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Augmented Reality Brings the Fifth Dimensional Experience in Educational System – An Intensive Breakdown

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Abstract*: *Learning is a never-ending process since the evolution of mankind. The learning process has brought mankind to breakdown the atom to the formation of space exploration from International Space Station (ISS). There are many supporting tools and techniques to support the teaching and learning process. In this line of tools and techniques, Augmented Reality (AR) has kept the footprint in the educational system after a struggle of 50 years of research. The research in AR has great anticipation in enhancing the educational system by redefining the articulations of the system. It is believed that AR can bring a different perspective on the educational system. This research article shall investigate the facts and reasons from the past that can be attributed to this phenomenon. This article begins with the introduction of the educational system from the traditional method to present practice, the facts & research findings and concludes with the references at the end.

Keywords*: *Education, Augmented Reality, Virtual Reality, Real-World, Imaginary-World.

I. INTRODUCTION

Education is knowledge acquired from a school, whereas learning is an experience and understanding acquired from education. So, it can be said that learning is the capability to get understanding from the educational system. Learning had started from our very first ancestors where they were sent from the curse of a serpent. Learning has reached a remarkable transformation from the wilderness to sophisticated smart rooms. The five dimensions of the educational system are Knowledge through hearing, Knowledge through seeing, Knowledge through reading, Knowledge through teaching and Knowledge through technology.

Based on culture, geographical location and adaptation to certain circumstances, the educational model has experienced many changes. But the method delivery has not changed starting from the Kuru dynasty, classroom, distance learning and self-learning. Learning starts from the moment a foetus gets attached to a mother's womb. From the prehistoric period, the neonate starts learning from the mother. She is responsible for almost all education.

The educational system had started around 2000 BC by Mesopotamia which is the first evidence of schooling. This school gave education beyond daily needs. It mainly concentrated on literature that was offered to privileged classes. Ancient Greece went a step ahead and redesigned the schools by giving comprehensive educational knowledge in varieties of subjects which includes Arithmetic, Music and Physical Education beyond the cultural needs. During the 18th century, a new agent was defined in 1787 by Frederick William II of Prussia, who enacted a degree to wrest educational responsibility from clergy to the Ministry of Education by a clear illustration of academic system. This new agenda is the basis of our modern educational system.

AR is the blend of real-world and the imaginary world. It brings extra information and content by the concept of mixed reality. The mixed reality is defined as a framework that enables the possibility of viewing the digital content over real world environment. AR has Scene Generator which generates a scene in the device. Tracking system tracks predefined target image to bring the digital content. The display unit is the end component in the line which orchestrates the complete mixed reality in the display. Four major classes of AR can be distinguished by their display type: Optical See Through, Virtual Retinal Systems, Video See-Through, Monitor Based AR and Projector Based AR [1].

II. AN INTENSIVE BREAKDOWN

It has been evidenced from past researches and research articles that the benefits of AR will be of several folds in the educational system as found in the references. The primary discoveries of these researches emphasize the teaching and learning process.

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A. Definition of AR

The definition of AR is coined by Sutherland's [2] using mixed reality [3]. The figure 1 below illustrates the relationship between reality and virtuality.

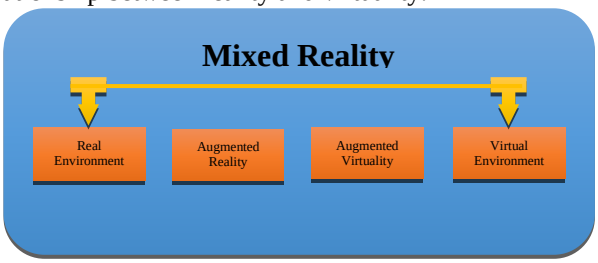

Figure 1: Reality – Virtuality Spectrum [4]

Figure 1 gives an abstract view of reality-virtuality spectrum. The left hand side is the real world scenario and the right hand side is the virtual world scenario. The real world would get faded gradually and completely disappear and it would be in virtual world. AR brings extra information for any object in the existing and real world [5, 6]. The AR technology is capable of tracking multiple image targets and it can deal with 2D and 3D objects and also with audio and video contents. [7, 8]. Figure 2 and 3 shows the concepts of AR visualization and AR visualization systems respectively.

