



Challenges in Augmented Reality: An Empirical Analysis

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Abstract: Nowadays, the rapid enhancement in the field of Computer Sciences, especially the emerging technology like Augmented Reality (AR) which turns the direction toward itself, but at the same time it gains attention of world researchers regarding critical challenges appear in multiple situations. Augmented totally out of the box of virtual reality, basically it creates a platform where digital information and reality collaborate with same platform, where super imposed imaginary objects turn up in the real-world environment. In this repaper, we investigate the vast history, challenges arise in different environment, crucial mechanism & approaches for the development, application, status, and future of AR in upcoming couple of years.

Keywords: Augmented Reality, Virtual Reality, Artificial Intelligence

1. INTRODUCTION

Technology-enhanced learning (TEL) research focuses on emerging technologies such as Augmented Reality (AR). AR is not as new as people think, but technology move with digital environment and things changes, that's why people might be think it's a latest technology. In real world, augmented perform a vital role collaboration with digital system and the reality. Nowadays, AR is a technology to superimpose information in real environment i.e. virtual image, text, haptic, etc. Virtual image or text is about the selected object. Another definition, "the integration of digital information with the user's surrounding in real time environment". Unlike, virtual reality (VR) is totally oppose of AR, VR takes user to artificial environment where all those virtual things created by designer of the application. AR applications are available for both system software Android & IOS, some apps are free to use and other can be useable when user buy these apps in lower prices: Sketcher, Pokemon Go, Ink Hunter, Google Translate, Amikasa, Ingress, just a Line, Genesis Augmented Reality and many more. AR contributes in every field like entertainment, medical, fashion, decoration and everywhere. It turns technology in a different way, facilitate human's thinking and convert it into reality.

It uses the existing environment and place new information on top of it. Now, it's an emerging technology which comes in different forms of user's viewing, sometimes it uses screen for visible things (virtual text or image etc.) into reality, Monitor, Helmet Facemask, Glasses (recently Google Glass is very popular), Head Mounted Display (HMD),

Window & others. AR apps can be design and develop by using special 3D program. Developers creates contextual digital information of computer program and it can run in real world. There is no need to create a virtual environment, it's all happening. The using of different sensors (gesture, posture, eye, heat, sound or voice sensing etc.) can enhance or increase the capability of augmented reality technology.

Next sections elaborate a briefly overview of the technology and it resolve lots of reader's query about AR.

2. HISTORY

The journey of augmented reality had started in 1901, when L. Frank Baum describes the 'Character Marker' in his novel 'The Master Key'¹. The character maker consists of electronic spectacles, these spectacles view letter in person's forehead regarding their character². Augmented reality got exponentially more popular in recent era, but the idea was too older then we might think. In 1952, first virtual reality machine made by Morton Heilig. The scientist called this device 'Sensorama Machine' (SM) and it was patent in 1964. Ivan Sutherland designed, and developed world's first head mounted display device named 'The Sword of Damocles' in 1968. At the end of 1974, the researcher Myron was creating Video place which were used an interactive environment surrounding by users.

