Module-I
Introduction toAugmented Reality and Virtual Reality

Augmented Reality Introduction

Augmented reality (**AR**) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory. AR can be defined as a system that fulfils three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.

The overlaid sensory information can be constructive (i.e. additive to the natural environment), or destructive (i.e. masking of the natural environment). This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one. Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

Difference between Augmented Reality and Virtual Reality and Mixed Reality

The difference between virtual, augmented, and mixed reality technologies:

- **Virtual reality (VR)** immerses users in a fully artificial digital environment.
- **Augmented reality (AR)** overlays virtual objects on the real-world environment.
- **Mixed reality (MR)** not just overlays but anchors virtual objects to the real world.

Virtual Reality

This technology immerses users in a completely virtual environment that is generated by a computer. The most advanced VR experiences even provide freedom of movement – users can move in a digital environment and hear sounds. Moreover, special hand controllers can be used to enhance VR experiences.

You need to wear a special VR headset to experience virtual reality. Most VR headsets are connected to a computer (Oculus Rift) or a gaming console (PlayStation VR) but there are standalone devices (Google Cardboard is among the most popular) as well. Most standalone VR headsets work in combination with smartphones – you insert a smartphone, wear a headset, and immerse in the virtual reality.

Immersive videos

Have you ever noticed a small cardboard icon when watching videos on YouTube? It enables the 360-degree mode that means you can wear a VR headset and experiences fully immersive videos. 360-degree videos are considered a form of VR.

Augmented Reality

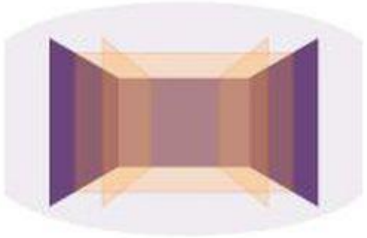
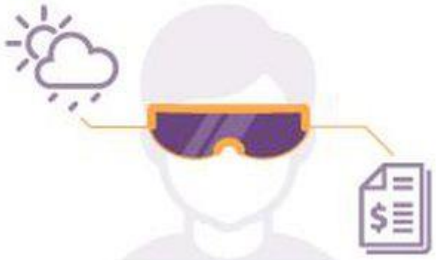
In augmented reality, users see and interact with the real world while digital content is added to it. If this sounds unclear think of Pokemon Go – millions of people all over the world have been rushing with their smartphones in search for small virtual creatures. That's the most vivid example of augmented reality.

If you own a modern smartphone, you can easily download an AR app and try this technology. There's a different way to experience augmented reality, though – with special AR headsets, such as Google Glass, where digital content is displayed on a tiny screen in front of a user's eye.

