VR) has been the “next big thing” for several years, but its time has finally come as a way to generate realistic images, sounds, and other sensations that put you smack in the middle of a spectacular imaginary world. Augmented Reality (AR), which adds virtual stuff to your real world environment, is contributing to the buzz, and both technologies should become a big part of our future. With Mixed Reality (MR), you can play a virtual video game, grab your real world water bottle, and smack an imaginary character from the game with the bottle. Imagination and reality have never been so intermingled.

So much is happening so fast that the differences between VR, AR, and MR can seem a little puzzling at first. Each of these spellbinding technologies are accessible to almost everyone, but before you throw down your hard-earned money for the latest head-mounted display, let’s take a closer look at what you’ll need for an amazing VR, AR, or MR experience.

## **The History and Future of Virtual Reality**

We’ve been trying to capture “Virtual Reality” for much longer than just the past five to ten years. There were popular peer-through toys in the 1950s and enclosed flight simulators debuted in the 1960s, but the *idea* of VR goes back even further.

As early as the 1930s, science fiction writers, inventors, and tinkerers dreamt of an environment where you could escape from reality via art and machines. We were weighing questions about Virtual Reality vs. Augmented Reality vs. Mixed Reality long before we had the technology to make them possible.

Technology has caught up to fiction, and market researchers predict rapid growth for the VR industry.

## **VR and AR Meet MR**

First things first, let’s define the terminology. Virtual Reality can be used as an umbrella term to describe other technologies similar to, but different from, an actual Virtual Reality experience. But what’s the difference between Augmented Reality and Mixed Reality? Here are some more details:

### **Virtual Reality**

VR is the most widely known of these technologies. It is fully immersive, which tricks your senses into thinking you’re in a different environment or world apart from the real world. Using a head-mounted display (HMD) or headset, you’ll experience a computer-generated world of imagery and sounds in which you can manipulate objects and move around using haptic controllers while tethered to a console or PC.

## Augmented Reality

AR overlays digital information on real-world elements. Pokémon GO\* is among the best-known examples. Augmented reality keeps the real world central but enhances it with other digital details, layering new strata of perception, and supplementing your reality or environment.

## Mixed Reality

MR brings together real world and digital elements. In mixed reality, you interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. Mixed Reality allows you to see and immerse yourself in the world around you even as you interact with a virtual environment using your own hands—all without ever removing your headset. It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary, offering an experience that can change the way you game and work today.

## Using Virtual Reality Technologies

From gaming, to movies, to medicine, the uses for Virtual Reality, Augmented Reality, and Mixed Reality are expanding.

- **Healthcare**—For training, such as for surgical simulations
- **Film and TV**—For movies and shows to create unique experiences
- **Virtual travel**—For virtual trips to an art museum—or another planet—all from home
- **Professional sports**—For training programs like [STRIVR](#) to help pro and amateur athletes
- **Gaming**—For over 1,000 games already available, from first-person shooters to strategy games to role-playing adventures

## What You'll Need: Headsets

There are many, many VR headsets available, all with varying performance levels and prices. Entry-level gear, such as Google Cardboard\*, uses your mobile phone as the screen, whereas PC-operated devices, like the HTC Vive\* or Oculus Rift\*, are immersive—providing a premium VR environment. Microsoft has their Windows\* 10 Mixed Reality platform that uses fully immersive headsets offered by Acer, Asus, Dell, HP, Lenovo, and Samsung.

Some AR headsets are available on the market today, with more rumored to be coming in the future. The Microsoft Hololens\*, Google Glass\*, and the Meta 2\* headset are great examples.

Every PC-connected HMD will have different system requirements, so if you're buying a new Virtual Reality headset, make sure you check with the HMD vendor for their recommended and minimum system requirements.

## What You'll Need: Computers

If you are looking for a new computer and you're interested in VR, you'll need something that can handle heavy loads. When it comes to high-end desktops or laptops for Virtual Reality (and other advanced tasks like gaming or video editing), the CPU, GPU, and memory are the most critical components.

Without these high-performing components working in sync, you could have a pretty miserable experience. A powerful system will ensure that you'll have fun as you lean in, stand up, or walk around. VR that lags makes it impossible for the virtual world to respond as you expect, which can lead to more than just disappointment; it increases the risk of motion sickness.

A high-end processor assists in positional tracking and controls how real and immersive your virtual environment will be, so you'll enjoy a deeper experience in a higher-fidelity environment. For a great VR experience, consider the latest generation Intel Core™ i7 processor.

A discrete graphics processing unit (GPU) is recommended, or in the case of Oculus Rift\*, HTC Vive\*, and Windows Mixed Reality Ultra\*, it is required. The GPU is responsible for rendering the high resolution, immersive images needed for VR. [Oculus](#), [HTC](#), and [Microsoft](#) all have profiler tools that you can download from their websites, and you can use to run on your PC to determine if it meets the minimum requirements for their VR headsets.

## What Is Virtual Reality (VR)?

Virtual Reality, or VR, is a simulated and immersive experience projected by a device into the user's sight. Imagine walking down the Champs-Élysée (Paris), while still sitting in your basement in San Francisco. All you need is a headset projecting you into a simulation via a viewfinder. That's exactly what VR promises, and much more.

## How Does VR work?

Some of you may remember what a thrilling experience it was using Mattel's View-Master, which was introduced in the 1960s. Today's VR is the modern version of that stereoscopic sightseeing effect: It requires a set of lenses inside a viewport on a headset, and a mounted device where the experience is stored or computed. From pure observation to complete immersion, the range of VR capabilities varies depending on the device and type of headset used. Using a remote control in sync with the mounted headset allows the user to interact with 3D objects in space, within the experience—either for [VR games](#) or virtual interfaces and apps.

