AUGMENTED REALITY IN EDUCATION

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Abstract - Technology in education can influence students to learn actively and can motivate them, leading to an effective process of learning. Previous research has identified the problem that technology will create a passive learning process if the technology used does not promote critical thinking, meaning-making or metacognition. Since its introduction, augmented reality (AR) has been shown to have good potential in making the learning process more active, effective and meaningful. This is because its advanced technology enables users to interact with virtual and real-time applications and brings the natural experiences to the user. In addition, the merging of AR with education has recently attracted research attention because of its ability to allow students to be immersed in realistic experiences. Therefore, this concept paper reviews the research that has been conducted on AR. The review describes the application of AR in a number of fields of learning including Medicine, Chemistry, Mathematics, Physics, Geography, Biology, Astronomy and History. This paper also discusses the advantages of AR compared to traditional technology (such as e-learning and courseware) and traditional teaching methods (chalk and talk and traditional books). The review of the results of the research shows that, overall, AR technologies have a positive potential and advantages that can be adapted in education. The review also indicates the limitations of AR which could be addressed in future research.

1. INTRODUCTION

Immersing learners to real world and interact them with that world mostly cannot be convenient. Although the natural world is three-dimensional, we prefer to use two-dimensional media in education which is very convenient, familiar, flexible, portable and inexpensive. But it is static and does not offer the dynamic content. Alternatively, computer generated three-dimensional virtual environment can be used but these scenes requires high performance computer graphics which is more expensive than others.

Although lots of opportunities virtual worlds may present for teaching and learning, it is hard to provide an adequate level of realism. When users are completely immersed in this environment they become divorced from the real environment. So, it gives you virtual things by modeling the real world you're experiencing.

This study has a dual aim. Firstly, definition of augmented reality (AR) is given about this new artificial and augmented environment. Augmented reality has been defined by many authors but simply could be said as "three-dimensional virtual objects which get integrated on three dimensional real environments in real time."

In fact, there are three essential properties of augmented reality, viz.

1) combination of virtual & real objects in real environment
2) alignment of virtual & real objects with each other, and
3) running both virtual & real objects interactively in real time.

Characteristics of augmented reality system are provided and technologies are classified used in this system. Secondly it's potential in education within this context.

Augmented Reality

Nowadays a new medium "Augmented Reality' offer us unique affordances, combining physical and virtual worlds. This is the new way of manipulating how we interact with that world.

Without replacing the real world you're experiencing, this technology augments virtual information on top of the real world with continuous and implicit user control of the point of view and interactivity. It provides a composite view for the user with a combination of the real scene viewed by the user and computer generated virtual scenes. This is an augmentation of real world by engaging an ordinary place, space, thing or event in a way that is partly unmediated. We can offer learners' seamless interaction between the real and virtual worlds by combining augmented reality interfaces with the educational content. This new approach enhances the effectiveness and attractiveness of teaching and learning. The ability to overlay computer generated virtual things onto the real world changes the way we interact and trainings becomes real that can be seen in real time rather than a static experience.

Augmented Reality brings virtual information or object to any indirect view of user's real-world environment to enhance the user's perception and interaction with the real world. Augmented Reality tries to augment virtual objects on the real ones or scenes for maximizing natural and intuitive user experience in real time. It is an interactive environment where a real life is enhanced by virtual things real time. According to Azuma (1997), Augmented Reality must have three characteristics: combining the real and virtual worlds, having real-time interaction with the user, and is being registered in a 3D space. Augmented Reality allows the user to see the real

world and aim to supplement reality without completely immersing user inside a synthetic environment.

Methods Adopt to Adopt Augmented Reality

There are various techniques/technologies which can be used in augmenting the reality these are described below:

1) To augment a user, one can wear or carry a device (usually on head/hands) to get the information about physical objects. These devices allow the users to see, hear and touch the artificially created objects so that they become immersed into virtual computer environment like sophisticated flight simulators to imaginative games. For example, by wearing a data glove, projections of slides and video can be controlled in the same way as user does by making natural gestures. The user can make such gestures while making a talk. There are some applications whereby user can see through physical objects. For example, an obstetrician can examine pregnant women with her ultrasound report in the form of video image of women merged with computer-generated ultrasound image which will be replica of current position of live image." Knowledge-Based Augmented Reality for Maintenance Assistant (KARMA) lets repair technician to look through relevant repair diagrams superimposed onto a live video image of actual device.

2) To augment physical object, that physical object is changed embedding input, output or computational devices on or within it. An electronic brick can be made by simple electronic devices such as sensors (to sense light, sound, touch, proximity), logic devices (like gates, flip-flops, timers) and action elements like motors, light etc.

3) To augment environmental surroundings by user and object so that neither the user nor the object get affected is done through independent devices which provide and collect information from surrounding and display information onto object and capture information about the user's interactions with them. For example, a digital desk comprised of video camera to detect where user is pointing and close-up camera to capture the images of numbers, which are then interpreted via optical character recognition. An overhead projector projects the changes made by user back onto the surface of desk

Technology for Augmented Reality Systems
Augmented Reality and Virtual Reality use same hardware technologies and share lots of factors like computer generated virtual scenes, 3D objects and interactivity. The main difference between them is where virtual reality aims to replace the real world while augmented reality respectfully supplements it.

The main devices for augmented reality are displays, computers, input and tracking devices. See-through and Monitor-based displays are two major types of displays used in augmented reality. See-through displays place both images of the real and virtual environment over the user's view of the world. Video-see through and Optical see through systems are two types of see-through displays.

