Computers & Education 56 (2011) 1045–1061

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

ARSC: Augmented reality student card
An augmented reality solution for the education field

Neven A.M. El Sayed [a,*], Hala H. Zayed [a], Mohamed I. Sharawy [b]

[a] Department of Computer Science, Faculty of Computers, Benha University, Benha, Egypt
[b] Department of Electrical and Computer Engineering, Shoubra Faculty of Engineering, Benha University, Cairo, Egypt

ARTICLE INFO

Article history:
Received 7 June 2010
Received in revised form
13 October 2010
Accepted 21 October 2010

Keywords:
Augmented reality
Mixed reality
Computer Assisted learning
Optical tracking

Index terms:
I.3 [COMPUTER GRAPHICS]: Augmented Reality
I.3.8 [Applications]: Education application

ABSTRACT

Augmented Reality (AR) is the technology of adding virtual objects to real scenes through enabling the addition of missing information in real life. As the lack of resources is a problem that can be solved through AR, this paper presents and explains the usage of AR technology we introduce Augmented Reality Student Card (ARSC) as an application of AR in the field of education. ARSC uses single static markers combined in one card for assigning different objects, while leaving the choice to the computer application for minimizing the tracking process. ARSC is designed to be a useful low cost solution for serving the education field. ARSC can represent any lesson in a 3D format that helps students to visualize different learning objects, interact with theories and deal with the information in a totally new, effective, and interactive way. ARSC can be used in offline, online and game applications with seven markers, four of them are used as a joystick game controller. One of the novelties in this paper is that experimental tests had been made for the ARTag marker set for sorting them according to their efficiency. The results of those tests were used in this research to choose the most efficient markers for ARSC, and can be used for further research. The experimental work in this paper also shows the constraints for marker creation for an AR application. As we need to work in both online and offline application, merging of toolkits and libraries has been made, as presented in this paper. ARSC was examined by a number of students of both genders with average age between 10 and 17 years and it found great acceptance among them.

1. Introduction

Augmented Reality (AR) is the technology of adding an unreal object to real life (The EDUCAUSE Learning Initiative). AR applications and research were triggered by a dream of the computer graphics' godfather, Ivan Sutherland, over 45 years ago (Sutherland, 1965). A lot of problems and points in the AR are still under research due to the need to combine different technologies and features to create such an application. The AR working process can be classified into a sequence of steps leading to the desired goal achieved as follows (Azuma, 1997):

- Image Segmentation.
- Feature Extraction.
- Marker Detection.
- Camera Orientation.
- Rendering.
- Augmentation.

* Corresponding author. Tel.: +20 2 0101355491.
E-mail address: neven.elsaid@gmail.com (N.A.M. El Sayed).

0360-1315/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.compedu.2010.10.019

Two main decisions have to be made for each AR application. One decision regarding the display type and the other is the tracking system technique (Diggins, 2005; Joele et al., 2005; Vallino, 1998). For the proposed application the decision was made to use the Spatial Displays and Optical tracking system.

Talking about AR will lead to discussions about some of the technology benefits and drawbacks. The advantages of the AR can be classified into two parts: advantages of AR application and advantages at the AR creation phase. Using an AR application allows the simulation, visualization, addition of information, and interaction with the virtual objects without being totally immersed in the virtual life (Diggins, 2005). The AR creation process is less expensive than that of the Virtual Reality (VR); this is considered one of the most important advantages of AR. Until now, all AR drawbacks are some weak points in the technology starting from the tracking time, registration error, and rendering quality.

Increasing the visualization ability for students, with the minimum tools used, was our motivation for ARSC. ARSC leads to better understanding by increasing the visualization ability, according to the survey results (will be mentioned in brief in Section 8). Also ARSC supports the edutainment learning techniques by the 3D objects augmentation with real scene, and the availability for connecting to extra outsource edutainment lesson materials. The greater percentage surveyed agreed that using ARSC make learning more fun and effective. Using ARSC adds to the learning tools a practical, interactive and creative ways, which is now heavily needed (Zhou, Duh, & Billinghurst, 2008) to increase the student creativity and practical skills.