## The Brief History of VR and Its Evolution Through Time

Leaving aside the technicality of VR for a moment, and focusing on the immersive 360° experience that it aims to project us into, we could argue that virtual reality started from the “360-degree murals (or panoramic paintings) from the nineteenth century,” as the [Virtual Reality](#)

[Society](#) states on their [History of Virtual Reality](#). We shifted from an early flight simulator (1929), to Morton's first VR Head Mounted Display in 1960, to Neo experiencing the whole world as a simulation inside The Matrix in 1999.

## Which Companies Are Leading the VR Market Today?

Fast forward to 2014 where Google initiated a mass market DIY headset that uses a smartphone to drive the VR experience: [Google Cardboard](#). Samsung followed the year after with their [Gear VR](#), and the new race for virtual reality was officially on. Officially acquired in June 2014, Oculus VR joined the Facebook family to accelerate its aim for domination in the high-end spectrum of the virtual reality headset.

## What Is Augmented Reality (AR)?

Just as the name suggests, Augmented Reality, or AR, adds to our perception of the world by overlapping computer generated graphics, images, or a set of interactive data.

## How Does AR Work?

As of today, AR only requires a smartphone with a camera and an AR app. Two key elements that make it work are the camera capacity to capture the environment around you as you move and the software that calculates and projects some computer-generated visuals or content.

One great example of this in action is IKEA's recent AR app that allows anyone to imagine how any room or space would feel with some of the brand's furniture.

[Designers](#) and architects could clearly benefit from this new way of creating life-scale objects in a real life context. "Now, technology has caught up with our ambition. AR lets us redefine the experience for furniture retail once more, in our restless quest to create a better everyday life for everyone, everywhere," [says Michael Valdsgaard](#), Leader of Digital Transformation at Inter IKEA Systems.

## A Brief History of AR

From casting the first virtual yellow line marker during a live NFL game in 1998 to overlapping map data to assist NASA flight simulations, augmented reality has lived outside of science fiction for many decades.

Back in 1974, Myron Kruger combined projectors and video cameras in an interactive environment—it was the birth of AR as we know it today.

More recently, AR took a big leap towards wider adoption at Apple's WWDC 17 when AR development was introduced to the masses with ARKit, a development framework for augmented reality applications created for iPhones and iPads.

# ARkit vs. ARCore – The Fight Between Apple and Google for AR Domination

[Apple's ARKit](#) for iOS 11 promises to democratize AR content development and mass consumption. It is a direct response to [Google's ARCore](#) who have the advantage of leveraging its knowledge from also being in the VR space, contrary to Apple. Both AR design and development frameworks promise to simplify and accelerate the creation process and put the technology in the hands of millions already using Android and iOS phones.

As augmented reality apps are still new to the mass market, it is too early to tell how really different these development kits are, except that they are each specific to their own operating systems and core audiences.

Now that the two most prominent tech companies—between them controlling 99% of the smartphone market—have made such a public move behind augmented reality, we should be ready to see industries being disrupted—again.

## What About Mixed Reality (MR)?

Mixed reality is a hybrid of VR and AR and aims to offer the best of both worlds. For instance, while it uses a headset just like VR, seeing through a translucent viewport or glass, it also projects visuals on top of our environment.

What makes MR stand out is its highly interactive aspect, and the realistic rendering of the projection it adds to our surroundings. Instead of depending solely on remote controllers or phone screens, we can interact with the immersive content using natural body and finger gestures.

Apple and Google clearly lead the way on AR technology, but today's MR landscape favors Microsoft (HoloLens), and massively funded Magic Leap (so far a concept demo only).

## Microsoft HoloLens and Magic Leap – The Two Kings of the Mixed Reality Race

### *Microsoft HoloLens*

Despite the commercial failure of [Google Glass](#), Microsoft didn't shy away from trying their own "[holographic computer](#)" in the MR game. The name "HoloLens" comes from the core experience "enabling you to engage with your digital content and interact with holograms in the world around you."

## Comparing Virtual Reality, Augmented Reality, and Mixed Reality

Virtual reality (VR), augmented reality (AR), and mixed reality (MR) are three prominent immersive technologies that have garnered significant attention. Each of these technologies blends the digital and physical worlds in distinct ways. This article delves into the differences and similarities between VR, AR and MR, allowing for a better understanding of their applications and potential use cases.

## What is Virtual Reality?

Virtual reality (VR) is a fully immersive digital experience that transports users to a simulated environment, completely replacing the real world. Users wear a VR headset that covers their field of view entirely and often wear accompanying accessories like gloves or handheld controllers to interact with the virtual world. The immersive nature of VR is achieved by tracking the user's movements and adjusting the display accordingly, creating a sense of presence in a computer-generated environment.

## Key Characteristics of Virtual Reality

- **Immersive Environment:** VR provides a fully immersive and interactive digital environment that isolates users from the physical world.
- **Complete Simulation:** Users experience an entirely artificial environment, which can be interactive, three-dimensional, and computer-generated.
- **Isolation from the Real World:** VR headsets occlude the real world, allowing users to be fully engrossed in the virtual environment.
- **Applications:** Gaming, education, simulations, virtual tours, therapy and training are popular applications of virtual reality.