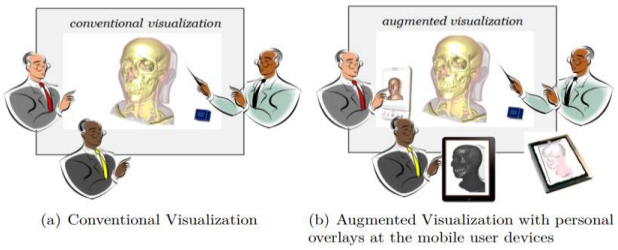

Figure 2: The concept of AR visualization

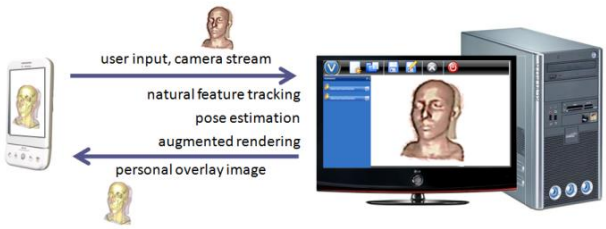

Figure 3: AR visualization system

AR is classified into three major categories Head Mounted Display (HMD), Handheld Display (HHD) and Projected Based (PB) [9,10,11, 5].

Figure 4: Head Mounted Display, Hand-held Display and Projected Based

B. Augmented Reality: History

AR is the dynamic orchestration of digital content in the real world. This orchestration being done by the influence of image and pattern recognition by sensor output which is fed as an input to the AR framework. The AR framework has several techniques for the rapid recognition of image patterns to bring the intended digital contents.

Starting from video games to industry and education, AR has a wide range of applications. Virtual reality and augmented reality are quite different from each other in the sense that AR replaces the real world with a simulation.

1838:

In 1838, Charles Wheatstone exploited with the Stereoscope the capacity of the human brain to associate two-dimensional images in a three-dimensional representation by a mirror game, giving a feeling of depth and immersion. It is still the process used by the current immersion helmets.

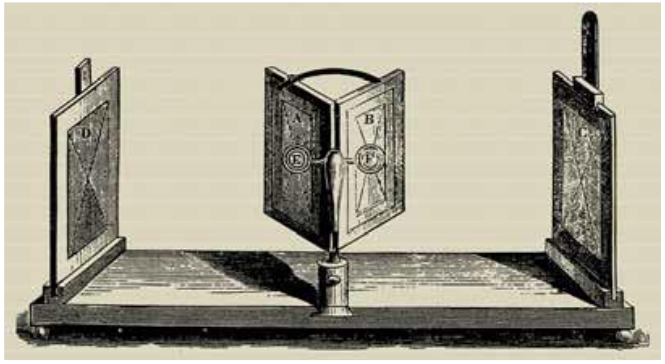

Figure 5: Charles Wheatstone, Stereoscope, 1838.

1901:

The multi-sensory immersion concept was enhanced in the first half of the 20th century. The year 1901, in particular saw the development of this concept. An author, L. Frank Baum, was the first to come up with the idea of an electronic display that could be superimposed on real-life data.

1930:

The Link Trainer was a series of simulators flights produced in the 1930's by Link Aviation Devices, Inc. Its founder Edwin Link developed the first mechanical flight simulator (as shown in Figure 6) to learn how to pilot, before quickly selling models to the Army Air Corps, interested for obvious reasons of safety and cost. At the same time Ivan Sutherland was developing The Sword of Damocles in a university lab. Tom Furness, another notable pioneer, was thinking about the practical application of virtual reality technologies within the American Air Force, thereby asserting his difference with Sutherland, as he expressed it in an interview with Kent.

Figure 6: Link Aviation Devices Inc., 1929.

1935:

The science fiction author Stanley G. Weinbaum imagined in 1935, in his new Pygmalion's Show, a pair of glasses allowing the user to immerse themselves in a film not only by sight and hearing, touch, smell and taste, but also to interact with the characters in the movie.

1955:

A few years later, in 1955, Morton Heilig conceptualized the Sensorama, an experience booth multi-sensory combination of the stereoscopic film with stereo sounds, smells and movements. Even before the first numerical simulations, the implication of the body and of all the senses was explored.

1957-1962:

A simulator which had sounds, visuals, smells as well as vibrations were created by Morton Heilig during the years, 1957-1962. A patent was filed for it and it was named the Sensorama. Images of the Sensorama can be found in Figures 7.

