

AUGMENTED REALITY

Augmented Reality (AR), which is related to mixed and virtual reality, is a rapidly growing technology that presents graphical overlays on top of real world objects and scenes. AR is a relatively young emerging technology that is currently experiencing a high degree of evolution. While there are some obvious applications and use cases (e.g. education/training, medicine, industry, military), fundamental research is still occurring to stabilize the technology and improve on challenges related to accuracy, computational demand, costs and user interface.



ENABLING SCIENCE AND TECHNOLOGY

3D Displays

Many different 3D display types are still being explored in the research literature, suggesting a leading technology has yet to be commercialized. Stereoscopic, auto-stereoscopic, volumetric, holographic and integral imaging displays are amongst the contenders. Major challenges include handling depth perception, multi-user displays, occlusions and shadows.

Edge/Fog Computing

Edge computing refers to the computational processes that occur at the edge of the network, while fog computing refers to the network connections between edge devices and the cloud. Both are ideal options for AR as they offer a means of lowering latency to the point of gaining real-time responses and context-aware data storage.

Big Data

The intersection of AR and big data presents two main opportunities including the enhancement of big data visualizations of real-time data streams with AR overlays and feeding AR applications with information gathered from big data sources, thus expanding their application beyond closed or limited datasets. Early adopters are in the areas of healthcare, public services, and location-based applications. Challenges include real-time performance and privacy issues.

Deep Learning

Recent developments in deep learning (DL) are increasingly being used in AR to provide improved image recognition, object detection and enhanced image processing. DL-based AR also provides superior performance in outdoor environments, robotic navigation and autonomous driving. It also offers improved hand

pose tracking which is essential for manipulating virtual objects.

Spatial Augmented Reality (SAR)

SAR is an emerging technique that renders a virtual object directly onto real surfaces as opposed to simply placing it within a user's visual field. SAR uses projectors as opposed to head mounted displays and can offer a wider field of view, higher resolution, and improved lighting and human factors.

“The way we perceive and interact with technology is undergoing a radical transformation. Conversational platforms, augmented reality, virtual reality and mixed reality will provide more natural and immersive ambient experience within the digital world.”

Cearley, D and Burke, B. *Top 10 Strategic Technology Trends for 2019*. October 15, 2018. Gartner.

SIGNALS

Academic



The University of British Columbia recently opened the Emerging Media Lab whose mission is to evolve learning by creating tools and techniques using emerging media such as augmented, mixed, and virtual reality.

Government



The Canadian Museum for Human Rights' mobile application uses AR to provide information about nearby Winnipeg landmarks from the perspective of the museum's lookouts.

Collaboration



The XR Association includes Google, HTC VIVE, Facebook, Oculus, Samsung and others, and promotes industry growth and the responsible development and adoption of augmented, mixed and virtual reality best practices through dialogue across stakeholders and research.

Defence



US Army Research Lab's *Mixed Reality Tactical Analysis Kit (MRTAK)* is an experimental platform to assess the value of AR during collaborative mission planning and execution and is being integrated into project AURORA (*Accelerated User Reasoning for Operations, Research, and Analysis*).

Corporate



The release of software-development kits (SDK) by Microsoft, Apple, Google, Snapchat, Facebook, Amazon, Magic Leap and the like, allow developers to create AR content for iOS and Android devices and will drive the advancement of many AR applications.

“DoD must take advantage of developing opportunities, both technological and institutional, to develop or adopt AR applications for use across a range of missions, including humanitarian assistance/disaster relief, counterterrorism, and unconventional warfare.”

Maj. Chris Telley, US Army information operations officer. <https://mwi.usma.edu/hearts-minds-augmented-reality-embracing-technology-information-fight/>

IMPACT



Social

“Microsoft Workers 4 Good” called on Microsoft to drop their US \$480 million deal with the US Army to provide 100,000 prototypes of HoloLens with the Integrated Visual Augmentation System (IVAS), an army platform designed to increase lethality. The workers stated they refuse to create technology for warfare.



Policy

The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems (A/IS) released their report *Ethically Aligned Design (EAD)*. It looks at five key ethical considerations in regards to mixed reality including social interactions, mental health, education and training, the arts and privacy, access and control.



Economic

The AR market was valued at US\$4.2 billion in 2017 and is expected to grow to US\$60.5 billion by 2023, representing a compound annual growth rate of 40% between 2018-2023. (Marketsandmarkets, 2017)



Environmental

AR systems can enhance situational awareness and decision making of first responders in the context of environmental disaster relief by fusing data from multiple sources and combining it with 3D georeferenced visualizations.



Defence

AR has the potential to optimize training tactics for military operation by making live, virtual and constructive training solutions that are safer, more realistic, reliable and cost-effective. The US Army's Synthetic Training Environment provides a collective mixed reality environment for immersive and semi-immersive training that allows leaders to accurately assess and adjust training in real-time.

“AR is going to take a while, because there are some really hard technology challenges there. But...it will happen in a big way, and we will wonder when it does, how we ever lived without it. Like we wonder how we lived without our phone today.”

Tim Cook, Apple CEO

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