(Make into product selector) Example Products: [Meta Quest 2](#), [Lenovo Mirage S3](#), [HTC VIVE Pro 2](#)

## What is Augmented Reality?

Augmented Reality (AR) overlays digital content onto the real-world environment, enhancing the user's perception of reality. AR is typically experienced through devices like smartphones, tablets, AR glasses, or specialized headsets. AR applications use the device's camera and sensors to detect the physical surroundings and integrate digital information, such as images, videos, or 3D models, into the user's view.

## Key Characteristics of Augmented Reality

- **Overlay of Digital Content:** AR enhances the real world by overlaying digital information, often in real-time, onto the user's physical surroundings.
- **Integration of Real and Virtual:** Users can interact with both the real world and digital elements simultaneously, creating an integrated experience.
- **Maintained Awareness of the Real World:** Unlike VR, AR does not block the user's view of the physical environment.

- **Applications:** Education, gaming, navigation, retail, advertising, remote assistance and healthcare are some of the areas where AR finds applications.

**Example Products:** [Epson Moverio BT-40S Smart Glasses](#), [Vuzix Longevity Series M400 Smart Glasses](#), [Lenovo ThinkReality A3 Smart Glasses](#)

## What is Mixed Reality?

Mixed reality (MR) represents a spectrum that combines elements of both VR and AR. MR integrates digital content into the real world while allowing users to interact with and manipulate both the real and virtual environments. The key aspect of MR is that digital content is anchored to and interacts with the physical world in real-time, providing a more seamless blending of the two realities.

## Key Characteristics of Mixed Reality

- **Seamless Blend of Real and Virtual:** MR creates a seamless integration of digital content into the real world, maintaining spatial awareness and interaction with physical objects.
- **Interactive and Anchored Objects:** Digital objects can interact with and be anchored to real-world objects, responding to the user's actions and movements.
- **Spatial Mapping and Understanding:** MR systems understand the physical space, enabling accurate placement and interaction of virtual objects in the real world.
- **Applications:** MR has applications in gaming, education, design, architecture, remote collaboration, and training, among others.

## Conclusion

Virtual reality, augmented reality and mixed reality represent a spectrum of immersive technologies, each offering unique experiences and applications. CDW offers AR, MR and VR solutions for a variety of industries, from education to entertainment. Interested in learning more? Explore our AR/MR/VR solutions now.

The digital world has changed dramatically with the introduction of Augmented Reality (AR) and Virtual Reality (VR). These exciting technologies blend the real and digital worlds, offering immersive experiences that transform how we see and interact with our surroundings.

AR enhances the real world by adding digital information to our physical environment. You may have seen it in popular apps like Pokémon Go or Snapchat filters, where digital elements appear in the real world, like virtual creatures or fun effects on your selfies.

VR, on the other hand, takes us to completely virtual environments. With special headsets, we can explore and interact with computer-generated worlds, feeling like we're truly there. It's like stepping into a different reality and experiencing things beyond our physical limits.

These technologies go beyond gaming and have applications in education, healthcare, architecture, and more. They are revolutionizing how we learn, work, and interact with our surroundings.

## *Understanding Augmented Reality:*

Augmented Reality (AR) is a technology that overlays digital information, such as images, videos, or 3D models, onto the real world in real time. It enhances our perception of reality by seamlessly blending virtual elements with our physical environment. Unlike Virtual Reality, which creates an entirely simulated environment, AR enriches our existing surroundings, providing an interactive and immersive experience.

The core principles of AR revolve around real-time tracking, registration, and rendering. Real-time tracking involves accurately tracking the position and orientation of the user or device in the environment. Registration refers to aligning the virtual content with real-world objects, ensuring that the virtual elements appear to be in the right place. Rendering focuses on seamlessly integrating virtual content into the real world, considering lighting, shadows, and other environmental factors to make it look more natural.

One of the key strengths of AR is its ability to enhance the real-world environment by adding contextual information and interactive elements. For example, imagine wearing AR glasses and walking through a city. As you look around, information about nearby landmarks, restaurants, or historical facts is displayed in your field of view. You can receive real-time directions, reviews, or ratings, all overlaid onto the physical world. AR can provide users with a deeper and more engaging experience by supplementing their perception with relevant digital information.

AR has gained significant popularity through various applications that have captured the imagination of users worldwide. Pokémon Go, the mobile game sensation, brought AR into the mainstream by allowing players to hunt and capture virtual creatures in real-world locations. It demonstrated the potential of AR to merge gaming with the real environment, encouraging users to explore their surroundings.

Another popular example is Snapchat filters, which use AR technology to add interactive effects and overlays to users' selfies in real time. These filters can transform your face into various characters, apply virtual makeup, or add playful animations. By seamlessly integrating virtual elements with the user's face, Snapchat has created a highly engaging and entertaining AR experience.

The impact of AR extends beyond gaming and entertainment. In the retail industry, AR enables customers to visualize products in their real-world environments before making a purchase. For instance, furniture retailers offer AR apps that allow users to place virtual furniture in their homes, giving them a sense of how it would look and fit. This helps customers make informed decisions and enhances the online shopping experience.

Similarly, in advertising, AR campaigns can bring print ads or billboards to life by overlaying interactive content, such as videos, animations, or 3D models. This dynamic and engaging



approach captivates viewers, increases brand awareness, and facilitates deeper interactions with the advertised products or services.

AR also has significant potential in the tourism industry. It can provide interactive guides that offer historical or cultural information about landmarks as users explore them. Tourists can experience virtual tours of historical sites, museums, or natural wonders, enhancing their understanding and enjoyment of the destination.