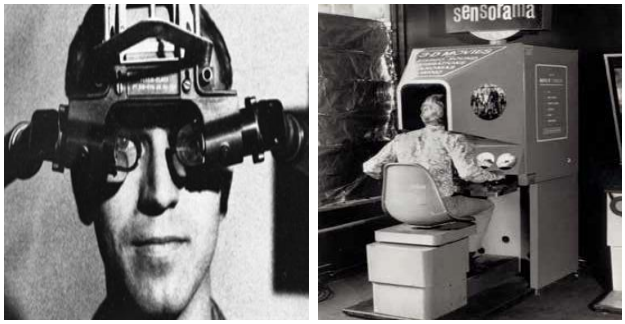

Figure 7: Morton Heilig, Sensorama, 1962.

1960:

In response to the growing complexity of piloting technologies of fighter jets it was conceptualized, in the year 1960 to develop a sighting system with the head displaying information or the possibility of making complex piloting systems more intelligible and easier to handle.

1968:

Ivan Sutherland created the first augmented reality machine in the year 1968. It allowed six degrees of freedom and implemented a transparent vision helmet even with the limited technologies available at that time. The Visiocasque was also invented by him and was positioned as a window to the virtual world. He built the first reality helmet prototype Virtual: Incredible Helmet, also known as Sword of Damocles in 1968 with the help of Bob Sproull at the University of Harvard and then the University of Utah, due to its imposing suspension system above the user's head. Incredible Helmet uses monoscopic cathode ray tubes – projection of the same image on both eyes - and can superimpose objects wired monochrome to the user's vision [12]. The images in Figure 8 and 9 show the Stereoscope developed by George M. Stratton in 1896, the Sword of Damocles and the World's first head-mounted display respectively.

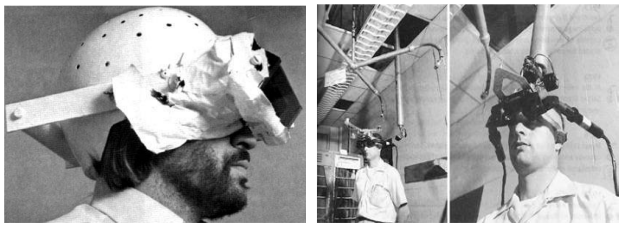

Figure 8: George M. Stratton, Stereoscope, 1896(left), Reproduction of G. Stratton's experience, The Sword of Damocles, 1968(Right).

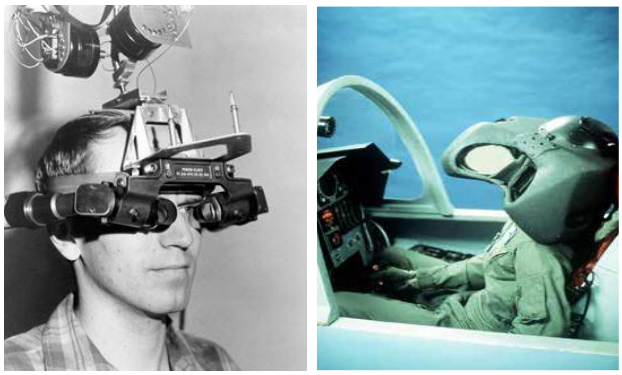

Figure 9: World's first head-mounted display. Courtesy of Ivan Sutherland(Left), Tom Furness, VCASS: Visually Coupled Airborne Systems Simulator, 1971.(Right)[21]

1971:

The limited size of the cockpit directed it towards the Augmented Reality, and culminated in 1971 with the creation of VCASS (Visually Coupled Airborne Systems Simulator), then Super Cockpit in 1986. Following these first experiments, research continued to progress in the military and academic circles, not without difficulties due to the limited computing power of computers and the high cost of manufacturing immersion technologies.

1989:

The term "Virtual Reality" was coined in 1989 by Jaron Lanier, wishing to stand out from the commonly used term at the time, "virtual worlds", to emphasize the possible social interaction in virtual reality.

1990:

The democratization of the computer and the Internet in 1990's introduced virtual worlds and virtual reality immersion to many disciplines and followed the first wave of theorization and experimentation by John Frazer, Marcos Novak or Lars Spuybroek in architecture. However, the extremely high cost of the immersion technologies marked a commercial false start and they quickly fell into oblivion.