¹<http://adsreality.com/history-of-augmented-reality-infographic/>

²<https://www.igreet.co/brief-history-of-augmented-reality/>

(Billinghurst, *et al.*, 2015) highlighting the year 1977 with respect to AR in entertainment environment. The first three-dimensional scene projected in 'Star Wars' movie (Billinghurst, *et al.*, 2015). This was the starting point when the technology entered in entertainment environment. After some years, AR technology started living in TV channels. This was the year of 1984, Dan Reitan promoted AR in News TV channel for weather casting. In 1990, the technology got official name 'Augmented Reality' by Tom Caudell. Steven Feiner developed a system named 'KARMA (1993)' which is knowledge-based AR. This system builds by Columbia University students, the proposed solution used to provide instruction for maintenance and repair procedures. After 1993, Julie Martin created first theatre in 1994 called 'Dancing in Cyberspace'. After couple of years, first 2D AR marker developed. In 1998, NFL (National football league) launched AR in live gaming, that was the time when AR moved one step forward to get more fame in virtual game environment. NASA used AR in 1999, created a dashboard for navigation purpose in X-38 system. The first AR open-source software library debuted in 2000 known as 'AR Tool Kit'. The journey of AR not ended yet; in 2008, the technology used in real time environment of US presidential campaign, CNN introduced the green room concept and showed the technology live (Billinghurst, *et al.*, 2015). No need to worry about distance of two or more people, AR makes it easy in just a blink of eyes. In 2011, Google started prototyping of Google Glass and producing these glasses on 2013-2014, but some reasons it could stop in 2015. Couple of years later, Google announced return of glass named 'Google Glass Redux' as enterprise edition (2017)³. It facilitates almost every fields and the contribution are highly appreciated. As we see the recent achievement in the technology, we assume that the future will be brighter than the recent era.

3. TYPES OF AUGMENTED REALITY

AR allows user to see the world with virtual objects (Azuma, 1997). Many applications running on augmented reality but no one knows that which application is related with which type of AR. There are some crucial types which we are discussing below:

3.1 Marker-Based AR

Marker-based AR also known as image-recognition. This type of augmented needs a camera and QR code, without these two things marker-based is useless. This AR type mostly used by industry for producing QR code for encoded each product's information and it can only be decoded by those who

allow to decode with the help of camera. Image recognition is the crucial task to detect an image and retrieve information in it. Moreover, it cannot need more processing power but the thing which matters is orientation and position of an image.

3.2 Location-Based AR

Location or position based but some time it may call 'Markerless' AR. It is widely used for implementing applications, such applications use velocity meter, digital compass, acceleration meter, GPS and many more digital components embedded in the device, which helps to locate position of the device with a click. It creates logs in database which show past location and recent activity of the device. Location-based AR applications allow users to detect location, mapping, nearby position of hotels, business offices, malls, utility stores, even find nearby friends also. This type of AR mobile applications resolves feature detection and extraction of location in a better way.

3.3 Outlining AR

Outlining AR isn't most popular than other types, object recognition can be done in this type. For example: it is used to recognize tracks of the road in dark environment; shape of cars, buildings, and different objects. It's quite blurry image but the objective is to recognize real time objects⁴.

3.4 Projection-Based AR

The artificial light projecting onto the real surface is known as projection-based. Its means digital image on physical object. Such kind of applications allow user to interact with projected image, touch the image and accomplish your task. It's totally based on human computer interaction. The three-dimensional interactive hologram is one of the projection-based AR technology, it reduces the distance gap and makes things easy. In Hologram, the person or things available at certain place without appearing in that physical environment.

3.5 Superimposition-based AR

The original view of real world either partially or fully changed with virtual objects. The word superimpose elaborates itself: 'to place or lay over'. The type of AR helps to take an action before it can be seen as virtual in reality. It is widely used in entertainment, medical sector, industry, gaming, construction, decoration and many other fields.

In future, we will expect more types of augmented reality and enhancement of existing types with more features.

³<https://medium.com/traction-report/google-glass-2-0-and-the-future-of-augmented-reality-ee85cd97b>

⁴<https://www.igreet.co/the-5-types-of-augmented-reality/>

4. **WORKING MECHANISM**

AR is much mature technology as compare to VR. To make an interactive environment, need some useful elements to build an effective AR system. Almost all the components are same which were using since 1960's, but day-to-day these components enhanced as per need. The objective and working of all parts are discuss below:

4.1 Visual Display

A Crucial component divided into three sub categories: video see-through, optical see-through & projective (Van Krevelen *et al.*, 2010). In video see through, cheapest and easiest implementation of visual display. Video feeds from the camera using head-mounted device. Removing digitizing into reality. For example: getting real time experiences, capture tracking memory, robot 3D vision, night-vision display etc. In Optical see-through, computer generated imaginary object appear in real world. It all can be happening through 'the glasses. Artificial objects look like a real one (as a mirror) in user's place. In projective, there is no need to wear anything for visual display. Projection can impose virtual things into real world (either it can cover the whole room, flat, plain surface or others), it seems like a realistic environment. All these displays contribute effective visual role in the field of augmented reality.

