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Stereoscopic Augmented Reality Approach for Brain Anatomy Learning: A Literature Review.

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Abstract Augmented reality (AR) has a potential as a new generation technology that attracted the attention of educators. The mixed of AR technology in educational content enhance the capability and attractiveness of learning for students in real life. Learning and teaching anatomy is a difficult task, partially due to the complexity of the subject and limitations of traditional pedagogic methods such as lectures, textbooks, laboratory, and anatomical dissections. This paper presents a literature review for further exploration on a stereoscopic augmented reality approach for brain anatomy learning. The intend work is potential users will interact with the system and the 3D model of brain anatomy by using VR box and VR controller. However, implementing 3D model in stereoscopic augmented reality to visualize the inner part of brain anatomy is challenging especially involve interaction between user. The 3D reconstruction based on multi-view will be used to develop high accuracy and moderate level of details that will suit AR visualization.

Keywords: **Augmented Reality, Stereoscopic, Brain Anatomy**

1. Introduction

Educational content can be experienced through a variety of media, ranging from non-interactive books to highly interactive digital experiences that fully engage the student's senses. Holzinger et al., (2005) believed that by adding the technology will benefit students in gaining information and reference material when they need it. In this era, with the various kind of technology, it promotes student motivations and stimulates the learning environments, which are important components in learning.

Education in anatomy is targeting to provide medical students with an extensive understanding of the morphology of anatomical structures, their position and spatial relations, for example connectivity and innervations. Medical students shall be capable to locate anatomical structures, which is the fundamental prerequisite for surgical interventions. They must be aware of the variability of the morphology and location, for example of branching

patterns of vascular structures. When studying the human anatomy instructors and students use cadavers, books, illustrations, mockups and more recently augmented reality (AR) solutions on mobile and computing devices. Bridging virtual and real worlds, augmented reality creates a reality that is enhanced and augmented (Bronack, 2011; Klopfer & Squire, 2007). New possibilities for teaching and learning provided by AR have been increasingly recognized by educational researchers.

Stereoscopic view will give the results to a highly improved perception of depth. This is because a user is able to distinguish how near or far is the subject from it. VR box or known as Head Mounted Display (HMD) will be used. The advantage of this technology over head-mounted display is that the focusing & vengeance issues didn't require fixing with the corrective eye lenses. For the 3D model of brain anatomy, the 3D reconstruction based on multi-view will be used to develop high accuracy and moderate level of details that will suit AR visualization.

2. Augmented Reality Technology

Augmented reality (AR) is referred to as 'mixed reality', or 'blended reality', is a technology that allows a live real-time direct or indirect real-world environment to be augmented by computer-generated virtual imagery information (Carmigniani & Furht, 2011; Lee, 2012). AR has been used since the 1990s in medicine, manufacturing, aeronautics, robotics, entertainment, and more recently in education. It has the great possible to bring impressive, contextual, and situated learning experiences, as well as to aid exploration of the complex interconnections seen in information in the real world. Students are able to use AR to create new perceptive learning based upon their interactions with virtual objects, which bring underlying data to life.

HoloSurgical is developing an AR and artificial intelligence (ARAI) surgical navigation system that has the potential to solve the critical limitations associated with surgical navigation and robotic systems. The application developed by Cristina et al. (2017) a low-cost AR learning system that enables students to visualize bones, muscles, and organs which help students identify the main elements of human anatomy in an easy and interactive way. Sevda et al. (2016) introduced a MagicBook for neuroanatomy topic by using mobile augmented reality (mAR) technology which allows users to interact with the environment by using mobile devices. Mobile augmented reality gives users an immersive sensory experience by integrating digital data into real environment (Hwang et al., 2008; Hwang et al., 2009; Chiang et al., 2014).

2. Stereoscopic Augmented Reality

Currently, stereo 3D display technology is discovering immense interest and application in entertainment such as medicine (imaging, robotic, training, virtual therapy and teleoperative surgery), movies and video games, industrial design (3D CAD), research and education (scientific and information visualization), and in the military (planning, training, image analysis, simulation, command & control, unmanned vehicle control, and teleoperative robotics). John et al. (2012) stated that stereoscopic displays have been presented to enlarge

performance on a variety of depth-related tasks. These tasks include deciding simple and relative distances, discovering and analyzing objects, and navigating.

Furthermore, there are several interest about stereoscopic view which are enhance the spatial understanding of 3D scenes or objects, it can increase the memory of scenes or objects, and improve learning of spatial relationships and environments. Head-mounted display (HMD) is use to allow the depth of perception. The use of localized HMD allows one to see a synthetic scene from a point of view aligned with the real user's point of view. Maurice et al. (2009) stated that a stereoscopic display could be beneficial in terms of a better spatial understanding of anatomical structures, better performance of tasks that require high level of dexterity, better approach of unclear anatomical structures, increased learning performance, and improved communication with patients or between doctors.

3. Conclusions

In conclusion, AR makes the impossible possible and its potential in brain anatomy learning for medical students. AR interfaces offer seamless interaction between the real environments and virtual worlds. Using AR, students can interact with the 3D information, objects and events in a natural way. Educators must work with researchers to develop AR interfaces and design the way to make learning more fun and interesting. Stereoscopic augmented reality in brain anatomy will help medical students to more understanding about the brain structure and also help them to study by themselves at their room as a revision activity. This proposed study is to help medical students to do their revision that only focusing on brain anatomy in anywhere at any time. This new pedagogy in education field could hope be useful for educators and also students in order to improve the learning skill by using technology. We are now reaching to industry 4.0 that will use technology in our daily life.

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