1992:

There was no existence of the term "Augmented Reality" until 1992. Tom Caudell and David Mizell proposed the term before its precise definition. This term was referred and exhibited by Paul Milgram and Fumio Kishino in 1994.

1994:

The first augmented reality play, "Dancing in Cyberspace" was created by Julie Martin. Funded by the Australia Council for the Arts, the theme of the play presented dancers and acrobats controlling virtual objects in real time, projected in the same plane of space as physical performance. There was a complete immersion of the acrobats in the virtual environment.

1996:

The work done in the past had precisely defined the limits of "mixed reality", from pure reality to pure virtuality, via augmented virtuality and, of course, augmented reality. Jun Rekimoto introduced the 2D markers which proved to be an important step in 1996. The introduction of 2D markers was done by allowing the virtual objects to be visualized with six degrees of freedom. Three years later this technology was widely disseminated by Hirokazu Kato and Mark Billinghurst, through their AR Toolkit software development platform, and still serves as a base for many augmented reality realizations, such as usable at home "animals of the future" Futuroscope Poitiers.

1997:

The differences between virtual reality and augmented reality were defined clearly in an investigation paper by R. Azuma. Three main features of augmented reality were highlighted in this paper: combine real and virtual; real time interactivity and presented in 3-D.

The first application of augmented reality outdoors, prefiguring current applications on the smartphone was presented in 1997. But it was not until 2003 that the augmented reality as we know it today, on our mobile phones, actually appeared with the Mozzies mosquito hunt on Siemens mobile phone. For the first time in 2007 in New Zealand, this technology was used to promote a zoo. The technology came out of the labs to begin to reach the general public only after 40 years of maturation and development.

2000:

Bruce H. Thomas developed AR Quake, the first outdoor augmented reality game. The aviation industry had always been closely linked to the development of immersion technologies, and it was he who owned until the year 2000 the best devices to train pilots on simulators of highly sophisticated flights. Figure 10 shows the image of a touring machine developed for Columbia University, with the concept of AR.

Figure 10: The Touring Machine. Courtesy of Columbia University(Left), Google Glass(Right). [21]

2012:

The advent of the smartphones in the 2000s greatly reduced the cost of making LCDs and microchips and improving their quality. But we had to wait until 2012 to see the first operational technology accessible to the general public with the launch of a fundraising campaign participative company Oculus and its Rift immersion helmet created by Palmer Lucky then aged 18, having raised $ 2.4 million.

2013:

The year 2013 witnessed the discovery of augmented reality glasses. The beta test of Google Glass was announced by Google. Internet connectivity could be experienced by the glasses with the help of a smartphone connected via Bluetooth. Whenever a user spoke, touched the frame or moved the head wearing these glasses, the glasses used to react [13]. The image in Figure 10 shows a sample of Google Glass.

2014:

Bought by Facebook for $ 2 billion in 2014, Oculus had relaunched the experimental and commercial dynamics of the 1990s.

2016:

Launch of Exporea, a project of kits "Events augmented reality " whose objective was to offer animations and contents of quality while controlling the budget. The first immersion prototypes appeared in the 60s, shortly after the development of the first computers. The visionary Ivan Sutherland, then a professor at Harvard, imagined in 1965 the Ultimate Display, a simulation device so realistic that it becomes impossible to distinguish virtual and current realities. The concept included a headset, a 3Dsound system, a haptic feedback, a computer capable of creating the simulation and the change in real time, as well as the ability for the user to interact with this virtual world.

Figure 11: Boing used a see-through HMD, Courtesy of David Mizell.[21]

Figure 12: HMD on printer maintenance. Courtesy of Steve Feiner, Blair MacIntyre, and Doreé Seligmann, Columbia University.[21]

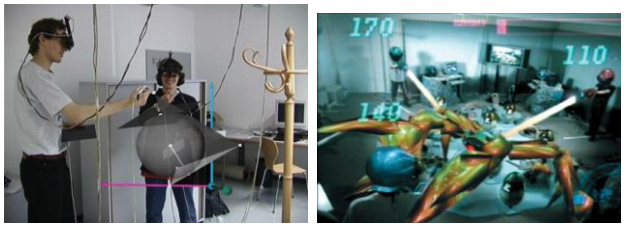

Figure 13: AR to high school students. Courtesy of Hannes Kaufmann(Left), RV-Border Guards game developed in Canon's Mixed Reality Systems Laboratory. Courtesy of Hiroyuki Yamamoto (Right)[21]