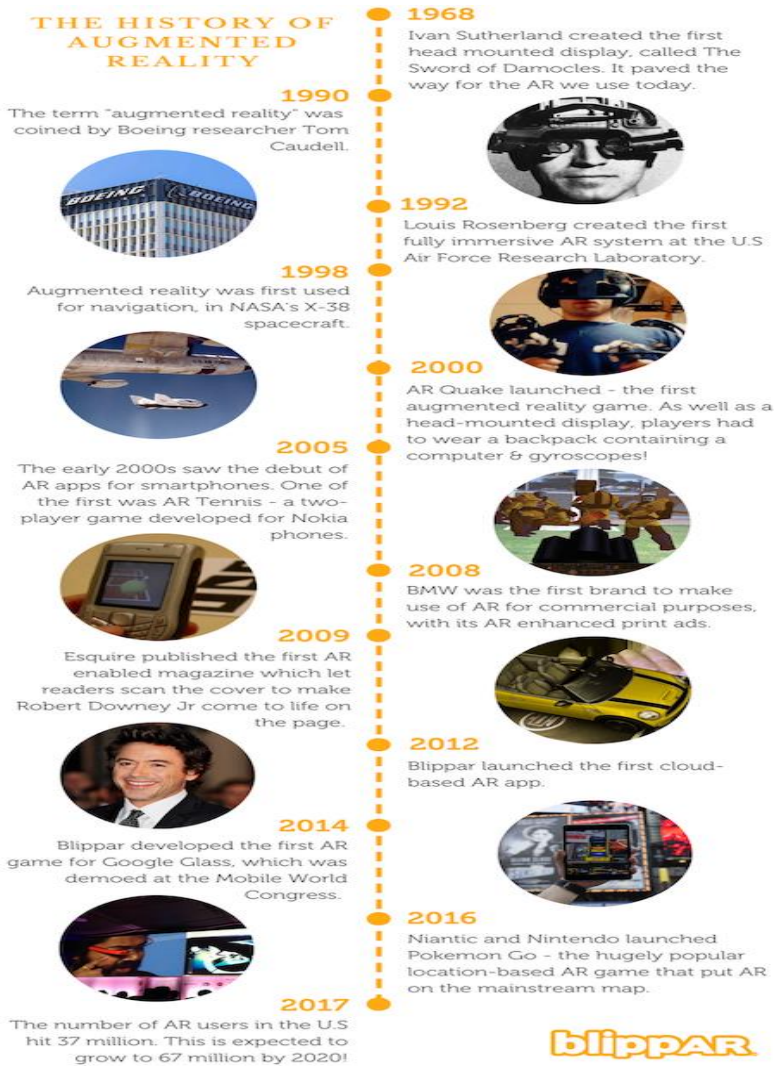
Mixed Reality

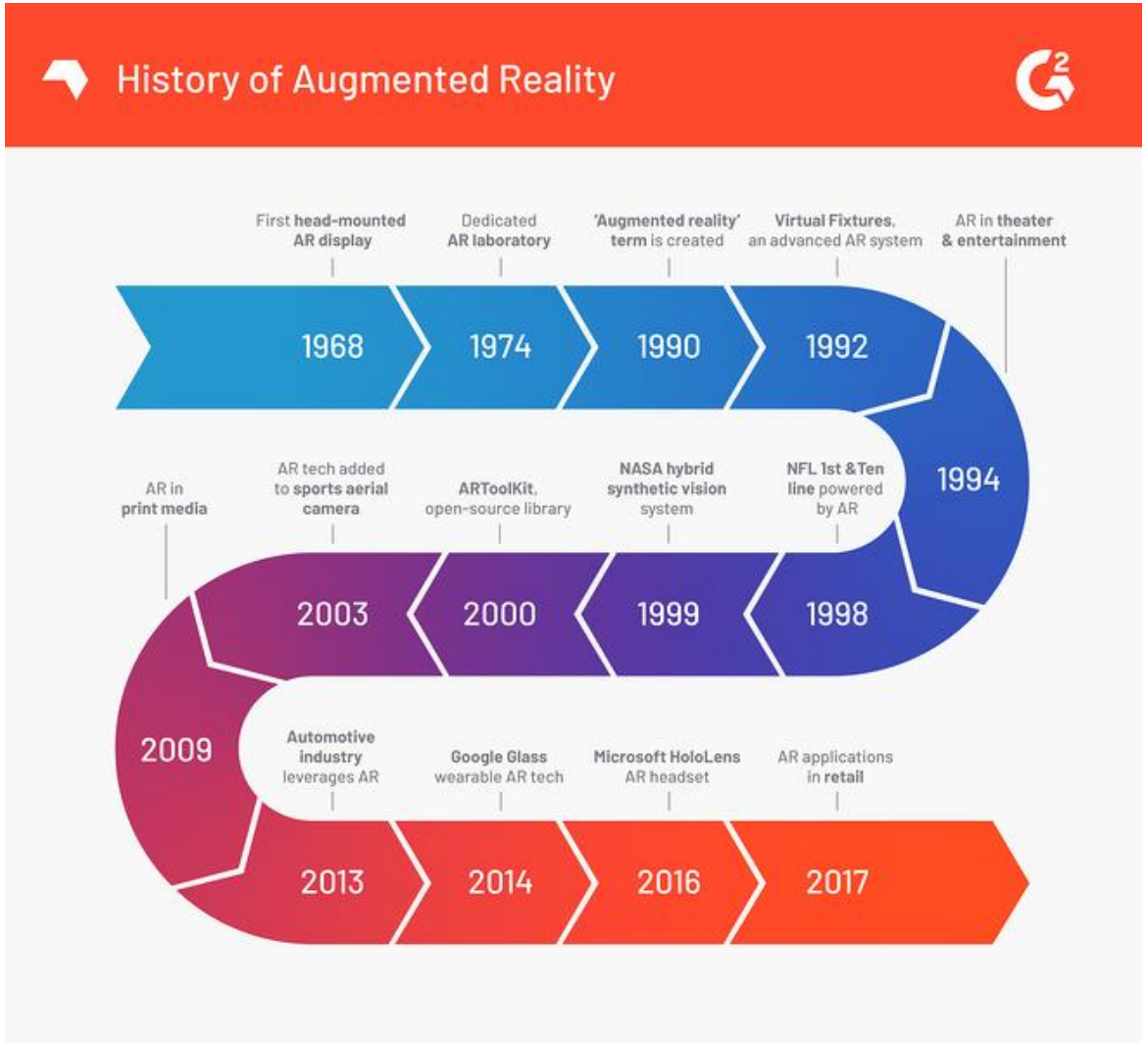
This is the most recent development in reality technologies that sometimes causes confusion, primarily because different experiences are called so. Without going too deep into science, let's look at two forms of reality technologies that are referred to as mixed reality (we've mentioned just one of them at the very beginning):