Head Mounted Displays

Head-mounted device is a kind of display which worn on the head or as part of a helmet. It has that has a small display optic in front of one or each eye. Video-see through systems are useful when you need to experience something remote or using an image enhancement system. Optical see-through systems combine computer generated scenes with "through the glasses" image of the real world. Generally, a slanted semi-transparent mirror is used for this. This mirror technology allows views of physical world to pass through the lens and graphically overlay information to be reflected in the user's eyes.

Video See through System   Optic See through System

Figure 1. Head Mounted Displays

Handheld Displays
Another type of devices uses video-see-through techniques to overlay graphics onto the real environment is Handheld Displays. These are small computing devices with a display that the user can hold in their hands. The two main advantages of handheld Augmented Reality are the portable nature of handheld devices and ubiquitous nature of camera phones. The disadvantages are the physical constraints of the user having to hold the handheld device out in front of them at all times as well as distorting effect of classically wide-angled mobile phone cameras when compared to the real world as viewed through the eye. Smart-phones, PDAs and Tablets with cameras, digital compasses, GPS units for their six degree of freedom tracking sensors and fiducial mark ar systems used as a handheld display in augmented reality.

Spatial Displays are use of video-projectors, optical elements, holograms, radio frequency tags, and other tracking technologies to display graphical information directly onto physical objects without requiring the user to wear or carry the display. Another way used to combine physical objects and computer-generated information is Projection Displays. In this physical three-dimensional model computer image is projected to create a realistic looking object.

A handheld AR system displaying a three dimensional graph registered to the cones and table.

Smart AR, a visual technology that capable to capture visual objects through its smartphone Webcam and project it out as a moving object over an actual 3d space

Fig 2. Handheld Displays

Augmented Realty in Education

Augmented Reality technology is not a new issue. It has been used in fields such as: military; medicine; engineering design; robotic; tele robotic; manufacturing, maintenance and repair applications; consumer design; psychological treatments, etc. Displaying information by using virtual things that the user cannot directly detect with his own senses can enable a person to interact with the real world in ways never before possible. We can change the position, shape, and/or other graphical features of virtual objects with interaction techniques augmented reality supports. Using our fingers or motions of handheld devices such as shake and tilt we have an ability to manipulate virtual objects, as well as to physical objects in the real world.

Augmented Reality can be applied for learning, entertainment, or edutainment by enhancing a user's perception of and interaction with the real world. User can move around the three-dimensional virtual image and view it from any vantage point, just like a real object. The information conveyed by the virtual objects helps users perform real world tasks. Tangible Interface Metaphor is one of the important way to improve learning. This property enables manipulation of three-dimensional virtual objects simply by moving real cards without mouse or keyboard.

Augmented Reality can also be used to enhance collaborative tasks. It is possible to develop innovative computer interfaces that merge virtual and real worlds to enhance face-to-face and remote collaboration. These augmented reality applications are more similar to natural face-to-face collaboration than to screen based collaboration.

Web technologies and internet are popular, as a practical situation people still prefer reading books instead of facing screens and textbooks are still widely used. Another interesting

Pedagogical Challenge

As with many educational innovations in the past, the use of augmented reality in learning may encounter resistance and constraints from administration and teachers themselves. Since learning with augmented reality requires approaches such as simulations and studio based pedagogy which is quite different then teacher centered conventional methods covering the syllabus content with in given time frame also restrict the innovation in education.

Learning Challenge

Augmented reality based learning environment offers a large amount of information with the use of multiple devices and accomplishing complex tasks. Therefore, learners may feel overloaded in such multitasking environment. Students have been reported to be overwhelmed and confused during such multi-user augmented reality simulation because they deal with unknown and unseen technologies. 15 A proper support is necessary to help the learners in generating appropriate plan of action, search for possible solutions of problem they encounter, interpret the clues provided by technological devices. In addition to it augmented reality environment uses

both fantasies along application of this technology is in augmented reality textbooks. With reality that can cause confusion among students. The loss of

These books are printed normally but point a webcam to the book brings visualizations and interactions designed. This is possible by installing special software on a computer, using special mobile apps or a web site. This technology allows any existing book to be developed into an augmented reality edition after publication. Using 3D objects and views, miscellaneous and imaginative media, simulations with different types of interactions is the easiest ways of connecting the two isolated worlds. Through the use of Augmented Reality in printed book pages, textbooks will become dynamic sources of information. In this way people with no computer background can still have a rich interactive experience.

2. CHALLENGES OF AUGMENTED REALITY IN EDUCATION

Some of the reported challenges faced during application of augmented reality in education are listed as follows:

Technological Challenge

One type of technologies used in augmented reality uses head-mounted display with additional backpack computer equipment. It is cumbersome design to carry during learning process which causes problems like discomfort and poor understanding. This problem can be avoided by using portable technologies that are less obtrusive and enhance sense of immersion and presence. Even then these involve lots of devices which lead to issues of interfacing between multiple devices and stability of such devices. The device errors cause student's frustration and therefore identified as noticeable problem. Such problems are expected to be solved by rapid development with regard to faster processors, wireless receivers, large hard drives etc. track of real environment may not be productive in fact sometimes may threat students' physical safety.

3. CONCLUSION

Discussions above indicate that augmented reality can be created by use of multiple technologies and has great potential to support teaching-learning process even compared to mature technologies like multimedia and web based platforms. Even though its application is at the early stages but still empirical studies show its evidence of effect on students during learning. Most of the studies are based on development, usability and initial implementation of augmented reality tools with small sample size and with exploration purpose only. In order to get more evidence on educational value out of augmented reality, a comprehensive evaluation studies that include large sample with good implementation is needed. Such studies needed to be done with especial designed curriculum complemented by technology used which could not be accomplished by traditional learning media.

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