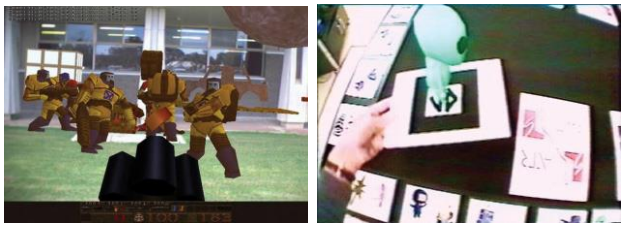

Figure 14: AR Quake, Courtesy of Bruce Thomas and Wayne Piekarski, AR Toolkit, Courtesy of Mark Billinghurst [21]

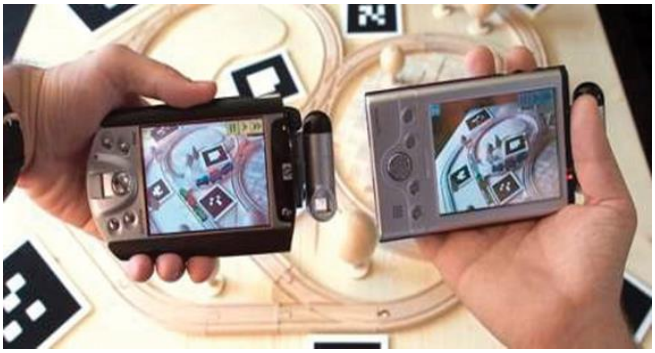

Figure 15: The Invisible Train was a handheld AR game. Courtesy of Daniel Wagner [21]

Figure 16: AR used for discrepancy analysis in industrial facilities. Courtesy of Nassir Navab [21]

Figure 17: The touchscreen display (left), which can be used for discrepancy analysis directly on the factory floor (right). Courtesy of Ralph Schönfelder. [21]

Figure 18: AR with GPS(left). virtual excavation (right). Courtesy of Gerhard Schall [21]

Figure 19: Drone AR overlay. Courtesy of Stefanie Zollmann, Coffee machine maintenance with AR. Courtesy of Peter Mohr [21]

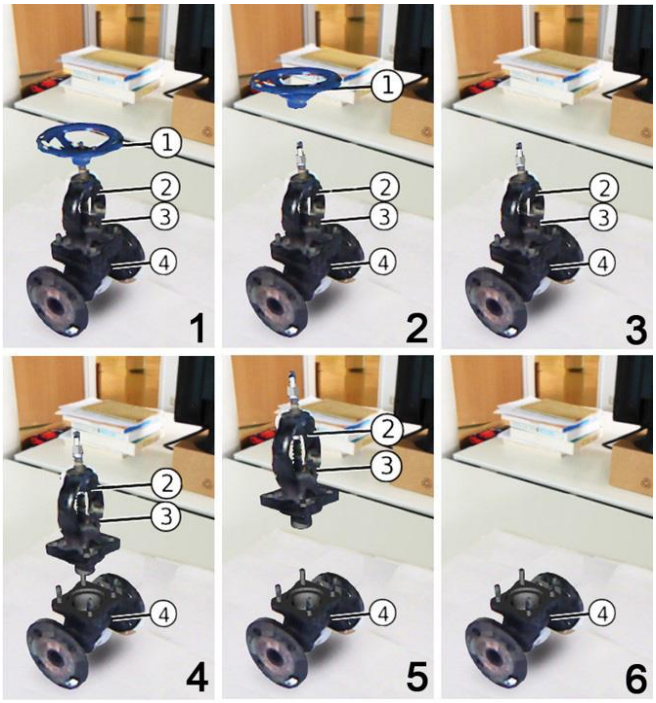

Figure 20: Disassembly sequence of a valve. Courtesy of Peter Mohr [21]