## *Exploring Virtual Reality:*

Users can explore and interact with a computer-generated, virtual environment thanks to a technology called virtual reality (VR). It immerses individuals in a completely artificial world, isolating them from the physical environment and stimulating their senses to provide a sense of presence and realism. With specialized hardware and software, VR transports users to virtual realms, enabling unique and immersive experiences.

The basic principles of VR involve creating a convincing illusion of presence and interactivity. Presence refers to the feeling of being physically present in the virtual environment, despite knowing that it is not real. It is achieved through a combination of sensory inputs, including visual, auditory, and sometimes haptic (touch) feedback. By delivering a seamless and convincing experience, VR tricks the brain into perceiving the virtual environment as real.

To experience VR, users typically rely on hardware and equipment designed specifically for this purpose. Headsets are the primary component, worn on the head to provide a visual and auditory experience. These headsets often include high-resolution displays that cover the user's field of view, delivering stereoscopic 3D visuals that create a sense of depth and immersion. They may also incorporate built-in headphones or speakers for spatial audio, enhancing the audio experience.

VR systems frequently feature controllers or input devices that allow users to interact with the virtual environment in addition to headsets. These controllers can track the user's hand movements, enabling them to manipulate objects, perform gestures, and navigate within the virtual space. Some advanced VR setups may include full-body tracking systems, haptic feedback devices, or motion platforms that further enhance the sense of immersion and realism.

Gaming has been one of the primary drivers of VR adoption, and it continues to be a popular application for this technology. VR gaming offers a whole new level of immersion and interactivity, allowing players to step into the virtual worlds of their favorite games. From exploring fantastical realms to engaging in realistic simulations, VR gaming offers a captivating and immersive experience.

Beyond gaming, VR has found significant applications in training simulations across various industries. In fields such as aviation, medicine, and military training, VR provides a safe and cost-effective way to practice complex tasks and scenarios. Trainees can experience realistic simulations that replicate challenging or hazardous situations, allowing them to develop skills, improve decision-making, and enhance their overall performance.

Virtual tourism is another area where VR is making an impact. With VR, individuals can virtually visit far-off destinations, historical sites, or natural wonders without leaving their homes. VR tours provide an immersive experience, allowing users to explore and interact with virtual environments, giving them a taste of different cultures and locations.

Furthermore, VR has shown promise in areas like architecture and design, where it allows architects and clients to visualize and experience architectural concepts before construction begins. It enables users to walk through virtual buildings, make real-time modifications, and get a realistic sense of scale and space.

### *AR vs. VR: Bridging the Gap:*

Augmented Reality (AR) and Virtual Reality (VR) are often mentioned together, but they are distinct technologies with different purposes and applications. Understanding their differences and similarities is crucial for comprehending their potential and how they can shape the future of immersive experiences.

## **Differentiating between AR and VR technologies:**

AR and VR differ primarily in their level of immersion and the way they interact with the real world:

1. *Augmented Reality (AR)*: AR superimposes digital data on the physical world, improving our experience of reality. Users can see and interact with virtual elements that appear to coexist with their physical environment. AR does not replace the real world but supplements it with contextual information.
2. *Virtual Reality (VR)*: VR, on the other hand, creates a completely simulated environment that isolates users from the physical world. By wearing a VR headset, users are immersed in a virtual world that blocks out their surroundings. The real world is replaced with a computer-generated environment in virtual reality.

## **The complementary nature of AR and VR:**

While AR and VR have distinct characteristics, they also complement each other and can work together in various ways:

1. *Enhanced experiences*: AR can augment VR experiences by overlaying real-world elements into virtual environments, creating a more immersive and interactive experience. For example, using AR to show the user's hands or physical objects within a VR simulation can enhance realism and interaction.
2. *Seamless transitions*: AR and VR can be used together to enable seamless transitions between the real and virtual worlds. Users can start with AR, interact with the real world, and gradually

transition into a fully immersive VR experience. This combination offers a continuum of experience and allows for more flexible applications.

## **Mixed Reality (MR) and the Fusion of AR and VR:**

Mixed Reality (MR) represents the fusion of AR and VR technologies, creating a spectrum of experiences that seamlessly blend the real and virtual worlds:

1. *Mixed Reality (MR)*: MR encompasses experiences that merge digital content with the real world, anchoring virtual elements to real-world objects. This fusion enables realistic interactions between virtual and physical entities, allowing users to manipulate and perceive virtual objects as if they were truly present.
2. *Spatial Computing*: Spatial Computing is a term often used in the context of MR, referring to the ability of AR and VR technologies to understand and interact with physical space and objects. It enables more natural and intuitive interactions by recognizing and responding to gestures, movements, and spatial relationships.

### *Impact of AR and VR on Industries:*

AR and VR technologies have made a significant impact across various industries, revolutionizing traditional processes, and opening new possibilities. Here are some key areas where AR and VR have transformed industries:

1. *Gaming and entertainment*: AR and VR have brought a paradigm shift in gaming and entertainment. VR gaming provides immersive experiences, transporting players into virtual worlds where they can interact with objects, characters, and environments. AR-based games, like Pokémon Go, have introduced location-based augmented experiences that engage players with their surroundings. These technologies have redefined gameplay, storytelling, and user engagement, creating entirely new avenues for entertainment.
2. *Education and training*: AR and VR are reshaping the landscape of education and training. Immersive simulations and virtual environments enable interactive learning experiences. Students can explore historical events, visit virtual museums, or participate in lifelike training scenarios. VR offers medical professionals a safe environment to practice complex procedures, while AR enhances classroom learning by overlaying additional information on real-world objects. These technologies improve retention, engagement, and skill development in educational settings.
3. *Healthcare and therapy*: AR and VR have the potential to transform healthcare and therapy. Surgeons can use AR to visualize patient data, overlaying diagnostic information onto the surgical field to improve precision. VR is employed for pain distraction during medical procedures and as a tool for rehabilitation. Mental health professionals utilize VR to create controlled environments for exposure therapy and treat anxiety disorders. These technologies enhance patient care, improve outcomes, and provide new avenues for therapeutic interventions.

