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Augmented reality in education: current technologies and the potential for education

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Abstract

Although the physical world is three-dimensional, mostly we prefer to use two-dimensional media in education. The combination of AR technology with the educational content creates new type of automated applications and acts to enhance the effectiveness and attractiveness of teaching and learning for students in real life scenarios. Augmented Reality is a new medium, combining aspects from ubiquitous computing, tangible computing, and social computing. This medium offers unique affordances, combining physical and virtual worlds, with continuous and implicit user control of the point of view and interactivity. This paper provides an introduction to the technology of augmented reality (AR) and its possibilities for education. Key technologies and methods are discussed within the context of education.
Keywords: Augmented Reality, Technologies for Augmented Reality Systems;Augmented Reality in Education

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. 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

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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.

Technologies 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 system
(Trivisio, 2011)

Optic-see through system
(Inition, 2011)

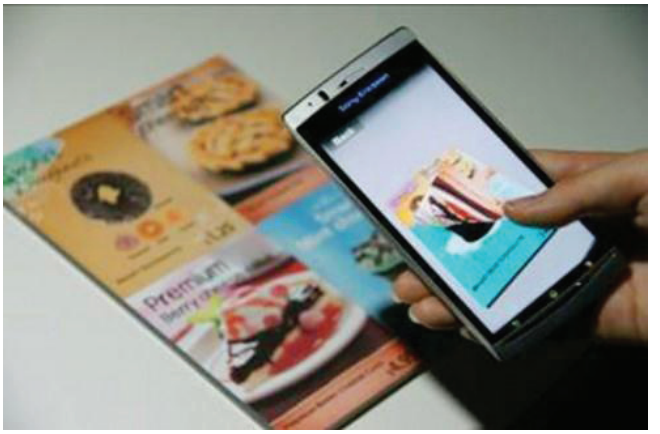
Figure 1. Head Mounted Displays

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.

Handheld Displays

Small computing devices with a display that the user can hold in their hands.

A handheld AR system displaying a three dimensional graph registered to the cones and table (CSM, 2011)



Smart AR, a visual technology that capable to capture visual objects through its smartphone webcam and project it out as a moving subject over an actual 3D space (Sony, 2011)

Figure2. Handheld Displays

Another type of devices use 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 (Feiner, 2011). Smart-phones, PDAs and Tablets with cameras, digital compasses, GPS units for their six degree of freedom tracking sensors and fiducial marker 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 (Bimber, Raskar, & Inami, 2007). 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.

Pinch gloves, wand with buttons and smart phones that signals its position and orientation from camera images are main input devices used in augmented reality. Pinch is a pair of stretch-fabric gloves contains sensors in each fingertip which detect contact between the digits of your hand. It is a remarkable new system used gestures for a wide range of control and interactive functions and interacting with 3D simulation.

Pinch Gloves

A pinching gesture can be used to grab a virtual object, and provides a reliable and low-cost method of recognizing natural gestures.

Pinch Gloves (Inition, 2011)

Data Glove (CyberGloves, 2011)

Figure3. Pinch Gloves

Digital cameras and/or other optical sensors, accelerometers, GPS, gyroscopes, solid state compasses, RFID and wireless sensors are used as tracking devices for positioning and orientating of the user's head, hand(s) or a handheld input device. These technologies offer varying levels of accuracy and precision. Computers generally used to analyze the sensed visual and other data. They synthesize and position augmentations and then reflect users display devices.

Type of devices and interaction of system between the user and the virtual content of augmented reality applications define systems interface. There are four main ways of interaction in augmented reality applications: tangible, collaborative, hybrid and emerging multimodal interfaces. Using these devices we can develop five different augmented reality systems. These systems fixed indoor/outdoor systems, mobile indoor/outdoor systems, and mobile indoor and outdoor systems. Mobile ones are the systems that allow the user for movement with the help of a wireless system and Fixed ones are the systems wherever they are set up without having the flexibility to move.

Augmented Reality in Education

Augmented Reality technology is not a new issue. It has been used in fields such as: military; medicine; engineering design; robotic; telerobotic; manufacturing, maintenance and repair applications; consumer design; psychological treatments, etc. (Azuma, Baillot, Behringer, & Feiner, 2001). 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 (Kiyokawa, et al., 2002).

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 application of this technology is in augmented reality textbooks. 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 became dynamic sources of information. In this way people with no computer background can still have a rich interactive experience.

Conclusion

Augmented reality has power to change how we use computers. Augmented reality makes the impossible possible and its potential in education is just beginning. Augmented reality interfaces offer seamless interaction between the real and virtual worlds. Using augmented reality systems learners interact with the 3D information, objects and events in a natural way. The educational experience offered by Augmented Reality is different for a number of reasons as Mark Billinghurst (2002) mentioned:

- Support of seamless interaction between real and virtual environments
- The use of a tangible interface metaphor for object manipulation
- The ability to transition smoothly between reality and virtuality

It is essential to coordinate a team of specialist to possible augmented reality solution in educational issues. In order to achieve realistic solutions we need to design and coordinate multi-disciplinary research project to enhance content and environments. Educators must work with researchers to develop augmented reality interfaces. Software and hardware technologies play an important and key role to produce augmented reality applications. There are engineers, who can design different augmented reality environments. However for learning, in educational technology field, there is a big need for instructional designers, who can design learning activities for augmented reality.

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