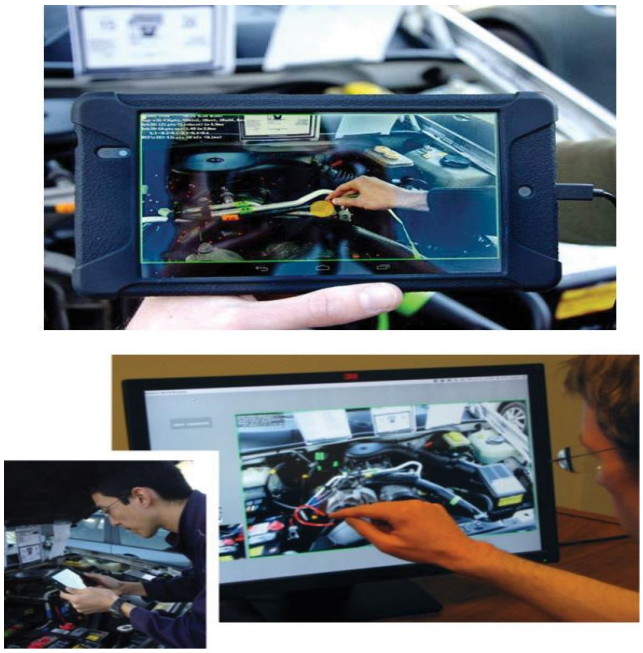

Figure 21: A car repair assisted by AR, Courtesy of Steffen Gauglitz [21]

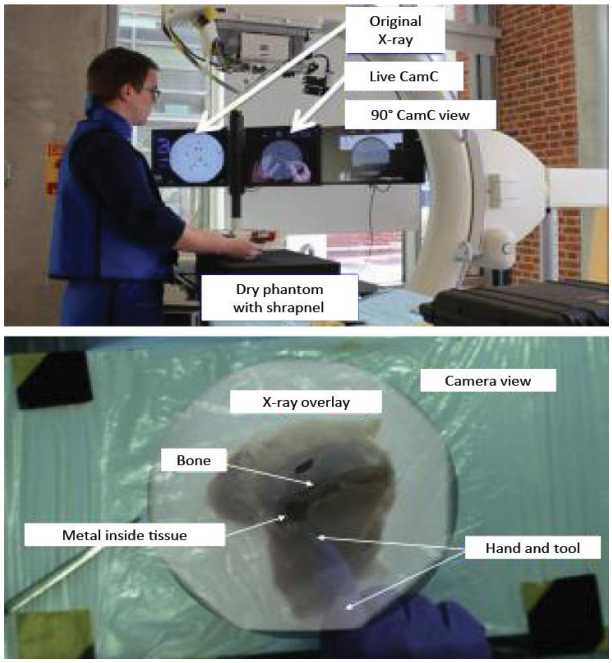

Figure 22: The CamC. Courtesy of Nassir Navab [21]

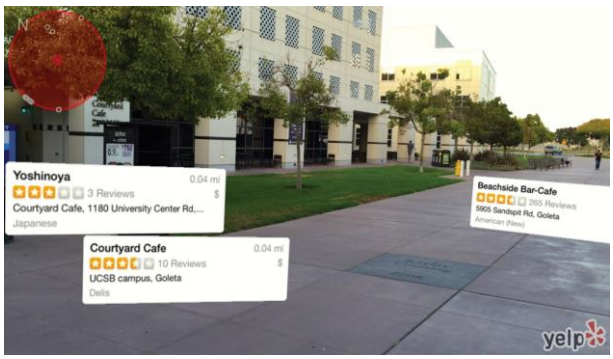

Figure 23: AR browsers [21]

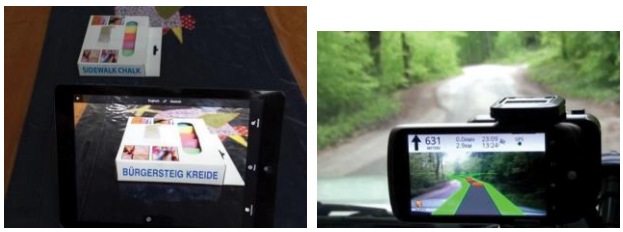

Figure 24: Google Translate, over the camera image(Left), Wikitude Drive superimposes. Courtesy of Wikitude GmbH(Right). [21]

Figure 25: The parking assistant. Courtesy of Brigitte Ludwig(Left), Augmented TV broadcast of a soccer game. Courtesy of Teleclub and Vizrt, Switzerland (LiberoVision AG)(Right) [21]