4. *Architecture and design:* AR and VR have revolutionized the way architects and designers visualize and present their ideas. AR allows clients to see virtual objects or structures overlaid in the real world, aiding in visualizing finished projects. VR enables architects to immerse themselves and their clients in virtual walkthroughs of buildings before construction, facilitating better design decisions and identifying potential issues. These technologies enhance collaboration, streamline design processes, and improve client satisfaction.

5. *Retail and e-commerce:* AR has had a significant impact on the retail industry, particularly in e-commerce. AR apps and tools enable customers to virtually try on clothing, visualize furniture in their homes, or test makeup products before making a purchase. This technology bridges the gap between online and offline shopping experiences, reducing uncertainty and increasing customer satisfaction. VR is also being explored for creating virtual shopping experiences, allowing users to browse and interact with virtual stores. *Tourism and hospitality:* AR and VR offer immersive experiences in the tourism and hospitality industry. AR-based tour guides provide real-time information and augmented experiences at historical sites and landmarks. VR allows tourists to virtually visit destinations, providing a taste of different locations and cultures. Hotels and resorts utilize VR to showcase their amenities and offer virtual tours to potential guests. These technologies enhance travel experiences, attract visitors, and improve marketing efforts.

## *Challenges and Considerations:*

While AR and VR technologies have shown great potential, they also come with their own set of challenges and considerations that need to be addressed for widespread adoption and successful implementation.

1. *Technical limitations and hardware requirements:* Both AR and VR technologies require specialized hardware to deliver immersive experiences. High-quality headsets and powerful computing devices can be costly and may pose barriers to entry for some users. Additionally, technical limitations such as limited field of view, motion sickness in VR, or inaccuracies in AR tracking can affect the overall user experience. Continued advancements in hardware and software are needed to address these limitations and make the technologies more accessible and user-friendly.

2. *Ethical considerations in AR and VR experiences:* As AR and VR technologies become more pervasive, ethical considerations come to the forefront. Issues such as user safety, content appropriateness, and responsible use of data need to be carefully addressed. Developers and content creators must consider potential risks associated with immersive experiences, including psychological effects, addiction, or social isolation. Establishing ethical guidelines and industry standards is essential to ensuring the responsible development and deployment of AR and VR applications.

3. *Privacy and data security concerns:* AR and VR applications often collect and process large amounts of user data. This data may include personal information, user preferences, or even biometric data. Privacy concerns arise regarding how this data is collected, stored, and used.

Ensuring robust data security measures, obtaining user consent, and implementing transparent data practices are vital to protecting user privacy and maintaining trust in these technologies.

*4. Overcoming barriers to adoption and mainstream acceptance:* Despite the advancements in AR and VR, there are still barriers to widespread adoption and mainstream acceptance. Some challenges include limited content availability, the perception of high costs, the need for user education and familiarity, and concerns about social acceptance. Collaboration among industry stakeholders, investment in content development, and effective marketing strategies are necessary to overcome these barriers and drive broader adoption.

*5. Accessibility and inclusivity:* Making AR and VR experiences accessible to everyone is an important consideration. Ensuring compatibility with assistive technologies for individuals with disabilities, providing options for customization and personalization, and considering diverse user needs is essential for creating inclusive experiences. Designing interfaces and interactions that are intuitive and accommodating to a wide range of users is crucial for maximizing the reach and impact of these technologies.

## *The Future of AR and VR:*

AR and VR technologies continue to evolve rapidly, and the future holds exciting possibilities for their development and impact. Here are some emerging trends and predictions for the future of AR and VR:

### *1. Emerging trends and technologies: Several trends are shaping the future of AR and VR:*

- Improved hardware: Advances in hardware, such as lighter and more comfortable headsets, higher resolution displays, wider field of view, and better tracking systems, will enhance the overall user experience and drive adoption.
- Gesture and voice recognition: Natural and intuitive user interfaces, such as gesture recognition and voice commands, will become more prevalent, enabling more seamless interactions within AR and VR environments.
- 5G and Edge Computing: The deployment of 5G networks and edge computing infrastructure will reduce latency and enable real-time processing, unlocking the potential for more responsive and immersive AR and VR experiences.
- Spatial computing and mapping: Spatial computing technologies will enable precise mapping of the physical world and facilitate the seamless integration of virtual content with the real environment, enhancing realism and interaction.
- Augmented Reality glasses: AR glasses, designed as lightweight and stylish wearables, are expected to gain popularity. They will provide a more integrated and immersive AR experience, seamlessly blending digital information with the real world.