This paper is organized as follows: Section 2 shows the previous work, fields of augmented reality and the most common categories this technology serves. Section 3 discusses, in brief, the hardware, software and card deigns in the ARSC system. Section 4 shows how the ARSC solution works; starting from system initialization through system shutdown. Section 5 describes ARSC scenarios in detail. Section 6 shows experimental results. Section 7 shows the paper conclusion. Section 8 shows the future work.

2. Related work

According to year 2009 Hype Cycle for Emerging Technologies (Fig. 1), it shows 2009 was the year of Mixed and Virtual Reality. Augmented Reality made good steps towards the peak stage with an adoption status "5–10 years" getting the technology back after disappearing for a year during 2007. Many technologies were triggered due to the Mixed and Virtual Reality used in holographic displays, head mounted displays, and eye tracking. In 2009, Virtual Reality appeared in the stable state, and the popularity of the public virtual Worlds increased.

Over the past ten years many applications and research have been published. The related work of AR can be classified into two classifications (Awad & Dziadosz):

First, by the fields it serves which can be classified mainly as follows:

- Game application
- Marketing and Advertising
- Filming
- Education
- Navigation

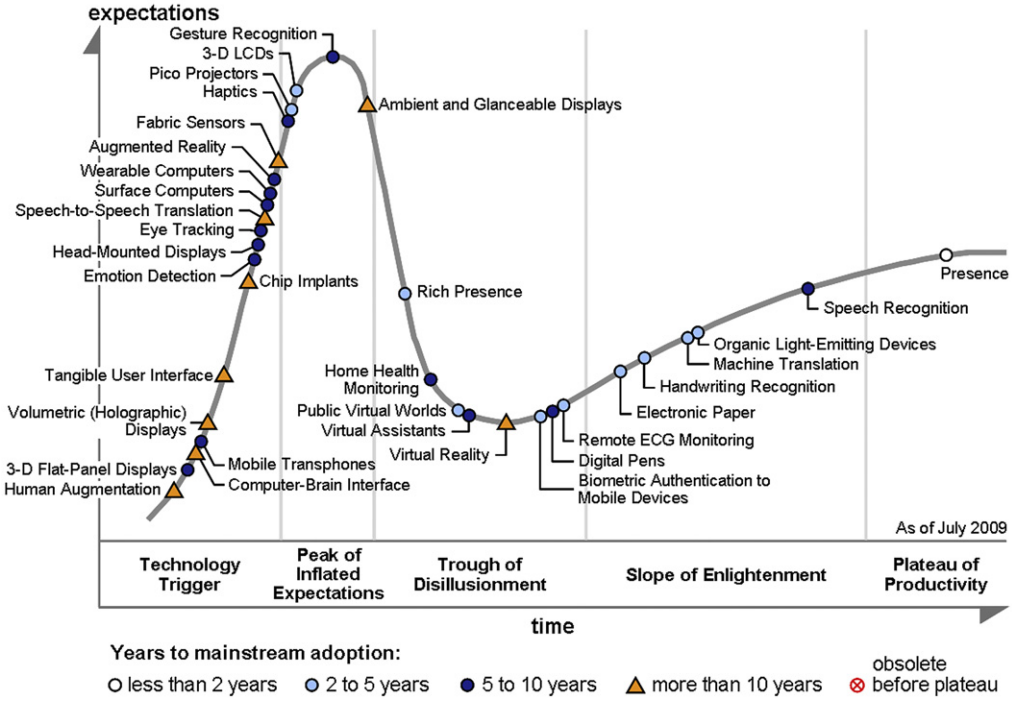

Fig. 1. Hype cycle for emerging technologies, 2009