



# What Is AR/VR?

ITIF Technology Explainer Series • [www.itif.org](http://www.itif.org)

## Summary

Augmented and virtual reality (AR/VR) are immersive technologies that enable users to experience digitally rendered content in both physical and virtual space. In augmented reality, this content is overlaid onto a user's physical surroundings using a head-mounted display (HMD), heads-up display (HUD), or mobile device (see below). In virtual reality, HMDs fully immerse users in a virtual space in which they can interact with digital content and users. Gaming and entertainment are the most visible uses for AR/VR, but these technologies also offer a wide range of potential use cases for businesses, governments, and consumers.

## Why Now?

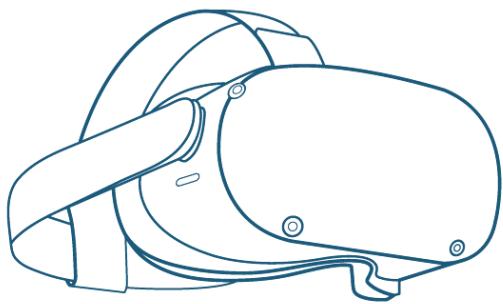
Researchers and engineers throughout the 20th century aspired to create immersive technology. In the 1960s, the U.S. military succeeded in using the first HMDs in immersive flight simulators, and by the 1990s, technology had advanced enough for manufacturers to offer the first consumer AR/VR devices. But the devices were too cumbersome and costly to gain widespread adoption. It has only been in the last decade that AR/VR innovation has advanced beyond hobbyist circles and high-tech industries.

Multiple innovations have accelerated AR/VR adoption. In particular, ubiquitous mobile phones with high-quality cameras and displays allow individuals to use AR/VR technology without having to invest in other expensive hardware.<sup>1</sup> In addition, advancements in computing power and battery efficiency have made it possible to develop smaller, more cost-effective devices and produce high-quality, interactive content.

Virtual content has evolved due to advancements in 360-degree image capturing and high-resolution digital displays. While previous generations of immersive experiences were often unwieldy and disorienting, the screen resolution available on mobile and head-mounted devices today offer users much more realistic and engaging experiences. Creators can now seamlessly stitch together high-resolution, 360-degree images to develop quality immersive content at a relatively low cost.

Taken together, the advancements of the last decade have produced two essentials for more widespread adoption: comfortable and affordable hardware, and an expanding selection of content that will appeal to a broad range of consumers and enterprise users.

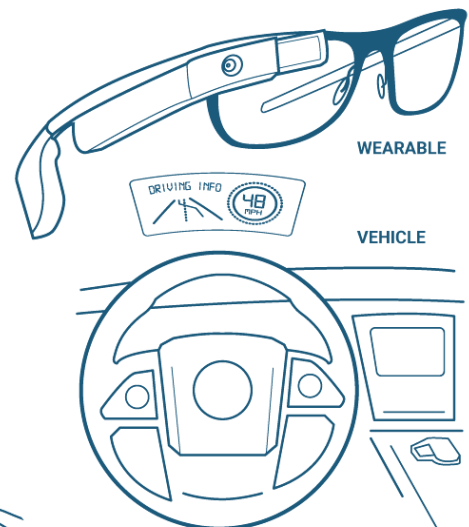
## Types of AR/VR Devices



HEAD-MOUNTED DISPLAY



MOBILE



HEADS-UP DISPLAY

## Prospects for Advancement

Further technological advancements will continue to propel AR/VR. For example, 5G network technology will be instrumental in building high-quality, responsive mobile AR/VR experiences by minimizing latency and expanding cloud-based data processing capabilities. Developments in key technologies, such as eye-tracking (detecting where a user is looking) and haptic feedback (indicators such as vibrations that simulate impact with physical objects), will also improve user experience and expand AR/VR's potential consumer and enterprise uses.

Three-dimensional image capturing technologies, such as LiDAR (sensors that use reflected laser light to measure objects), will make it easier to use AR/VR to replicate and interact with physical space. For example, creators can construct virtual replicas of real-world physical spaces and place virtual elements in different locations. Users can then experience these virtual additions to their physical space using handheld or wearable AR devices such as smart glasses.

