GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

A Report

On

'Augmented Reality'

Submitted in partial fulfillment of the

Requirement for the award of the degree of

'B.Tech CSE'

Under The Supervision of

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GALGOTIAS UNIVERSITY, GREATER NOIDA

INDIA

December, 2021

CANDIDATE'S DECLARATION

We hereby certify that the work which is being presented in the thesis, entitled **"Augmented Reality"** in partial fulfilment of the requirements for the award of the B.Tech submitted in the School of Computing Science and Engineering of Galgotias University, Greater Noida, is an original work carried out during the period of 9, 2021 to 12 and 2021, under the supervision of Mr. K.Parbu Assistant Professor, Department of Computer Science and Engineering/Computer Application and Information and Science, of School of Computing Science and Engineering , Galgotias University, Greater Noida

The matter presented in the thesis/project/dissertation has not been submitted by me/us for the award of any other degree of this or any other places.

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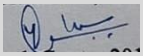

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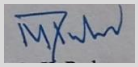

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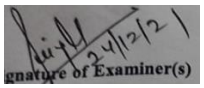

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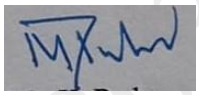

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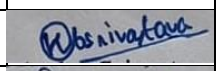
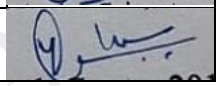
Karmendra Bahadur Srivastava	201010611	6/3rd Sem	karmendra5902@gmail.com	
Yash Gupta	201010803	9/3rd Sem	m5s4jyash@gmail.com	

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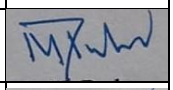
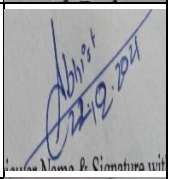
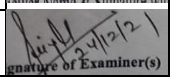
Mr. K. Prabu	Mentor/Guide	k.prabu@galgotiasuniversity.edu.in	9080340376	
Mr. Abhist Kumar	Reviewer - 2	Abhist.kumar@galgotiasuniversity.edu.in	8126788064	
Ms. Priyanka Gaba	Examiner	Priyanka.gaba@galgotiasuniversity.edu.in	7042167421	

Context -

Abstract

Augmented Reality is a combination of real world and computer or non-real thing. It is accomplished by adding computer-generated images to the real world. It is a four-dimensional fact, based on the mark, based on speculation and based on the unpopularity of taxpayers. It has many applications in the real world. AR is used in a variety of fields such as medicine, education, manufacturing, robots, and entertainment. The fact is that the unpopularity of taxpayers we see falling within the category of mixed facts. It can be considered as the opposite manifestation of Virtual Reality. Both have some similarities and differences. This paper provides information on Some Favorites and How to Get Started. It analyses the different types of taxpayer information we see, its use and its advantages and disadvantages. This paper also gives us information about those major threats they will face in the near future as well as your current and future applications. It gives us a comparison between two related topics, the unpopular truth of the taxpayers we see and the truth. The following page also helps us to understand the effect of Augmented Reality on human life.

Introduction

What is AR?

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

Amid the rise of data collection and analysis, one of augmented reality's primary goals is to highlight specific features of the physical world, increase understanding of those features, and derive smart and accessible insight that can be applied to real-world applications. Such big data can help inform companies' decision-making and gain insight into consumer spending habits, among others.

Augmented reality (AR) involves overlaying visual, auditory, or other sensory information onto the world in order to enhance one's experience.

Retailers and other companies can use augmented reality to promote products or services, launch novel marketing campaigns, and collect unique user data.

Unlike virtual reality, which creates its own cyber environment, augmented reality adds to the existing world as it is.

Understanding Augmented Reality

The unpopular reality of the taxpayers we see continues to grow and spread widely among many different applications. Since its inception, retailers and technology companies have had to contend with the perception that the unpopular reality of taxpayers we see is more than just a marketing tool. However, there is evidence that consumers are beginning to reap tangible benefits from this activity and look forward to it as part of their purchasing process.

For example, some newcomers to the field of marketing have developed technologies that are designed to improve consumer perception. With the actual integration of unpopular taxpayers we see in catalog applications, stores allow consumers to visualize what

different products might look like in different locations. With furniture, buyers point the camera at the right room and the product comes from the front.

Elsewhere, the real benefits of anonymity may extend beyond the health care sector, where they can play a significant role. Another option would be applications that allow users to view detailed, 3D images of different body systems as they move their mobile device over the target image. For example, the unpopular reality of the taxpayers we see could be a powerful learning tool for medical professionals in all their training.

Some experts have long assumed that clothing items may be the result of improved reality. While smartphones and tablets show a small part of the world-class design of users, smart eyeglasses, for example, can provide a perfect link between real and virtual environments if they develop enough to become commonplace.

What exactly is Augmented reality?

In layman's terms, Augmented Reality is a technology that enhances the real world by affixing layers of digital elements onto it. These elements include computer-generated graphics, sound or video effects, haptic feedback, or sensory projects.

The intention behind adding this digital information is to provide an engaging and dynamic customer experience that is enabled with the input received from varied hardware like smart glass, smart lenses, and smartphones.

Augmented Reality (AR) is often mistaken with Virtual Reality (VR). The main difference between the two is that while Virtual Reality replaces the entire real environment with an artificial one, Augmented Reality is applied in a direct view of an existing real environment and adds elements like sounds, videos, or graphics onto it.

The term Augmented Reality was coined back *in 1990 by Boeing researcher Tom Codell* and one of the first commercial uses of this technology was in television and the military. As the world shifted towards becoming more technology-driven, AR became increasingly prominent in multiple fields, rolling out its second wave and drawing its connection towards the

interactive concept. As the technology develops there emerge several new trends in Augmented Reality.

Now how does the AR technology work?

When we use a device or application enabled with the AR technology the hardware of the device or application captures the object's picture, sharing it with the computer vision program which then processes the image to gather all relevant details like the measurements of the object, any other objects which are present on the same surface, while also calculating how far these other objects are from the main object in focus.

By applying these insights the AR-enabled device will then develop and create virtual information that will serve as an overlay over the real object, giving a unique customer experience.

History of technology

Technical history is one of the stages of world history. Technology can refer to methods ranging from simple tools such as stone tools to sophisticated genetic engineering and information technology that have emerged since the 1980s. The word technology comes from the Greek word techne, which means art and art, and the word logos, which means word and expression. It was originally used to describe the art used, but is now being used to describe developments and changes affecting the environment.

New knowledge enables humans to create new things, and in contrast, many scientific endeavors are made possible by technology that enables humans to travel to previously inaccessible places, and the scientific tools with which we study nature in more detail than our natural senses. allow.

Since many technologies are used in science, the history of technology is linked to the history of science. From those resources, technology produces other resources, including technologies that are used in everyday life.

Digital Media

American engineers began to develop digital technology in the mid-twentieth century. Their strategy was based on the mathematical ideas suggested by the 17th-century German mathematician Gottfried Wilhelm Leibniz, who proposed a binary computer program. His new invention inspired numerical codes such as the American Standard Code for Information Interchange (ASCII) which describes digital objects.

Digital information is recorded in the binary code of the combination of digits 0 and 1, also called bits, representing words and pictures. Digital technology allows large amounts of information to be stored on small storage devices that can be easily stored and transported. Digital digitization also speeds up data transfer speeds. Digital technology has changed the way people communicate, learn, and work.