- ***Mixed reality that starts with the real world*** – virtual objects are not just overlaid on the real world but can interact with it. In this case, a user remains in the real-world environment while digital content is added to it; moreover, a user can interact with virtual objects. This form of mixed reality can be considered an advanced form of AR.
- ***Mixed reality that starts with the virtual world*** – the digital environment is anchored to and replaces the real world. In this case, a user is fully immersed in the virtual environment while the real world is blocked out. Sounds like virtual reality, right? In fact it does, but the digital objects overlap the real ones whereas in conventional VR the virtual environment isn't connected to the real world around a user. To experience this form of mixed reality, you can wear Windows mixed reality headsets

VIRTUAL REALITY (VR)	AUGMENTED REALITY (AR)	MIXED REALITY (MR)
Fully artificial environment	Virtual objects overlaid on real-world environment	Virtual environment combined with real world
		
Full immersion in virtual environment	The real world enhanced with digital objects	Interact with both the real world and the virtual environment
		

History of Augmented Reality





Augmented reality in the 60s & 70s

Let's take a look back to see how AR technology was created in the first place.

1968: Ivan Sutherland, a Harvard professor and computer scientist, created the first head-mounted display called 'The Sword of Damocles'.

1974: Myron Kruger, a computer researcher and artist, built a laboratory at the University of Connecticut called 'Videoplace' that was entirely dedicated to artificial reality.

Augmented reality in the 80s & 90s

Now, let's learn how AR transitioned out of the lab and into various industries and business applications.

1990: Tom Caudell, a Boeing researcher, coined the term 'augmented reality'.

1992: Louis Rosenburg, a researcher in the USAF Armstrong's Research Lab, created 'Virtual Fixtures', which was one of the first fully functional augmented reality systems.

1994: Julie Martin, a writer and producer, brought augmented reality to the entertainment industry for the first time with the theater production titled *Dancing in Cyberspace*.

1998: Sportsvision broadcasts the first live NFL game with the virtual 1st & Ten graphic system – aka the yellow yard marker. The technology displays a yellow line overlayed on top of the feed to that views can quickly see where the team just advance to to get a first down.

1999: NASA created a hybrid synthetic vision system of their X-38 spacecraft. The system leveraged AR technology to assist in providing better navigation during their test flights.

Augmented reality in the 2000s

By now, AR has a foothold in the fast-paced tech landscape. Let's see how its eventually rolled out to everyday consumers.

2000: Hirokazu Kato developed an open-source software library called the **ARToolKit**. This package helps other developers build augmented reality software programs. The library uses video tracking to overlay virtual graphics on top of the real world.

2003: Sportvision enhanced the 1st & Ten graphic to include the feature on the new Skycam system – providing viewers with an aerial shot of the field with graphics overlaid on top of it.

2009: *Esquire Magazine* used augmented reality in print media for the first time in an attempt to make the pages come alive.

2013: Volkswagen debuted the MARTA app (Mobile Augmented Reality Technical Assistance) which primarily gave technicians step-by-step repair instructions within the service manual.

2014: Google unveiled its Google Glass devices, a pair of augmented reality glasses that users could wear for immersive experiences.

2016: Microsoft starts shipping its version of wearable AR technology called the HoloLens, which is more advanced than the Google Glass, but came with a hefty price tag. It's definitely not an everyday type of accessory.

2017: IKEA released its augmented reality app called IKEA Place that changed the retail industry forever.

The future of augmented reality

As we become increasingly dependent on our mobile devices, the adoption of augmented reality technology will begin to rise. **AR software** advances will be the way forward as the overwhelming majority of consumers have a smartphone and already take it everywhere with them, making it a convenient medium to bring AR to nearly every consumer.