4.2 Audio Sensors

Audio grab the user's attention same as display devices, without audio visual display is totally useless. The collaboration of audio-visual aids can enhance the capability of the technology. In aural device, the word haptic means 'sense of touch', it generates sense when human felt (like: vibration, force, motion) rather than heard. This type of aural display already embedded in user's device for completely feel like a reality.

4.3 Human Movement Sensor

It performs a vital role and connect human-digital information in a platform. Human can do some movement and system fetches those movement through sensors & perform task with efficiency. It includes positioning as-well-as orientation of human gesture. The collaboration of human motion and gesture can reduce stress of the technology. Motion provides orient (using GPS etc.) and gesture provides position & movement of the body. In 2010, Leap motion (LM) invented which divert the direction of the technology, LM has additional functionality which scan the movement of fingers through camera and identify the actual move of each joint of a body. The system produces exact movement (each joint) output of a body into the display. Before the invention of this, traditional approach contains a camera only detect person's body movement except finger's joints movement.

4.4 Modeling Environment

Nowadays, researchers are head together to improve the ability or make better 3D creation for AR consumers. The tracking devices and techniques are relying on environmental model. There are two major environments named: global and local. Modeling enable user to integrate real world and virtual object in a place. The ray-tracing and z-buffer algorithms used to create image in real time. Utilization of ultrasonic, mechanical and magnetic components to enhance capability of the system.

4.4.1 Global (Outdoor) Environment

In Global Environment, GPS perform an important role in AR location and positioning. Connect different indoor environments through GPS of wide area accuracy up to 10-15 meters. For the augmentation system (WAAS) technology, accuracy increases up to 3-4 meters (Hollerer and Feiner 2004). It contains glasses, sensors, camera, tracking movement etc. which can store experiences of outside world. Global isn't too difficult to create as compare to local environment but need strong GPS system and access all the time.

4.4.2 Local (Indoor) Environment

Indoor environment required special equipment to be placed around the users. It contains a colored room, highly efficient cameras, sensors (aural, gesture, heat etc.), ultrasonic, magnetic, mechanical & others. Every instance action can be seen by the camera and perform exact same reaction in augmented environment but consider user's local surrounding. Early HMD named 'Sword of Damocles' used ultrasonic waves to determine the position and send or received data (Sutherland. 1968). It was the mechanical tracking device. Need specific place for running a system and bound to access in four walls, without this we can't use it.

4.5. Connectivity

Only wireless network isn't the part of connectivity, there are several other things including hardware connectivity with different sensors and network. I/O devices connection and configuration make user experience better. Sensors enhance the accuracy of a system, provide actual feel to the user and seems like real place. GPS also the part of connectivity, help to find location or position. Wireless network connects us to the world, share same platform to others (play same game with different people through network). Camera contributes a unique role in AR, perceive data and convert it into information which shows display in the screen. Higher resolution better performance.

At the end, all components have unique functionality and the mixture of all those parts can make a mature technology known as augmented reality.

5. APPLICATION, IMPLEMENTATION AND CHALLENGES

The technology drive toward the practical usage in every field by every person. There is lots of AR application available, but the biggest portion covered by gaming apps. As we already discuss in introduction section regarding popular application's title and it's running as-well-as available in both operating systems (Android and IOS). Now, implementation can be done on different programming languages for different purpose, but few languages contributes more in AR: C#, C++, java, python, JavaScript, swift and visual development tools. Mostly, developments done on C#& C/C++ and the developers give priority to that languages (according to the survey, 'The State of The Developer National Q1 2017 report')⁵. As we understand the overall scenario but there are several problems regarding the limitations and challenges faced by researchers plus developers. The first challenge is hardware limitation, to run high quality graphical representation then need a unique or strong system (strong system means more memory, processor speed, video card, power and energy) which able to operate 3D environment. Multi-user experience, two or more users are connected and perform some specific task in a same platform. It's hard to maintaining or design such platform where different people interconnected with different places. In this content, if we have hardware but without application, we can't utilize technology and can't get the multi users experience. So, the collaboration of all those challenges or limitations' solution can built appropriate.