Communication relies on digital means of communication. In the early 1980's, advanced fiber optics enabled the development of digital communication networks. Digital technology has replaced the analog signals in many forms of telecommunications.

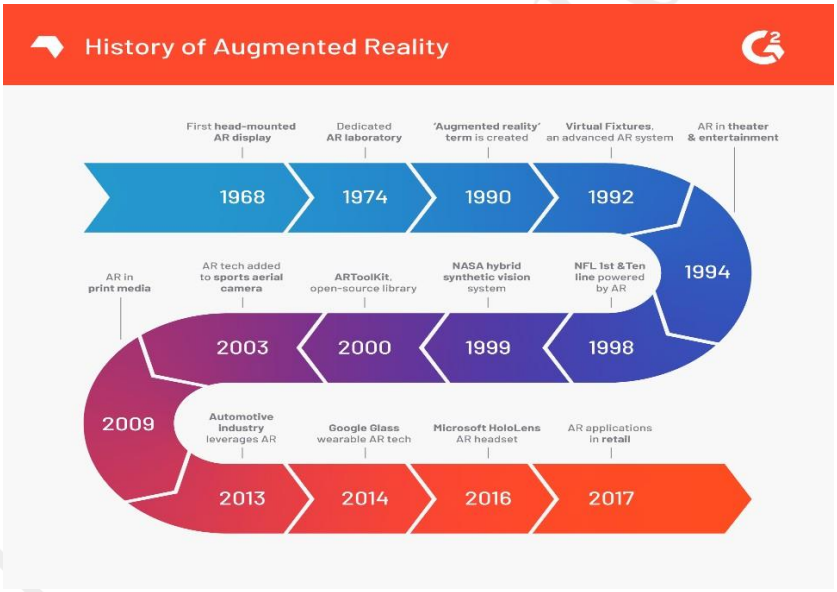
In 1998, digital television broadcasts were shown for the first time in the United States. Communication satellites (DBS) transmit compressed digital signals so that viewers can access several hundred television programming options. Other types of digital information, including audio programs, were sent to subscribers via satellite.

Digital printing with electrophotographic and formatted data technologies has changed the way books and magazines are published. The Library of Congress National Digital Library Project has worked to maintain and expand access to rare objects. Copyright issues related to digital technology deal with the copying of music and videos without actors receiving royalties.

In the early 2000's, digital computers ranging from laptop computers to internet networks came in many sizes and performed a variety of functions. Computers have created sophisticated statistical analysis that analyzes large amounts of data. Digital Data Broadcast System (DDBS) directs air traffic control. Along with digital camers capturing color and intensity of light pixels and Photo and video compression JPEG.

Discovery of AR

- The launch of Pokémon Go for both for the gaming industry and for Augmented Reality (AR). After launching in July 2016, the game hit its peak in August of almost 45 million users. The phenomenon demonstrated AR's potential to be adopted by mainstream culture.
- Aside from complex technological advances (smartphones), three other elements have enabled the mass adoption of AR apps: 1) meaningful content, 2) convincing and realistic interaction of the virtual with the physical environment, 3) unique value that goes beyond what other technologies deliver.
- Pokémon Go hits all of these targets, and it offers useful direction for designing future AR games. But it also has implications for areas outside of entertainment, such as marketing, fashion, tourism, and retail.



Phase 1: Attention-grabbing early efforts

The first AR technology was developed in 1968 at Harvard when computer scientist Ivan Sutherland (named the "father of computer graphics") created an AR head-mounted display system. In the following decades, lab universities, companies, and national agencies further advanced AR for wearables and digital displays. These early systems superimposed virtual information on the physical environment (e.g., overlaying a terrain with geolocal information), and allowed simulations that were used for aviation, military and industrial purposes.

The first commercial AR application appeared in 2008. It was developed for advertising purposes by German agencies in Munich. They designed a printed magazine ad of a model BMW Mini, which, when held in front of a computer's camera, also appeared on the screen. Because the virtual model was connected to markers on the physical ad, a user was able to control the car on the screen and move it around to view different angles, simply by manipulating the piece of paper. The application was one of the first marketing campaigns that allowed interaction with a digital model in real time.

Other brands started adopting this idea of situating content on a screen and having consumers interact with it through physical tracking markers. We start seeing more advanced versions by brands such as National Geographic in 2011, which showed rare or extinct animal species as if they were walking through a shopping mall; Coca-Cola in 2013, which also simulated environmental problems, such as ice melting right beside you in a shopping mall; and Disney in 2011, which showed cartoon characters on a large screen in Times Square interacting with people on the street.

In each of these examples, the AR technology was used to engage customers at events or in public spaces. These types of displays aren't always scalable, as they require considerable investment - but we still see them today. For instance, Skoda ran a campaign in 2015, placing an AR mirror in a Victoria railway station in London, so that people passing by could customize a car and then see themselves driving it on a large screen.

Phase 2: Trying on products at home

Simulating digital products, so that they interact with movements in the real world in real time (usually through paper printouts), was a popular approach to AR in the early 2010s, especially for watches and jewelry. This technology let people virtually "try on" a product. Even the Apple watch was available for a similar virtual try-on. However, the task of printing out and cutting a special paper model so that it could fit one's finger or wrist has always been somewhat clunky, and it requires some effort from the consumer.

Much more successful apps are those that can offer a more seamless experience. Trying on products virtually, by instant face recognition, has been one of the most successful uses of AR in the commercial context so far, and make-up companies have been leading this use.

Predecessors of this technology were websites that overlayed make-up on an uploaded photo or avatar. But AR mirrors, developed by agencies like Holition, ModiFace and Total Immersion, have allowed customers to overlay make-up on themselves in real-time. The technology behind this is highly sophisticated, as it requires adapting virtual make-up to an individual's actual face. In order to create this personalization of virtual content - and make it seem real—the software uses 2D modeling technology and advanced face-tracking techniques. The effect delivers a highly perceived value: seeing one's face augmented with make-up not only offers a more convenient and playful way to try it on, but also allows consumers to assess looks that they would not have been able to create themselves or to try on combinations that they would not have thought of. That can't be delivered by simply uploading a photo to an app.

And this type of technology continues to advance. London-based AR agency Holition and agency Coty recently launched an AR app for the make-up company Rimmel, which lets a consumer scan the make-up of another person or an image and then immediately try that same look on his or her face. It takes the experience of look creation to a whole new level. Not surprisingly, the fashion industry has touted the technology, already picking up on its practicality, and consumer ratings for this type of AR apps keep increasing.

Phase 3: A broader range of uses

Aside from try-ons, a rich body of research also shows that AR can be incredibly valuable for exploring various cultural, historical, and geographic aspects of an environment. This type of app typically operates on the basis of a user pointing his mobile device towards an object or a site, in order to see superimposed content on the screen.

Apps developed for tourism purposes started appearing in the 2000s, but initially they were predominantly created in university labs. They've only started to become more widely used in recent years, thanks to technological advancement and a better understanding of the consumer experience. For example, the Museum of London has an app that shows you how the particular London street you're standing in used to look in the past - you just have to point your phone camera at it for the augmented version to appear on your screen.
Similarly, apps designed for museum contexts let visitors get more information about famous paintings by overlaying a description over it on smartphone screens in real time. Then there's

also Google Translate, an app that lets you instantly translate a text, whether it's on a sign or elsewhere, into a language you can read. And Google Sky Map can help you identify stars and planets if you just point your phone camera view toward the sky.