The truth is, augmented reality is already used by everyday consumers – they just don't know it. AR still seems to be misconstrued as too 'high tech' for your average Joe. But, the Snapchat dog filter and others are powered by AR. The biggest shift in augmented reality will have to be how its delivered to change the perception.

Basic Characteristics of Augmented Reality:

- **Overlay of real and digital world**

Augmented **reality** (AR) uses **digital** technology to **overlay** information in video, text or image format onto everyday objects in the **real world**. The user will normally use a smartphone, tablet or headset to view the **world** using AR. ... AR differs from virtual **reality**

- **Real-time interaction**

Augmented Reality has matured significantly over the last few years and the AR landscape has recently experienced some tectonic shifts which make it clear the demand for real time shared experiences within immersive virtual realities.

- **Registration and alignment in 3d**

The patient's head for the **alignment** between the patient and the D model from his beacons, **3D** prints, **3D** virtual experiences -**augmented** reality

Challenges and Issues With Augmented Reality

The following challenges with augmented reality are negatively affecting the mainstream adoption of the technology:

Hardware issues
AR headsets have bulky hardware that may also be too expensive for the masses.

Limited content
Creating augmented reality content to promote businesses can be extremely complex and expensive.

Lack of regulations
Currently, there are no regulations to govern the usage of augmented reality.

Public skepticism
Consumers are unaware of the benefits and applications of augmented reality.

Physical safety risks
Augmented reality applications can be immensely distracting and may lead to physical injuries.

Hardware issues

Currently, every available AR headset is a bulky piece of hardware that may be too expensive for the masses. Also, a majority of AR headsets need to be tethered to a computer, making the entire experience limited and inconvenient. Alternatively, consumers can use their smartphones or tablets for AR applications. However, mobile AR faces major issues in displaying visuals accurately. For instance, mobile sensors such as accelerometer can be disturbed by electric interference, which is commonly witnessed in urban areas. Additionally, smartphone cameras are built for 2D image capture and are incapable of rendering 3D images. Hence, the hardware required for AR technology needs to be enhanced before mass adoption.

Limited content

One of the major challenges with augmented reality is creating engaging content. The content created for augmented reality devices consists of games and filters used in social networks such as Instagram and Snapchat. However, creating content that can promote businesses can be extremely complicated and expensive. Also, augmented reality developers have not created enough high-functioning use cases that can be used by consumers on a daily basis.

Lack of regulations

Currently, there are no regulations that help businesses and consumers understand which type of AR applications can be used and how data can be processed. Hence, the technology can be used with malicious intent. For instance, a cybercriminal can hijack personal accounts by mining data output and manipulating AR content. In such cases, consumers may have questions like who could be held accountable, which mitigation strategies can be used, and how to avoid such incidents in the future. Hence, one of the significant challenges of augmented reality is creating regulations that can ensure the privacy and security of consumer data as well as simplify mainstream adoption of the technology.

Public skepticism

Although augmented reality is a popular topic of discussion among tech experts, consumers are unaware of the benefits of the technology. Consumers have only used the most popular applications of augmented reality such as trying out glasses, wardrobe, and accessories. Therefore, consumers need to be informed about various applications and benefits of augmented reality. Additionally, a lack of awareness may lead to concerns about privacy and security while using augmented reality technology. Hence, users' concerns need to be addressed to accelerate the mainstream deployment of augmented reality.

Physical safety risks

Augmented reality applications can be immensely distracting and may lead to physical injuries. For instance, many people were injured while playing Pokemon Go. Likewise, augmented reality applications can lead to serious injuries in case they are used in potentially risky environments such as busy roads, construction sites, and medical institutions.

Although augmented reality technology is still in its infancy, its existing applications have shown that further research and development to address the challenges with augmented reality can enable large scale deployment of the technology. And once that happens, the implementation of augmented reality can be witnessed in law enforcement, healthcare, finance, and other critical areas.

Augmented Reality With SDKs

When it comes to choosing a development kit, it's easy to get frustrated by the number of tools available. In order to pick the SDK that best suits your project, you should make sure it supports all the features your app requires.

In the following, we detail the main points to consider.

- Cost
- Platforms
- Image recognition
- 3D recognition and tracking
- Unity support
- Open Scene Graph support
- Cloud support vs local storage
- GPS support (geolocation)
- SLAM support

Cost

Pricing is the first distinguishing mark of an AR SDK. For those who want to try AR development for the first time, the best options are free open-source AR SDKs, which are open to contributions and can be extended with new features proposed by developers.