***2. Integration with other technologies: AR and VR will increasingly integrate with other emerging technologies, expanding their capabilities and applications:***

- Artificial Intelligence (AI): AI algorithms and machine learning will enhance AR and VR experiences by enabling intelligent object recognition, scene understanding, and personalized content generation, leading to more immersive and adaptive experiences.
- Internet of Things (IoT): Integrating AR and VR with IoT technologies will enable the visualization and interaction with real-time data from connected devices, creating augmented and virtual experiences that leverage the power of the physical and digital worlds.
- Wearable devices: The convergence of AR, VR, and wearable technologies will offer new possibilities for personalized and contextualized experiences, with devices like smartwatches, fitness trackers, and biometric sensors augmenting and enhancing AR and VR interactions.

***3. Potential societal and cultural implications: AR and VR technologies have the potential to impact various aspects of society and culture:***

- Communication and social interactions: AR and VR could revolutionize remote communication, enabling people to connect in immersive virtual environments, bridging the physical distance, and providing more engaging and realistic interactions.
- Virtual economies and commerce: Virtual marketplaces and digital economies within AR and VR environments may emerge, allowing users to buy, sell, and trade virtual goods and services, opening up new business opportunities and revenue streams.
- Cultural experiences and storytelling: AR and VR can transform cultural experiences by recreating historical events, offering immersive storytelling, and preserving cultural heritage in interactive and engaging ways.

***4. Predictions for the future of AR and VR: While the future is full of possibilities, some predictions for the future of AR and VR include:***

- Ubiquitous AR: AR will become more integrated into our daily lives, seamlessly overlaying digital information onto the physical world through lightweight glasses or contact lenses.
- Complete VR immersion: VR will continue to advance, providing increasingly realistic and immersive experiences that fully transport users into virtual environments, with enhanced haptic feedback and sensory stimulation.
- Hybrid reality: The lines between AR and VR will blur, leading to the emergence of hybrid reality experiences that seamlessly blend virtual and real elements, creating entirely new types of immersive experiences.

- AR and VR in work environments: AR and VR will find broader applications in work settings, enabling remote collaboration, virtual meetings, and immersive training simulations across industries.

In conclusion, Augmented Reality (AR) and Virtual Reality (VR) are revolutionizing industries and transforming how we perceive and interact with the digital world. AR enhances our real-world environment with digital overlays, while VR immerses us in fully simulated experiences. These technologies have limitless potential in gaming, education, healthcare, architecture, and more.

While there are challenges to overcome, advancements in hardware and integration with AI and IoT are propelling AR and VR forward. The future holds improved experiences, personalized interactions, and widespread adoption. AR and VR will continue to shape our society, creating new communication methods, virtual economies, and cultural experiences.

As we embrace the possibilities, it's essential to address technical limitations, ethical considerations, and privacy concerns. Responsible development and deployment will maximize the positive impact of AR and VR on individuals and society.

## **What is augmented reality?**

Augmented reality (AR) is a technology that enriches the user's perception and provides a live view of the real world with digital information, aiming to expand it by adding images, sound, video and other virtual details.

[The purpose of AR is to augment the environment](#) and let virtual elements interact with real objects to create intended meanings. In AR, informatively-designed virtual environments coexist with the real ones by providing additional data about the real world. So, how does augmented reality work?

Most often, special equipment is not needed to create an AR, which is usually generated by common devices, mainly smartphone cameras, instead. Virtual three-dimensional (3D) objects and environments are superimposed by AR systems on real-world objects in real time based on their geometric relationships since the systems calculate the position and orientation of objects relative to others.

Today, AR technology is commonly complemented by mobile phone technologies such as GPS, 3G, 4G and remote sensing. The combined image is usually projected onto mobile screens, augmented reality glasses and other devices.

Examples of AR systems are those that are used in photography and editing like Snapchat filters, virtual dressing rooms, interior decoration applications like IKEA mobile as well as virtual battlefields, and games such as Nintendo's Pokémon Go. Moreover, AR is also widely used in marketing, and medical and healthcare applications.



# What is virtual reality?

Virtual reality (VR) is a technology and method that regenerates 3D digital images and [videos to create real visual experiences for users](#). So, how does virtual reality work?

The purpose of VR is to create an illusion of immersion in a life-size 3D digital environment. To make 3D images and videos, much of which reproduce the real or imaginary world, VR systems usually use computer vision and advanced graphics that add depth and reconstruct the scale and distance between static two-dimensional (2D) images. All this together is designed to replace a real-life environment with a simulated one, creating an immersive effect that feels like you are part of the particular computer-generated digital environment that you are viewing.

To explore and control 3D environments, users utilize computers and sensory devices like VR headsets and gloves. Due to the special lenses in the VR headset and controllers, which have sensors, users can experience virtual content and interact with it naturally just like in the real world.

Some modern VR devices are more advanced than 3D. They have real-time tracking features that enable the use of VR in real-time explorations and allow users to experience their VR environment through all five human senses.

Examples of VR include entertainment applications, particularly video games, [education applications such as classroom training](#), and business applications that are generally used for virtual meetings.

## Augmented reality vs. virtual reality

While both AR and VR are designed to provide users with a simulated computer-generated 3D experience, each technology is unique and includes distinct use cases. So what is the main difference between AR and VR?

An important distinction between them is that VR tends to replace the real world up to total immersion, while AR attempts to add the virtual by projecting digital information on top of the environment already being viewed by the users.

Also, since VR tends towards full immersion, devices require shutting users off from the real world by blocking their field of vision to present VR content instead. Thus, VR is best explored with special equipment such as a VR headset or gloves. At the same time, it is possible to use AR in two-dimensional (2D) and 3D environments very easily, such as on a smartphone.