Research I conducted with Professor Yvonne Rogers and Dr. Ana Moutinho from University College London and with the English National Opera, suggests that AR apps could offer innovative support to cultural institutions as well. We observed how opera singers and theatrical make-up artists would take to virtual try-on apps: the AR mirror assisted singers as they were getting into character and building their roles; and make-up artists used it as a helpful tool for developing the artistic looks for each character. Visitors also interacted with the mirror to see what they'd look like as one of the operatic characters.

Each of these examples demonstrate how AR has distinctly evolved to complement and transform the way users experience products and their surroundings. And it will continue to advance as people come to expect more from it. Recent research I conducted with Dr. Chris Brauer of Goldsmiths, University of London, explored how this new generation of digital technologies are changing consumer experiences. Wearables and the Internet of Things have made consumers expect highly customized solutions and instant access to detailed personal data. And AR is reinforcing consumers' appetite for compelling and creative visualizations of content.

However, our research has also shown that despite the increased use of such technologies, consumers are not yearning for the robotic digitization of their everyday lives. Rather, they want technologies that weave themselves seamlessly into their activities. Consumers expect their digital experience to be more human and empathic, to be filled with emotional content, to surprise them with serendipitous occurrences, to allow for reciprocity and interactivity, and to offer the option of personalized adaptations. As designers and marketers continue to craft AR experiences, it will become crucial to acquire better understanding which areas of human lives can be visually enhanced.

Advantages of AR

1. The primary benefit of Augmented Reality is that it can be used by anyone including mentally and physically disabled individuals.
2. It blurs the line of difference between the virtual and real world, thus increasing its usability and effectiveness in the area of application.
3. It possesses a highly interactive nature which enable to assess several instances in advance.
4. Success or failure of an instance can be determined by using the computing power of AR, thus saving a ton of money.
5. It finds its heavy usage in the field of health, thus increasing the accuracy of diagnosis for diseases. Since now, it has saved lives of numerous patients.
6. It provides a much-enhanced sense of reality than any other technology in use.
7. It reduces the difference between what is digitally generated, and which is real in physical world.
8. The instructions provided in the AR based application makes it easy to understand the workflow of the application.
9. With the guided pathways, it delivers great user experience, thus offers better customer retention as well.
10. It is also used by militaries across the world to simulate a battlefield before actually putting their lives at risk.

Disadvantages of AR

1. One major drawback of AR based application is the lack of privacy
2. AR based applications or devices cannot be leveraged without appropriate training thus increase costs and time involved
3. There can be certain instances where such applications have recorded low performance, thus reducing the overall appeal of the package.
4. It can get extremely costly to develop and maintain an AR based device or an application.
5. With so limited difference between reality and digital world, sometimes extreme conditions can be simulated which might prove to be dangerous for individuals.
6. The applications or devices associated with AR technology suffers from lack of privacy thus putting user data at risk
7. There is a huge list of hardware and software resources required for the implementation of AR technology.
8. The AR technology involves extremely high costs of development, implementation, and maintenance.
9. The applications lay extraordinarily little emphasis on maintaining confidentiality of an individual.
10. There can arise certain situations which can even lead to devastating accidents and huge health issues such as psychological effects

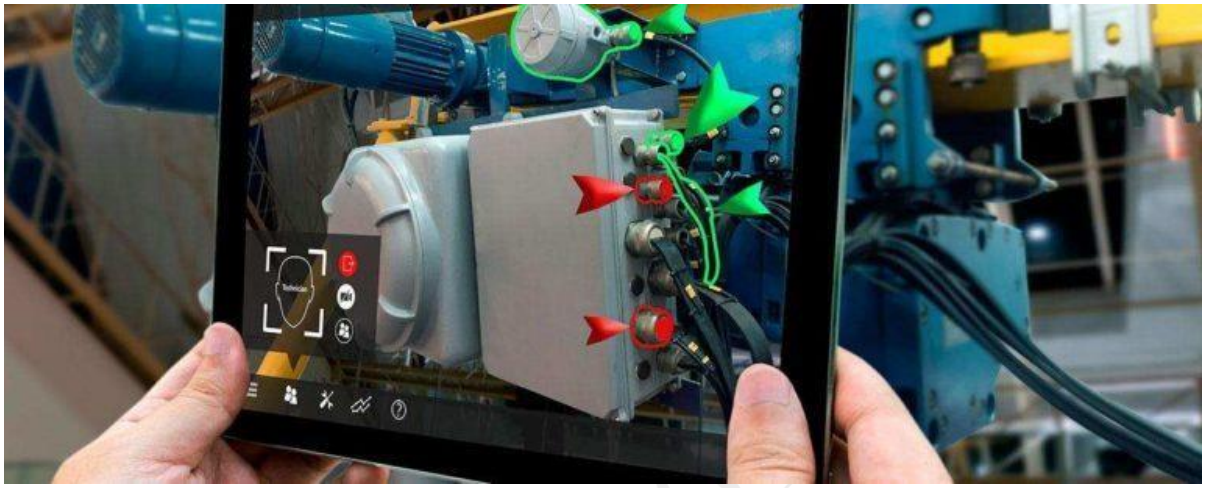
Application of AR

a) Real-life Based –

1. Medical Training - From operating MRI equipment to performing complex surgeries, AR tech holds the potential to boost the depth and effectiveness of medical training in many areas. Students at the Cleveland Clinic at Case Western Reserve University, for example, will now learn anatomy utilizing an AR headset allowing them to delve into the human body in an interactive 3D format.

2. Retail - In today's physical retail environment, shoppers are using their smartphones more than ever to compare prices or look up additional information on products they're browsing.

3. Repair & Maintenance - One of the biggest industrial use cases of AR is for repair and maintenance of complex equipment. Whether it's a car motor or an MRI machine, repair and maintenance staff are beginning to use AR headsets and glasses while they perform their jobs to provide them with useful information on the spot, suggest potential fixes, and point out potential trouble areas.