Although it grabs the attention of different people in different fields, the application of augment in educationist quite useful for teaching and learning perspectives. Hsin-Kai Wu *et.al* highlighting the fluctuation grow in instructional and systematic approaches by the technology, the complex relationship and abstract concepts visualized virtually in real environment (Arvanitis, *et al.*, 2007).. Facilitate human in terms of experience phenomenon which can't be consider in other technologies (Klopfer, 2008). In learning environment, (Squire *et. al.*, 2007). elaborate the development of the system can provide a way where learning practice is much easier than previous (Squire, *et. al.*, 2007). These types of key benefits have made AR one of the key emerging technology for education over the next five years (Johnson *et. al.*, 2010a). (Johnson, *et. al.*, 2010b). (Martin, *et. al.*, 2011). The value of AR in every department are not solely based on the use of technologies but closely related to how AR

utilized in formal and informal learning situations (Wu, *et al.*, 2013)..

6. STATUS OF AR TECHNOLOGY

Recently, Apple launched 'AR Kit' and Google introduced 'AR Core' which made work easier for designers and developers to design & implement the application faster with minimum time⁶. Facebook create 'AR Studio', amazon create 'Sumerlan' and AR View' just for 3D application development. In 2016, the app worth was 725 million dollars and it will be expected 15.497 billion dollars in 2020⁷. There are several companies making AR digital devices: Oculus Rift, HTC Vive, Sony PlayStation VR etc. which provide higher controlling, tracking system and sensors.

According to Hughes-Hallett *et.al*, the status of AR in the clinical environment, especially in nephrectomy examining systematically, examiner needs more sophisticated analysis on the real situation. The reason behind, authors highlighting the main agenda regarding AR for visual information of partial nephrectomy, to supplement this loss of haptic sensation (Hughes- *et. al.*, 2014). In learning perspectives, AR fulfilling the huge gap between traditional and advanced learning approach. Conclude thirty-two survey papers between 2003-2013 in six indexed journals, motive is to find systematic review of AR in the field of education. In education, AR mostly used in science and humanities & art for the betterment of the students understanding, and least applied in health & welfare, teachers training and agriculture (Bacca, 2014). So, its clear that AR used in almost every field of education and provide unique way of learning.

7. CONCLUSION AND FUTURE OF AR TECHNOLOGY

We conclude as, Augmented Reality isn't the end of computing technology but it's just a beginning of digital world, many researches running on this field nowadays and lots of contribution we saw in pervious researches. It rapidly turns the table into another level where we saw real world with virtual objects. Superimposition of virtual object isn't the only task of the technology, it can either be used as projection, position-based or Markerless, marker-based and outlining the purposed. Hologram is one of the biggest examples of that technology. It is playing a vital role in every field, in gaming, it got more popularity as-well-as ability to engage world with digital information. Design and implementation of augmented content, there are

⁵<https://www.visionmobile.com/reports/state-developer-nation-q1-2017>

⁶<https://www.forbes.com/sites/bernardmarr/2018/09/05/16-fascinating-augmented-reality-quotes-everyone-should-read/>

⁷<https://www.geospatialworld.net/blogs/challenges-in-ar-mobile-app-development/>

several languages emerged which provide platform for the developers. The history was too delightful, present is more effective, and the strong future will yet to come. In coming years, augmented will be seeing everywhere in the world and considering as a part of life. It will be available for all, as a cheapest technology around the world.

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