## Advantages and disadvantages of augmented reality

AR can help create an entirely new, interactive experience for users, and as with any technology, AR has its pros and cons, which are usually compared to those of VR.



One of the main benefits of AR is that it is a great educational tool that can provide rich content and context. AR has the potential to increase users' knowledge and awareness by providing an enhanced experience. It offers personalized learning, fostering the learning process. Due to AR technology, users can share experiences with others in real-time over long distances.

Among its other benefits is that its applications are really easy to use as AR systems are usually less affected by device limitations. AR provides more freedom for smartphone users and more opportunities for AR developers and marketers since there is no need for a head-mounted display.

Users just need to point their camera at an object, and the AR app will show what it does with that particular item. Nevertheless, a high bandwidth is still required to create high-resolution and life-like objects for top-quality experiences.

Moreover, AR's great advantage is that it is now used in a wide variety of fields like gaming, marketing, education and healthcare, and has multiple applications for training, learning, navigation, design and entertainment (Snapchat, Google Lens, IKEA Place, et cetera). However, the lack of privacy and security is a major drawback of AR. It may seriously affect the overall augmented reality principle.

Among its other disadvantages, low adoption and application in day-to-day use remain. Current limitations of 3D systems that produce and support 3D visualizations, especially in real-time, slow down the spread of AR technology. It is still complicated and quite costly to develop, implement and maintain AR technology-based projects and their applications.

And it is worth noting that extreme engagement with AR can cause health issues. Too frequent and intense pastimes in AR can lead to major healthcare hazards such as eye problems, obesity, mental health problems, et cetera.

## **Advantages and disadvantages of virtual reality**

VR does come with several merits, and various areas have already been positively affected by the implementation of this technology.

First of all, VR helps create a realistic world so that users can explore and experiment with an interactive artificial environment. VR is more immersive than AR in terms of immersion and a virtual sense of presence. It gives users playing games or watching videos the impression of actually being in a different world.

One of the most important advantages of VR is that it makes education and practice easier, safer and more comfortable for users. The possibility of conducting training and practicing potentially dangerous real-world operations like surgery, plane flight or combat without any risk by simulating them is one of the technology's best benefits.

On the other hand, training in a VR environment never has the same result as practicing and working in the real world, and this is one of the technology's significant drawbacks. In this way, if a user does well with simulated tasks in a generated 3D VR environment, there is still no guarantee that a person would perform the same tasks as well in the real world.

Furthermore, the high price of VR systems discourages regular and ordinary usage. Not everyone can afford VR devices as they do not come cheap. Irrespective of the decrease in the price of VR technology over the years, it still has not been widely adopted. Low adoption means there are not many VR systems out there, and this then limits customer options.

There are also a lot of health concerns. VR could affect users' health; the technology must be improved before it can be used without its users experiencing temporary side-effects such as blurred vision, headache and nausea.

The possibility of progressive escapism is another issue. It became a long-term commonplace among VR users who then started to live in virtual environments instead of dealing with the real world. After spending significant amounts of time in the virtual world, they tended to enjoy it more, and as a result, spent even more time using VR, which eventually led them to become isolated from the real world.

## **Applications of augmented reality**

Essentially, AR applications allow users to do interesting, location-specific things at their location or things that connect virtual and real-life objects and experiences.

Types of AR applications vary. For instance, AR applications are widely used in retail and advertising. By presenting 3D models of products and helping consumers to make better choices, AR has the potential to improve customer experiences. AR applications can be used to lead customers to virtual stores and rooms.

They can boost remote design, give users a virtual walkthrough of a given piece of real estate or a better idea of how a sofa will fit into their house, or allow them to look at furniture from home and select suitable items to match their space.

Printing and advertising industries use AR technology applications to display 3D digital content on top of real-world newspapers and magazines to help companies popularize their brands to users.

In addition to placing advertisements on AR content, AR applications can be used by tourists for navigation, by providing data on destinations, directions and sightseeing. They may allow users to get suggestions for hotels that they can visit or preview a menu from which they might order. On top of that, AR enables virtual tourism.

Also, for drivers, AR applications can give directions to locations or show statistics about speed, assist in advanced navigation and help mark objects in real-time.

There are also a lot of AR games like Pokémon GO, Jurassic World Alive, et cetera and plenty of them are blockchain-based, such as DogemonGo and Terra Virtua, among others. The technology facilitates the development of real-time 3D games for better gaming experiences. Due to AR, gaming grounds in virtual environments are being improved so that users can perform real-world activities.

Another use case is remote collaboration. In manufacturing and maintenance, professionals can direct repair technicians to perform repair and maintenance work using AR applications without the technicians being on site.

AR can help train healthcare workers, or diagnose patients, and plan and monitor critical health situations. For regular users, fitness AR applications can show users' heart rates and other healthcare data on-screen while the users exercise.

Other examples are architecture and urban design, as now, AR more and more often aids in visualizing building projects. It is also used for urban regeneration and planning as well as for transportation projects.

## **Applications of virtual reality**

Virtual reality applications provide an immersive sensory experience that digitally simulates an artificial environment. Such applications can be developed in various fields.

Entertainment is the most common and popular use case for VR applications. Immersive experiences in video gaming, virtual music concerts, travel simulations and an opportunity to view films and scenes in 360 degrees are just some notable examples.

VR can present high definition, 3D interactive imaging, which recommends itself as a great opportunity and an alternative channel for digital marketing and advertising needs.