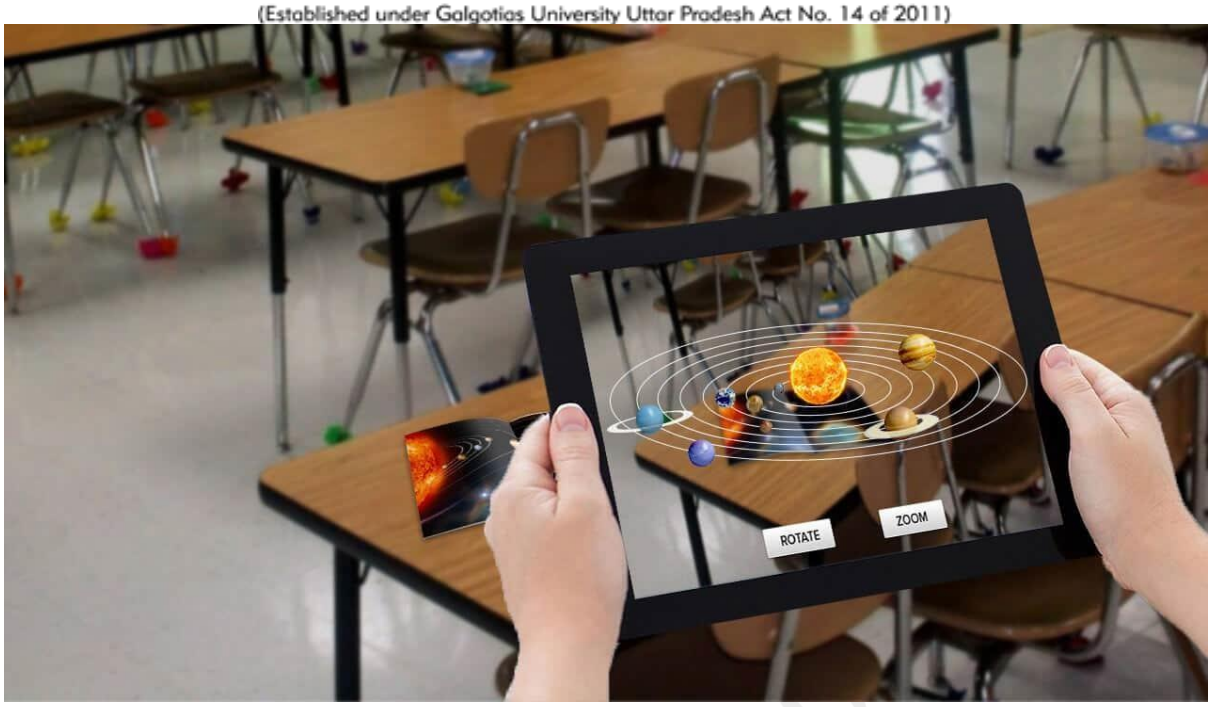


4. Design & Modeling - From interior design to architecture and construction, AR ishelping professionals visualize their final products during the creative process. Use of headsets enables architects, engineers, and design professionals step directly into their buildings and spaces to see how their designs might look, and even make virtual on the spot changes.

5. Business Logistics - AR presents a variety of opportunities to increase efficiency and cost savings across many areas of business logistics. This includes transportation, warehousing, and route-optimization.

6. Tourism Industry - Technology has gone a long way towards advancing the tourism industry in recent years, from review sites like TripAdvisor to informative website like Lonely Planet. But AR presents a huge opportunity for travel brands and agents to give potential tourists an even more immersive experience before they travel.

7. Classroom Education - While technology like tablets have become widespread in many schools and classrooms, teachers and educators are now ramping up student's learning experience with AR. The Aurasma app, for example, is already being used in classrooms so that students can view their classes via a smartphone or tablet for a more rich learning environment.



8. Field Service - Whether it's something as small as an air conditioner, or as large as a wind turbine, every day field service technicians get dispatched to repair a piece of mission critical equipment that needs to get up and running as soon as possible.

9. Entertainment Properties - In the entertainment industry, it's all about building a strong relationship with your branded characters and the audience. Properties like Harry Potter are immensely successful because readers of the books and watchers of the movies feel like they know the characters, and are hungry for additional content.

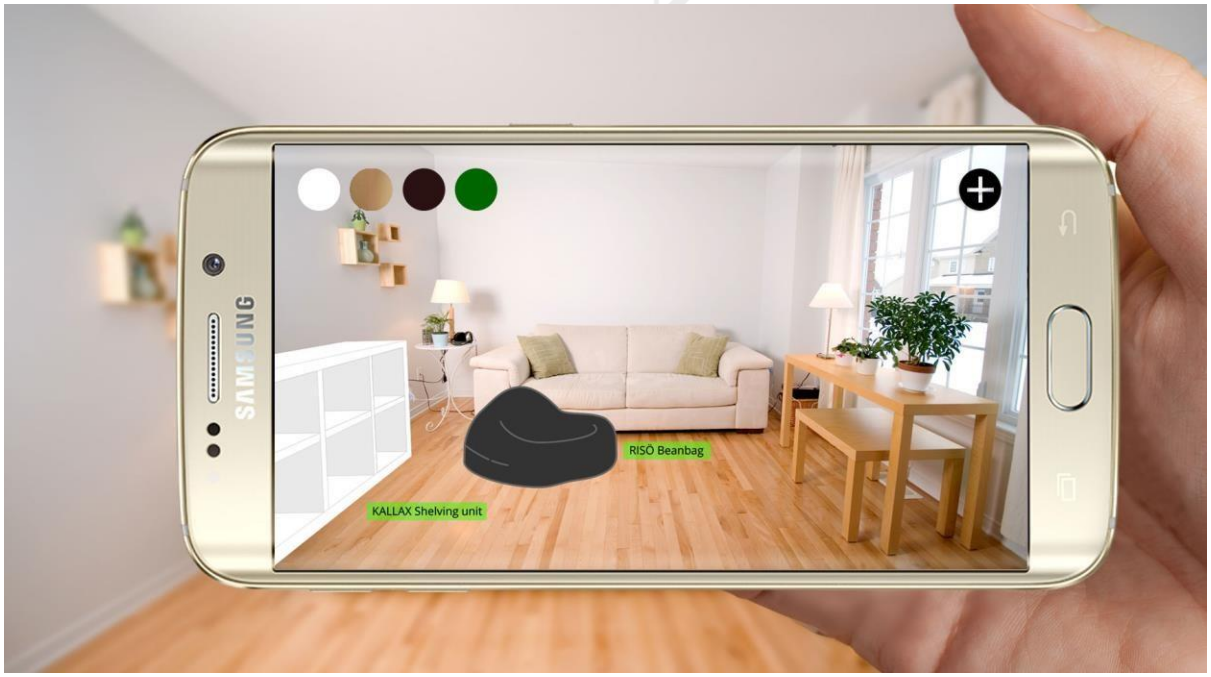
10. Public Safety - In the event of an emergency today, people will immediately reach for their smartphone to find out what's going on, where to go, and whether their loved ones are safe. Moreover, first responders arrive on the scene of a fire or earthquake trying to figure out who needs help, and the best way to get them to safety. AR is showing promise in solving both pieces of the public safety puzzle.

b) Virtual World based

1. Houzz - A great platform for home goods and furniture sellers, Houzz is one of the top AR apps for planning interior layouts and design. Primarily a home improvement app, Houzz has ecommerce functionality, allowing users to browse and buy products in-app.

The “View in My Room” feature uses AR technology to place products into a photo of the user’s home - using 3D technology.