Figure 26: The lifestyle magazine Red Bulletin . Courtesy of Daniel Wagner (Left), Marketing presentation of a Waeco air-conditioning service unit. Courtesy of magiclensapp.com (Right) [21]

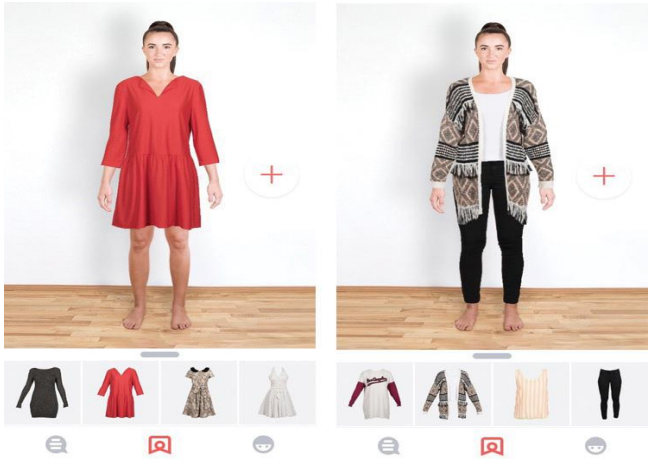

Figure 27: AR in garment sales, Courtesy of Stefan Hauswiesner, ReactiveReality. [21]

Figure 28: Vuforia, Qualcomm Connected Experiences, Inc. [21]

Figure 29: AR through TV, Courtesy of Microsoft Research. [21]

III. GOVERNMENTS INVESTING IN AR FOR EDUCATION

Many governments around the world are investing in AR technology to bring the revolution in the educational system. In this regard many countries like south Korea have developed a special unit like Korean Virtual Reality – Augmented Reality Complex (KoVAC) [17] for research and development of AR. Similarly, China has the largest investment in AR as compared to other countries. It has developed the China VR Research Institute [19]. Countries like USA and France have invested in improving the educational system in AR. [15][16]. The UAE has started concentrating to extract the maximum benefits of AR in Education [18].

IV. RESULT

This article has conducted an intensive survey on developments in Augmented Reality. The summary of the findings is as follows:

Year	Descriptions
1838	Optical illusion overriding the brain inference of 2D to 3D image by Charles Wheatstone .
1901	Electronic display using multisensory over real time images by Frank Baum.
1930	Development of first simulation for flights by Link Aviation Devices.
1935	Concept of having pair of glasses to realize sight, touch, smell etc., by Weinbaum.
1955	Sensorama setup with hybrid of multisensory and stereoscope by Morton.
1957	Filling of patent for the simulation of augmenting sound, visuals, smells and vibration by Morton.
1960	First head mount device development for flight training.
1968	Invention of first Augmented Reality Machine by Ivan Sutherland.
1971	Establishment of Augmented Reality based cockpit for Visually Controlled Airborne Systems Simulator
1989	Coining of the term "Virtual Reality" by Jaron
1990	Introduction of virtual worlds and virtual reality immersion to many disciplines and followed the first wave of theorization and experimentation by John Frazer, Marcos Novak

1992	Coining of the term "Augmented Reality" by Tom Caudell and David Mizell
1994	The first augmented reality play, "Dancing in Cyberspace" was created by Julie Martin.
1996	Introduction of 2D markers by allowing the virtual objects to be visualized with six degrees of freedom by Jun Rekimoto.
1997	The differences between virtual reality and augmented reality were defined clearly in an investigation paper by R. Azuma.
2000	Bruce H. Thomas developed AR Quake, the first outdoor augmented reality game.
2012	Introduction of advanced head mounted by Palmer Lucky.
2013	Introduction of augmented reality glasses. The beta test of Google Glass was announced by Google.
2014	Bought by Facebook for $ 2 billion in 2014, Oculus had relaunched the experimental and commercial dynamics of the 1990s.
2016	Launch of Exporea, a project of kits "Events Augmented Reality"

V. CONCLUSION

It is concluded that the augmented reality application has been a focus on modern research in innovation and development. On close observation of the literature review and background work it is evident that augmented reality has many benefits over the traditional educational model. The hypothesis of the AR proves that augmented reality influences the behavior and learning ability [20]. While the hypothesis applies to be true for all educational systems, obviously it can be applied for the Oman educational system also. The real time test data may be collected for analysis in my further higher studies.

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