Due to VR technology, employees can meet and collaborate remotely while feeling they are in the presence of others. Businesses can use it as a brainstorming tool, to test new ideas before the launch or discussing them with partners and collaborators. VR allows engineers and designers to experiment easily with the look and build of a vehicle before commissioning expensive prototypes.

What's more, VR is a proven way to rehabilitate. Immersive virtual reality technology is capable of recreating life-like natural experiences, and real-time 3D rendered environments. It is used in social sciences, psychology and clinical therapy since VR visuals can help distract patients from their suffering and affect the pathways by which pain travels to the brain.

In recent years, VR has become a primary method for treating post-traumatic stress disorder. Now, VR applications are widely used to soothe patients, manage anxiety symptoms and treat social and autism disorders. With the rise of social distancing, VR systems are used as digital training devices for medical simulation.

Apart from healthcare simulation, VR is used for training and learning in many different fields. For instance, the military uses VR for flight and battlefield simulations. It is also used in sports, creating the necessary conditions to play, and helping athletes to measure their performance and analyze their techniques. Such training develops skills without real-world consequences, saves costs, and does not put users in danger.

Furthermore, VR could revolutionize and democratize education by enabling users to learn interactively and experientially from anywhere in the world.

## **What is mixed reality (MR)?**

The term mixed reality (MR) refers to a hybrid of AR and VR, the merging of the virtual and physical environments to produce a new environment where interactions among virtual and physical items are enabled in real-time.

Unlike VR systems, which immerse users in completely virtual worlds, or AR, which overlays digital content on top of the real world without taking into account its unique and dynamic structure, MR systems constantly collect new information about the environment and what is occurring within it. MR unites the virtual and physical worlds so that they are intertwined.

MR is a rapidly growing field. A number of MR applications have been used in entertainment, education, design, healthcare, military training, marketing and remote working, to name a few.

Furthermore, AR, VR, and MR phenomena are inextricably linked with extended reality (XR). XR merges all digital and physical and combines human-machine interactions through the use of wearables such as headsets and devices.

## **Role of virtual reality and augmented reality in the metaverse**

The [metaverse refers to a simulated digital environment](#) that combines multiple elements of technology, such as AR, VR, MR and blockchain, along with social media concepts to create spaces that enrich users' interaction by mimicking the real world.

As a shared 3D virtual space with online infrastructure and real-time events, and with ever-evolving aspects which are collectively shared by its inhabitants, the metaverse is expected to change the way people interact with each other, connecting the virtual and physical worlds.

The real and virtual are merged in the metaverse using AR and VR technologies, which play a key role in the metaverse's formation. Augmented reality technology allows for embedding 3D visualizations into the real physical world, and offers real-time interaction.

VR is seen as an integral component of the new metaverse ecosystem, providing an immersive experience for users in a dynamic 3D virtual environment. Generally speaking, the metaverse is something users could leap into (via VR) or deliver to users' reality (via AR).

The metaverse concept has been one of the hottest trends in the tech space lately, especially after [Facebook's announcement that it was rebranding to Meta](#), and giant companies like Microsoft, Google, and Sony dived into the metaverse with their unique platforms or started investing.

### *Common Uses of AR and VR*

While AR and VR have several differences, their uses, functionalities, and roles do often coincide with one another, offering many similar solutions and experiences in various industries. Some of the most common uses of and industries leveraging these technologies include:

- **Gaming and Entertainment:** Popular games and apps like Pokémon Go and Snapchat leverage digital image layering AR technology. VR is often found in virtual theme park rides and simulations and used for interactive gaming and storytelling.
- **Education:** AR applications overlay informative content onto real-world objects, fostering a learning experience tailored towards student engagement. VR creates interactive learning experiences like showcasing a fully-virtual environment. For example, a historical geographic site can be studied and enables remote collaboration between students.
- **Retail:** Retail customers can use AR applications to visualize products when shopping online, which improves decision-making and enhances the customer experience. VR allows brands to showcase their products and services interactively to help improve customer engagement and brand awareness.
- **Healthcare:** Surgical planning and training AR applications help healthcare professionals by overlaying medical imaging data onto patients for real-time guidance. [VR healthcare applications create virtual environments to distract patients from pain or anxiety](#) and can help with other healthcare treatments like exposure therapy and rehabilitation.

AR and VR technologies are often found in similar industries, but with different roles and functionalities. Companies and organizations are responsible for identifying which technology is most useful and relevant to their processes and goals before integrating them into their business model.

### *Industry Outlook*

Economic and cultural disruption from the coronavirus pandemic have helped propel AR and VR technologies and products into the market. According to [Statista](#), the global extended reality (XR) market that includes augmented reality, virtual reality and mixed reality (MR) reached \$29.26 billion in 2022 and is anticipated to rise to over \$100 billion by 2026.

Businesses have steadily been incorporating AR and VR technologies into their business models to optimize their operations. Apple recently announced its [Apple Vision Pro](#), which is poised to be the next high-profile competitor to other XR products like the [Meta Quest 2](#) and the [PSVR 2](#). According to [Global Data](#), the gaming and entertainment industry is predicted to be the biggest demand generator for AR and VR technology in the global market.

### *Earn an Education in Creative Technology*

The expected growth in demand for AR and VR technologies and experiences means companies will need people with the skills to help develop and improve these products and services. A new breed of technology professionals will need to align themselves with the creative technology needs of the future. SMU's M.A. in Creative Technology is a new program that combines creative and design disciplines with core and emerging digital technologies to generate innovative solutions that are growing in demand across industries. This program merges the arts with technology to help develop creative tech-focused individuals who desire a deeper understanding of AR and VR.