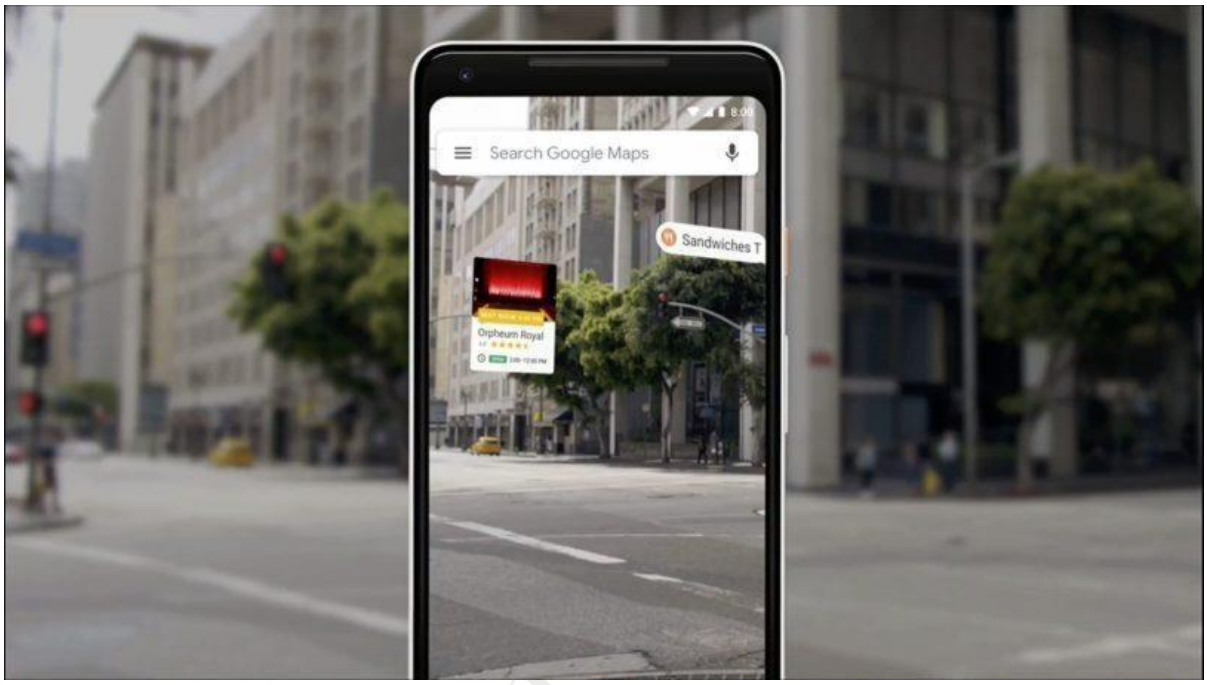
2. IKEA Place - It also focuses on home decor. The Swedish furniture retailer gives shoppers a chance to put their products in their homes - no assembly required. This app looks at the bigger picture, taking into account your home's entire floor plan to see which items will fit best where with Easy drag-and-drop functionality



3. YouCam Makeup – YouCam does allowing shoppers to test makeup from tons of major brands with AR technology.

4. GIPHY World - This app combines animated GIFs and AR, turning photos and videos into canvasses for 3D graphics (a lot like Snapchat does). It Add graphics and animated elements to product photos to give them extra flair for a social audience.

5. Google Lens - Google Lens enhances the search experience. Instead of typing in a text-based query, open the app and aim it at what you want to learn more about. Google Lens will identify the object, tell you what the text says, and even store important numbers. And will tells where to buy the object



6. Augment – The Augment is aimed at e-commerse store owners, who can use the app to create augmented images of their products. These assets are then primed for your own AR experience, whether that's in your mobile app, on your website, at in-person activations, or via some other channel.

7. ROAR – For business uses, There are tons of ways to use it: create an AR-powered online store accessible when customers scan product packaging at home, incorporate AR into print ads, and see which products and categories are most popular when experienced through AR.

On the consumer side, the app enhances both in-store and at-home brand experiences by providing deeper, more engaging content and information about the products they're interested in. They can browse reviews, look at pricing, and purchase the product in-app.

8. Amikasa – Amikasa aggregates products from all over the web, so shoppers can create a cohesive room without visiting every store or website. Users can even purchase items without ever leaving the app.

9. Snapchat - Brands can incorporate Snapchat marketing and AR into their strategy by creating a presence and also investing in branded filters.

10. Wanna Kicks - Designed specifically for sneaker lovers, Wanna Kicks puts virtual versions of footwear on your feet. You can see what they actually look like if you were to wear them - from any angle.

Current Market on AR

The augmented reality market was valued at USD 14.7 billion in 2020 and is projected to reach USD 88.4 billion by 2026; it is expected to grow at a CAGR of 31.5% from 2021 to 2026.

The key factors driving the growth of the augmented reality market include surging demand for AR devices and applications in healthcare, growing demand for AR in retail and e-commerce sectors due to COVID-19, rising investments in the AR market, increasing demand for AR devices and technology in the global automotive industry, and others.

The recent COVID-19 pandemic is expected to impact the global augmented reality market. Due to COVID-19, the manufacturing units of major players are highly hampered due to worldwide lockdown and limited availability of labor and raw material. A number of scheduled product launches and related developments have been postponed due to the pandemic. However, the impact of COVID-19 is expected to reduce during the forecast period.

APAC to account for the largest share of the augmented reality market during the forecast period, The flourishing enterprises (manufacturing) sector in China and Japan is projected to fuel the growth of the augmented reality market in APAC. The gaming industry in this region has also witnessed significant growth, thereby contributing to the increased demand for augmented reality technology in APAC.

Additionally, rising investments in commercial applications of augmented reality are also expected to contribute to the growth of the market in APAC. Moreover, the thriving healthcare and automotive sectors in Japan are also projected to drive the demand for AR technology in the region.

The novel coronavirus has affected the global economy to a large extent. The economies in APAC, including Japan, China, South Korea, India, and Australia, have a significant contribution toward the global economy as they are home to various manufacturing and assembly plants in the world.

China, which is known as the manufacturing hub of the world, faced a serious economic crisis owing to the spread of the virus and brought all economic activities to a

standstill for weeks. The other countries, such as India, Australia, South Korea, and Japan, have also witnessed a downfall in the economic activities across various sectors.

Some of the key companies operating in the augmented reality market are Google, Inc. (US), PTC Inc. (US), Seiko Epson (Japan), Microsoft (US), Lenovo (Hong Kong), Samsung Electronics (South Korea), Apple (US), and so on.

Premium Insights

- Augmented Reality Market in APAC to Grow at Highest CAGR from 2021 to 2026
- Software Segment to Hold Larger Size of Market from 2021 to 2026
- Consumer Segment Held Largest Share of Market in 2020
- China to Register Highest CAGR in Market During Forecast Period
- Hmd to Dominate Market from 2021 to 2026
- Market Dynamics

Drivers

- Increasing Adoption of AR Technology in the Healthcare Sector
- Growing Demand for AR in Retail and E-Commerce Sectors Due to COVID-19
- Rising Investments in AR Market
- Surging Demand for AR Devices and Technology in Global Automotive Industry

Restraints

- Trade War Between US and China
- Security and Privacy Issues Associated with AR
- Health Issues Associated with Excessive Usage of AR

Opportunities

- Continuous Developments in 5G Technology
- Opportunities in Enterprise Applications
- High Growth of Travel & Tourism Industry

Challenges

- Global Economic Slowdown Owing to COVID-19

- Reluctance of Users in Accepting AR Products Due to Health Concerns
- Reconfiguration of Applications for Different Platforms

Technology Analysis

- Mobile Augmented Reality
- Monitor-Based AR Technology
- Near-Eye-Based Technology
- Lidar Technology
- Web AR