## Applications and Impact

There is an expanding range of uses for AR/VR. Perhaps the most widely applicable use is workforce training. For example, an engineer can use AR to follow indicators and instructions overlaid directly onto a machine, or a first responder can practice reacting to different emergency scenarios in an immersive simulation. Similarly, AR/VR tools can have beneficial applications in education, from engaging children in virtual field trips to preparing medical students to perform high-risk surgeries.

AR/VR is an especially valuable tool for complex industries such as health care. Early research shows that VR programs may be able to help patients recovering from physical injuries or PTSD, and AR can assist health-care practitioners by providing 3D information about patients or procedures in real time. AR/VR can also allow health-care providers to assist patients remotely, giving them more detailed real-time information than traditional phone- or video-based telemedicine.

AR/VR also continues to grow for shopping, entertainment, and advertising. Individuals use AR on their mobile devices to preview furniture in their homes or add virtual objects or filters to their photos and videos. VR applications offer not only single-player immersive games, but also multi-player platforms, social experiences, and entertainment such as movies and live concerts. As advancements in AR/VR technology prompt more widespread consumer adoption, the range of consumer and entertainment content—and the value of AR/VR as an advertising and marketing platform—is likely to expand.

## Policy Implications

While AR/VR presents exciting possibilities, it raises interesting policy questions.

First, AR/VR presents a typical chicken-or-egg dilemma: Consumer demand for AR/VR devices depends on available content and services, but the supply of AR/VR content and services depends on consumer demand. Government can accelerate AR/VR adoption both by funding content, such as artistic, historical, and educational media, and by funding use, such as within schools and for worker training. This will encourage innovation in under-developed sectors, particularly education.

Second, AR/VR presents questions about privacy. HMDs for both AR and VR collect information about users, such as eye and movement tracking, to perform advanced capabilities such as gesture-based controls, biometric identification, or tracking user focus in product testing. AR devices also collect information about a user's surroundings, such as the location of physical objects or the presence of other individuals. Laws and regulations restricting the collection and use of personal data, including biometric data, may inhibit adoption of AR/VR.

AR/VR also introduces a new threat vector for cybersecurity. Some of these threats mirror those from other connected devices, such as the potential for malicious actors to collect personally identifiable information, including biometric data, from a compromised device. But the immersive nature of this technology adds new security concerns, particularly in social engineering. For example, someone could impersonate another user in a virtual meeting or insert misleading information in a virtual environment that prompts users to share sensitive data. Addressing these potential threats will become increasingly important as government agencies and private companies implement AR/VR solutions.

Finally, the health and safety implications of AR/VR are not yet fully understood. Immersive technologies, particularly HMDs, have unique psychological and physiological impacts that remain under-researched, including among children. It is also necessary to better understand the extent of potential impacts of AR/VR on digital wellbeing and addiction. Government health and product safety regulators should work with companies building AR/VR devices and programs to develop safety standards and best practices for these technologies.

---

1. PerkinsCoe and XR Association, *2020 Augmented and Virtual Reality Survey Report*, March 2020, <https://xra.org/wp-content/uploads/2020/07/2020-ar-vr-survey-report-0320-v4.pdf>.

## Recommended Reading

Daniel Castro, "Digital Twin Technologies Can Make Smart Cities Even Smarter," *Government Technology*, October 2019, <https://www.govtech.com/smart-cities/Digital-Twin-Technology-Can-Make-Smart-Cities-Even-Smarter.html>.

Daniel Castro, "COVID-19 Could Accelerate Government Adoption of AR, VR Tech," *Government Technology*, July 2020, <https://www.govtech.com/products/COVID-19-Could-Accelerate-Government-Adoption-of-AR-VR-Tech.html>.

Ellyse Dick, "AR and VR can Transform Government Work Beyond the Pandemic – If Done Right," *FedScoop*, September 14, 2020, <https://www.fedscoop.com/ar-vr-can-transform-government-work-beyond-pandemic-done-right>.