Paid SDKs in most cases offer several pricing plans, depending on the user's needs. As it happens, free tiers have limited possibilities and are meant to be a “demo version” of the full product. Building a complex app with large, dynamic content will likely require a commercial license. So be ready to pay.

Platforms

If you plan to develop your app for iOS or Android, there won’t be any problems when choosing an augmented reality toolkit, since nearly all of them support them. Meanwhile, the choice of tools that are compatible with Windows or macOS is rather small. Still, you can build your app for Windows computers or smartphones using augmented reality development kit, supporting the Universal Windows Platform (UWP).

Image recognition

This feature is a must-have for any AR app as it allows to identify objects, places and images. To this aim, smartphones and other devices use machine vision together with camera and artificial intelligence software to track images that can be later overlayed with animations, sound, HTML content etc.

3D recognition and tracking

3D image recognition and tracking is one of the most valuable features of any AR SDK. Due to the tracking, an app can "understand" and enhance the large spaces around the user inside of large buildings such as airports, bus stations, shopping malls, etc. Applications supporting it can recognize three-dimensional objects like boxes, cups, cylinders, toys etc.

Currently, this technology is commonly used in mobile games and e-commerce.

Unity support

Unity is known to be the most popular and powerful game engine worldwide. Though it's usually used for developing computer games, it can also be utilized for making AR apps with powerful effects. Whether you are going to create a cutting-edge experience or extend a more traditional idea with new techniques, multipurpose tool like Unity allows you to implement both.

Open Scene Graph support

OpenSceneGraph is an open source 3D graphic toolkit (application programming interface). It's used by app developers in such domains as computer games, augmented and virtual reality, scientific visualization and modelling.

Cloud support vs local storage

When developing AR mobile applications, you have to decide whether user data will be stored locally or in the cloud. This decision is mostly driven by the number of markers you are going to create. If you are planning to add a large number of markers to your app, consider storing all this data in the cloud, otherwise your app will use much storage on the device. Furthermore, having an idea of the number of markers your app uses also matters because some augmented reality SDKs support a hundred markers while others support thousands.

On the other hand, storing markers locally (i.e., on-device) enables users to run your augmented reality app offline, which could be convenient as you don't always have Wi-Fi or mobile-data available.

GPS support (geolocation)

If you are going to create a location-based AR application, geolocation is a fundamental feature that must be supported by the AR tool you are going to use. GPS can be used both in AR games like Pokemon Go as well as in apps made to overlay data on some nearby locations (for example to find the nearest restaurant).

SLAM support

SLAM means Simultaneous Localization and Mapping. It is an algorithm that maps the environment where the user is located and tracks all of their movements. AR apps containing this feature can remember the position of physical objects within some environment and position virtual objects accordingly to their position and users movements. SLAM has huge potential and can be used in many kinds of apps, not only AR apps. The main advantage of this technology is the ability to be used indoors while GPS is only available outdoors.

Top 6 Augmented Reality SDK for Mobile Apps

Vuforia

Vuforia is a leading portal for augmented reality application development that has a broad set of features. Vuforia augmented reality SDK:

ARToolKit

ARToolKit is an open-source tool to create augmented reality applications. Even though it's a free library, it provides a rather rich set of features for tracking, including:

Google ARCore

With two millions Android active users, Google could not miss the chance to give developers an opportunity to create AR apps on this operating system. That's how Google ARCore appeared.

Apple ARKit

With iOS11, Apple introduced its own ARKit, announced during Apple's Worldwide Developers Conference in June 2017.

Maxst

MAXST has two SDKs available: a 2D SDK for image tracking and a 3D SDK for environment recognition.

Wikitude

Wikitude has recently introduced its SDK7, including support for simultaneous localization and Mapping.

Advantage and Dis Advantage of Augmented Reality Vs Virtual Reality

Augmented Reality		Virtual Reality	
Advantage	**Disadvantage**	**Advantage**	**Disadvantage**
Increase user knowledge and information	Quite expensive to use it in everyday life and it might be less accessible for small businesses	Virtual Reality in education field makes education more easily and comfort	VR is becoming much more commonplace but programmers are still stuck with how to interact with virtual environments.
Ability to Share your experience with other people in real time over long distances	Regarding user experience, socially using Augmented Reality may be inappropriate in some situations	Virtual Reality user can experiment with an artificial environment	Escapism is common place among those that use VR environments and people often live in the virtual world instead of dealing with the real one