Case Study Analysis

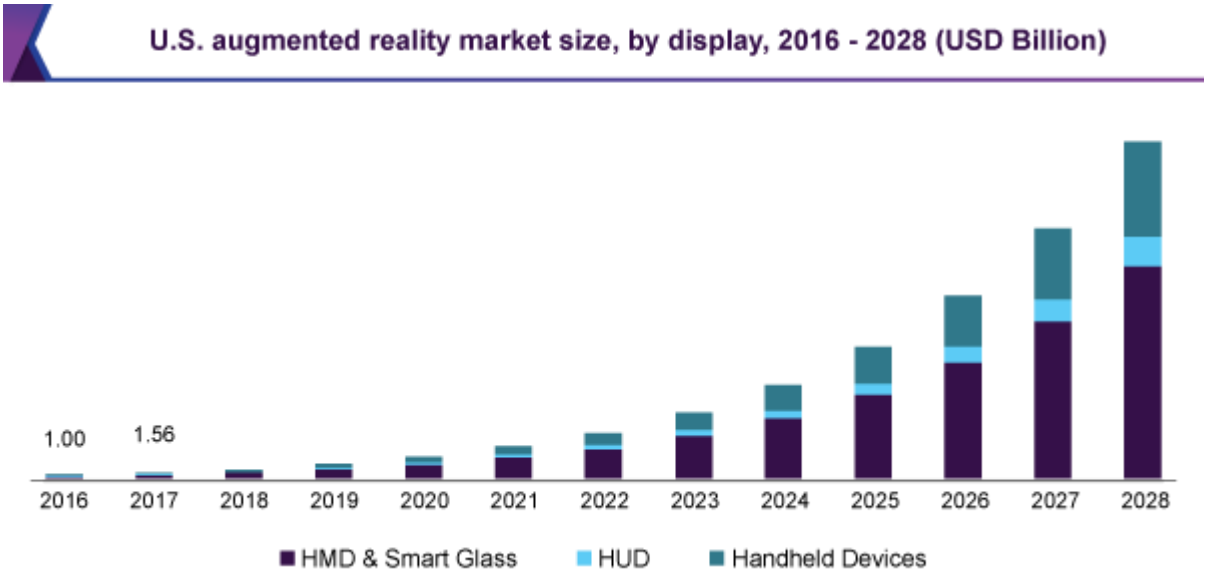
- Providing Dynamic Sales Training to Teams of Royal Enfield During Pandemic Using Vuforia Studio
- Transforming Dental Surgeries with Moverio Smart Glasses
- First Microsoft Hololens Surgery in Latin America: How Ar Can Change Surgical Experience for Doctors and Patients

Company Profiles

1. **Key Players**
   - Google, Inc.
   - Ptc Inc.
   - Microsoft
   - Lenovo
   - Samsung Electronics
   - Apple
   - Qualcomm
2. **Other Players**
   - Toshiba Corporation
   - Intel Corporation
   - Upskill
   - Visteon Corporation
   - Inglobe Technologies
   - Meta Company

Report Overview

The global augmented reality market size was valued at USD 17.67 billion in 2020. It is expected to expand at a compound annual growth rate (CAGR) of 43.8% from 2021 to 2028. The rising demand for remote assistance and collaboration from enterprises that assist in workflow management and optimization is expected to propel market growth. Businesses are using Augmented Reality (AR) - based apps for tracking, identifying, and resolving technical issues as well as for tasks, such as retrofitting, assembling, manufacturing, and repairing production lines. The growing preference among individuals for smartphones, smart glasses, and other handheld and wearable devices is driving the adoption of mobile AR technology to provide immersive experiences. As such, companies are particularly exploring the potential of AR technology to offer a customized and interactive experience to customers. For instance, in June 2018, Hennes & Mauritz AB's brand Monki adopted AR technology to offer a 3D experience to its customers through smartphones while presenting garments on the online platform.



The growing adoption of AR in healthcare applications is expected to drive the growth of the market. Several AR-based solution providers are collaborating with healthcare organizations to provide AR-powered healthcare applications for various purposes. For instance, in November 2018, Fundamental, VR entered into a strategic alliance with Mayo Clinic to jointly develop surgical VR simulations. Fundamental Surgery, a platform by Fundamental VR combining virtual reality with haptics to provide an affordable surgical simulator, has already been implemented at Mayo Clinic's main campuses in the U.S. states of Minnesota,

Florida, and Arizona. The adoption of AR technology has also been gaining traction in the marketing and advertising fields, especially since the outbreak of the COVID-19 pandemic, as AR-based virtual events, such as digital product and store launches, virtual exhibitions and tradeshows, and online commercials, are becoming the new norm. For instance, in July 2020, Blippar.Com Ltd. delivered the world's first product launch using AR technology and provided a highly interactive digital experience during the launch of OnePlus Nord.

The growing preference for using augmented reality in construction and architecture bodes well for the growth of the industry. AR technology can be used to prepare a 3D model of a plan using mobile devices to help architects in bridging the gap between imagination and reality. Similarly, in the education industry, AR can be used to provide a more detailed, immersive, and real-view knowledge to students. The potential AR holds in helping students in better understanding of the educational concepts using 2D/3D modeling, discovery-based learning, AR books, AR games, and AR-based skill development also bodes well for the growth of the market.

AR technology can also potentially transform indoor navigation. For instance, software development company MobiDev has already demonstrated indoor navigation using its ARcore platform by constructing an optimal route to the user’s desired destination and demonstrating it on a mobile device. When it comes to outdoor navigation, AR technology can help tourists in searching for suitable accommodation and selecting sites and locations to visit with the help of AR-based virtual tours. For instance, Hubs Hotels by Premier Inn has transmuted its rooms into a city map as part of the efforts to help customers in knowing about the tourist attractions near the hotel and other useful details. The growing adoption of AR technology in the travel and tourism industry is expected to drive the growth of the market for augmented reality.

Continued advances in AR technology and the growing adoption of the technology in consumer applications is driving the need for compatible AR chipsets. Companies, such as Qualcomm, AMD, and Intel, are responding to the situation and launching state-of-the-art AR-enabled chipsets. For instance, in May 2018, Qualcomm launched the Snapdragon XR1 chipset, which is dedicated to the extended reality platform. In December 2019, the company unveiled its 5G-enabled Snapdragon XR2 chipset for AR and VR hardware. Similarly, in July 2019, MediaTek Inc., a fabless chipmaker based in Taiwan, launched the MTK i700 chipset

for AR applications which is focused on Artificial Intelligence (AI) and Internet-of-Things (IoT).

Display Insights

The Head-Mount Display (HMD) and smart glass segment accounted for the largest revenue share of over 65.0% in 2020. It is expected to continue dominating the market over the forecast period owing to the significant demand for HMDs and smart glasses in industrial and enterprise settings. The growing number of applications in these settings, advances in OLED technology, and availability of lightweight HMDs are expected to drive the growth of the segment. While AR smart glasses require high computation power, the SoC is capable of processing the viewer's vision in real-time. For instance, in July 2019, Nvidia showcased an AR wearable that features a Foveated AR, which can track the viewer's eye and offer an improved visual experience. HMDs and smart glasses are also expected to transform the supply chain by identifying the possible use cases or optimal use cases in logistics and supply chain.

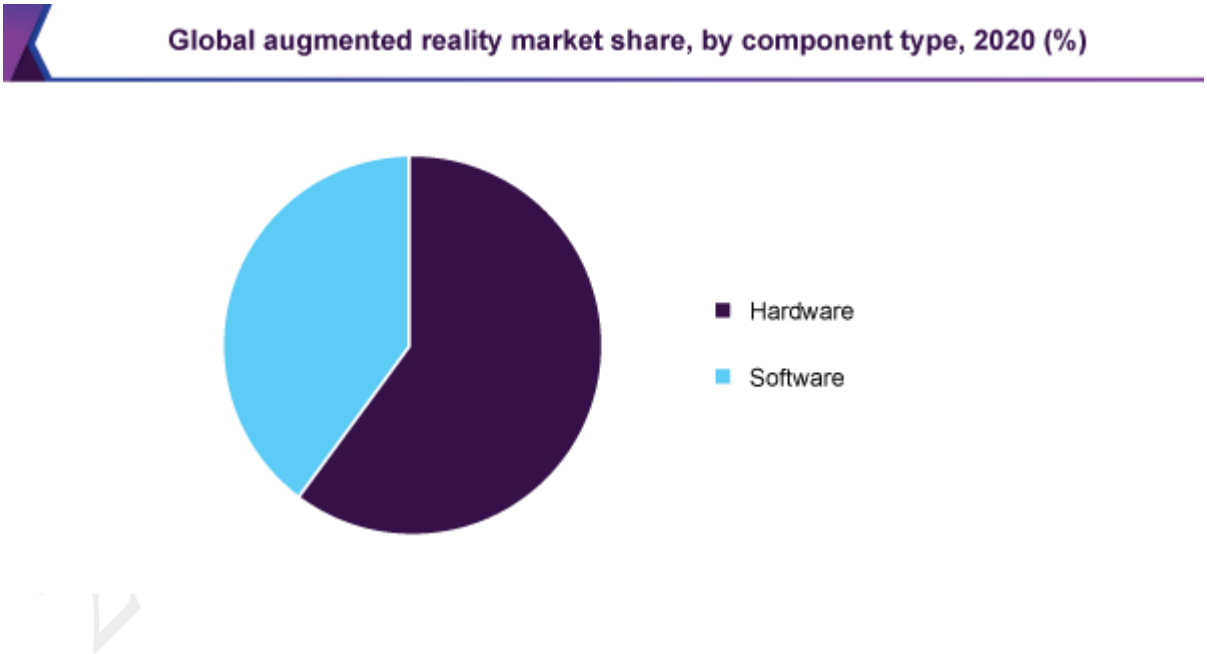
The handheld devices segment is expected to register the highest CAGR of over 45.0% from 2021 to 2028 owing to the growing deployment of handheld devices in retail and e-commerce applications. The proliferation of smartphones and tablets and the continued integration of AR in handheld devices is allowing companies to enhance consumer experience and gain a competitive edge in the industry. Handheld devices can help customers in trying out in-store products before making a buying decision. Aggressive deployment of AR across social media platforms is also driving the growth of the handheld devices segment. Companies, such as Google LLC and Apple Inc. are heavily capitalizing on the AR technology leveraging AR Core and AR Kit, respectively. For instance, in May 2019, Google LLC introduced AR applications in the Pixel 3A as well as the older version of the smartphone.

The Heads-Up Display (HUD) segment is expected to witness considerable growth over the forecast period owing to the latest innovations in driver assistance systems. A HUD system allows the driver to concentrate on the road while simultaneously tracking vehicle data, such as warning signals, speed, and turning indicators, on the windshield. Many automotive electronics companies, such as WayRay AG., Visteon Corporation, and Continental AG, have made a foray into the AR HUD market to tap the potential of immersive tools for better productivity and quality of work. In September 2020, Bayerische Motoren Werke AG

(BMW) introduced an AR HUD device for prototype engineering and vehicle concept. The company also introduced AR apps that offer a virtual experience of its cars.

Component Type Insights

The hardware component segment accounted for the largest revenue share of over 55.0% in 2020. The segment is expected to continue dominating the market over the forecast period owing to the growing adoption of AR devices across various industries and industry verticals, including education, healthcare, manufacturing, and retail and e-commerce, among others. For instance, AccuVein Inc., a medical imaging solutions provider, is using projection-based AR technology to project the image over the skin and help doctors in finding a suitable vein for vaccination. The key market players are investing aggressively in advanced AR products, fueling the demand for AR-compatible hardware. For instance, in January 2020, Hangzhou Tairuo Technology Co., Ltd. (Nreal), a mixed reality user experience provider, launched Nreal Light AR glasses with six Degrees of Freedom (DoF) spatial tracking and two spatial cameras for an improved experience of mixed reality.



The software component segment is anticipated to exhibit the highest CAGR from 2021 to 2028. The adoption of AR technology is gaining traction in the wake of the COVID-19 pandemic as individuals are looking forward to having an immersive and real-like experience at home. The proliferation of smartphones also bodes well for the growth of the software segment. AR software providers are expected to continue upgrading their offerings with new features and indulging strategic partnerships to support, automate, and simplify large-scale

AR deployments while offering more data and analytics tools required for proactive decisions. The growing popularity of AR applications, such as AcrossAir, Google Sky Map, Layar, and Lookator, is also expected to contribute to the growth of the segment. Enterprise software is also observed to boost the AR software market. For instance, Quick look, an AR-based tool by Apple, Inc. exclusive for iOS and iPad OS, allows users to experience specific products directly within their environment and is aimed at e-commerce companies willing to help customers in making informed purchase decisions.

Augmented Reality Market Report Scope

Report Attribute	Details
Market size value in 2021	USD 26.75 billion
Revenue forecast in 2028	USD 340.16 billion
Growth Rate	CAGR of 43.8% from 2021 to 2028
Base year for estimation	2020
Historical data	2016 - 2019
Forecast period	2021 - 2028
Quantitative units	Revenue in USD million/billion and CAGR from 2021 to 2028
Report coverage	Revenue forecast, company ranking, competitive landscape, growth factors, and trends
Segments covered	Component, display, application, region
Regional scope	North America; Europe; Asia Pacific; Latin America; MEA
Country scope	U.S.; Canada; U.K.; Germany; China; India; Japan; South Korea; Brazil
Key companies profiled	Google LLC; Microsoft; Samsung; Magic Leap, Inc.; Sony Corporation; Blippar Ltd.; Niantic, Inc.; Zappar Ltd.; Wikitude GmbH; Vuzix Corporation; Infinity Augmented Reality Ltd.
Customization scope	Free report customization (equivalent to up to 8 analysts working days) with purchase. Addition or alteration to country, regional & segment scope.
Pricing and purchase options	Avail customized purchase options to meet your exact research needs.

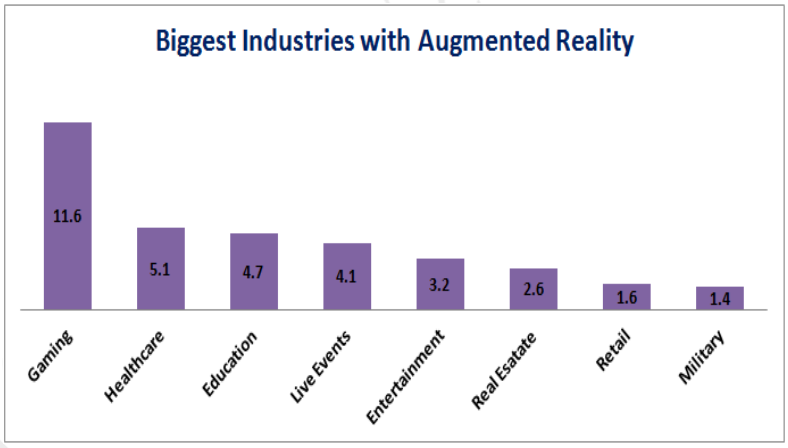
Understanding

Future Scope

Augmented Reality and Virtual Reality market has a potential to reach 151 Billion USD with a paramount CAGR of 70.4% by 2022 (Source: Markets and Markets).

It is true that the AR and VR technologies have driven the gaming and entertainment industry, but it also has a very good potential to transform the healthcare industry since it actually can change a lot of traditional healthcare operations and branches in a number of ways, including radiology, oncology, training, and more.

Still being at a very early stage, digital reality (AR/VR) technologies are helping care delivery specialists to save life and take critical decisions. These technologies have a potential to bring overall healthcare cost down. Considering this potential of VR/AR, healthcare may revolutionize the way diagnostic practice is carried out to view MRI and CT images.



AR technology has more to offer in the industry than just entertainment. By 2025, the healthcare industry will generate an estimated $ 5 billion and some within the technology industry will expect to see significant improvements in the healthcare industry as a result of the unpopular technology that taxpayers see. The tourism industry is expected to grow as 84% of consumers worldwide, of whom 42% believe that AR is the future of tourism. The future will be AR's when it comes to improving the efficiency of the work or the quality of the output of the user experience. Jessica Lowry writes to Next Web that AR is the future of design as we

know that mobile phones play an important role in everyone's lives, so thanks to this technology it will provide opportunities to improve user experience beyond measure.

After reviewing previous AR learning games lessons, we have six exciting discoveries. First of all, the lessons and learning content used in previous lessons were very limited. Studies for Science & Biology has attracted a lot of attention while there are a few subjects that focus on other subjects, such as Literacy and Mathematics. Second, most of the current AR learning games were played outdoors or in classrooms. However, as students spend more time at home and play digital games, it may be more effective to design AR home games that can be played at home, which may encourage them to learn more automatically and in a more enjoyable way. Third, a significant gap was found in the retention results.

Almost all studies evaluated results immediately after the use of AR learning games, and further research should be conducted on both short-term and long-term outcomes. With regard to measurements in previous studies, some commonly used instruments were dealt with, while other studies did not state how they constructed and tested their instruments. More attention should be paid to the appropriate measurement of results. Fifth, the results of social interaction were obtained by playing AR learning games, especially among students. However, a little research has focused on how these social interactions affect learning success or motivation. Also, more social outcomes were found among students than between student and teacher, or student and parents. AR games that focus on student-teacher interaction, or student and parents can lead to beneficial outcomes for both parties. Finally, we found various game features and AR features used in the construction of AR learning games. However, there is a lack of systematic research on how different aspects of AR and game elements influence or support direct impacts.

In addition, we came up with five recommendations for the design of AR learning games to achieve the best results, namely:

(1) incorporating students into the design process
(2) maintaining clear learning objectives
(3) designing. to promote social cohesion
(4) identify the effects of AR characteristics
(5) study game mechanics to select appropriate building materials.

Conclusion

With all the new changes in communication technology, the marketing and advertising community came up with their existing models in their first attempts to adapt to a new approach. Radio, television, the Internet, the Web, and mobile phones have all seen this game continue and VR and AR will likely follow suit. Finally there will be a new invention of ways in which the advertiser can bend messages, VR marketing strategies and strategies to convey the target audience an influential, emotional story that leads to a measurable level of product relevance and purchase effect.

The new AR / VR ecosystem may not be possible in all of the aforementioned ways but it will definitely happen in some of those ways. This next big thing in marketing ensures that it will provide many of the existing business models for sale and advertising that are outdated and replaced with new ones. It is reasonable to conclude that advertisers should be prepared to use this new ecosystem or see competitors gaining product recognition and market share at their own expense if they do not do it first. Every forward-thinking marketer should bring a healthy curiosity and determination to try and refine their content and marketing strategies to take advantage of this exciting new, vibrant and amazing new ecosystem. Advertisers, business owners and fundraisers and others who have been challenged to create attractive digital marketing campaigns should embrace AR / VR and find new ways to develop smart, attractive, effective and memorable messages.

Our Ideas and Goals

Based on the reviewed studies, we can identify recommendations for the design of AR learning games that may lead to better results for students. Generally, during the design process, five factors must be considered, namely student groups, learning objectives, AR features, game equipment, and social interaction.

Involve students in the design process

From the revised studies, we found that AR learning games may affect different types of students in different ways. Some students needed to read text in a play with assistance, while students with high literacy skills were able to read the text and play on their own. The study also showed that most students hated the idea of a cookie game because they thought it was being played by young children. To make students more determined to play the game, one of the revised courses designed different reading content and story themes for elementary school students, middle school students, and high school students respectively. Another advantage of AR learning games compared to traditional reading is that it can provide different reading content for different students. In the study, the results showed that different types of learning (i.e. independent and field-based cognitive styles), students reacted differently to the learning material. In one study, students from higher levels of education benefited more from the use of the AR learning game than students from lower levels of education. Players in the game can be divided into many types of players, such as winners, explorers, entertainers, and assassins, therefore, finding the types of players can be very effective in motivating students.

Therefore, when designing an AR learning game, designers should always include targeted student groups in the design process, requesting their preferences and feedback for game ideas, and taking into account their player types, learning skills and level of knowledge.

Literature Survey

Spatial ability plays an important role in chemistry learning, because students are required to visualize specific microstructures, but visualization of microstructures is a difficult task for students. According to Harley and Towns (2011), research focusing on visuospatial skills in chemistry has revealed specific student difficulties in understanding, interpreting and translating molecular representations. The study by Tucky, Selvaratnam and Bradley (1991) indicated that even at the university level, many students have difficulties with three-dimensional thinking. These difficulties are caused by a misunderstanding of only a few relatively simple concepts and skills. Sorby (2009) concluded that the implementation of a curriculum aimed at developing first-year engineering students' 3D spatial skills had a positive impact on student success, especially women. This result suggests that spatial skills can be improved through practice and result in better academic performance. Based on these studies, we aim to eliminate the difficulties encountered in chemistry microstructure instruction with respect to spatial skills.

A considerable number of computer-aided learning tools are used in chemistry teaching, and a large number of researchers have used these tools to design specific scenarios and test the effect of their learning on students. In recent years, the most praised of these tools for learning microstructures have been virtual reality- and augmented reality-based learning tools.

Compared with VR, AR demonstrates a more natural and innovative interactive concept, which provides students with opportunities to perform. El Sayed, Zayed, and Sharawy (2011) devised an Augmented Reality Student Card (ARSC), which can represent any lesson in a 3D format that aids students in visualizing different learning objects, interact with theories and manage information in a totally new way. The research suggests that ARSCs increase students' visualization abilities using a minimum number of tools. Nunez, Quiros, Nunez, Carda, and Camahort (2008) presented an AR system for teaching spatial relationships and chemical problems with university-level students. In the experiment, students could manipulate crystal structures of certain substances, such as ZrSiO4 with markers. However, in the studies above, only static images or structures are rendered. Some more recent studies indicate more interesting and engaging interactions between students and the computer, taking full advantage of AR technology.

Augmented Reality Teaching Platform (ARTP) in chemistry was proposed in Iordache, Pribeanu, and Balog (2012). A periodic table is provided where students can place colored balls to complete tasks. The researcher found the task of placing colored balls in different chemical components on the table giving children a sense of freedom and control, which is beneficial for their performance. The results show that students understand more and more easily about this tool. Wojciechowski and Cellary (2013) developed an AR environment in which students could perform chemical experiments, for example, hydrochloric acid (HCl) and sodium hydroxide (NaOH) react to the production of table salt (NaCl) and water. The results show that "Students' active participation in craftsmanship has a positive effect especially on imaginary pleasure, which leads to an increase in their motivation to learn", as such AR-free environments incorporate learning materials and a real-world environment for students, provision. they are opportunists.

In addition to scientific instructions, the AR environment also works well with art instructions. An AR library teaching program was developed, which led to significant improvements in learning performance and was really helpful in promoting students' motivation and motivation to learn. "Obviously, students are very satisfied with the proposed ARLIS for library teaching."

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