Evaluation Study Outcome of Augmented Reality Technology for Solving Engineering Problems in UNITEN:
Augmented Reality Technology for Solving Engineering Problems in UNITEN

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ABSTRACT

In this article, a study was done to compare the preferences of UNITEN students in using augmented reality technology user interface applications to solve selected engineering problems. Cross sectional study design and a Wilcoxon-Signed Rank Test approach was adopted to analyze the difference in the rankings of the engineering applications. Within a controlled environment, this research further applies “Trials within the same session but with breaks between tasks” an affirmed reliable method in measuring learnability that has been rarely explored by any related works locally. The results were captured through descriptive statistical analysis. The findings provided reliable evidences that multiple function user interface (MFIT) is more effective than the tangible user interface (TUI) for engineering students. Simultaneously, this research also presents evidences that MFIT is better than TUI in the engineering problem solving statistically.

KEYWORDS

Augmented Reality, Engineering, Software, Usability, Visualization

INTRODUCTION

As defined in the literature, “AR (Augmented Reality) is the digital overlay on top of the real world, consisting of computer graphics, text, video and audio, which is interactive in real time” (Azuma, 1997; Billinghamurst et al., 2014; Papagiannis, 2017). The technology can be interacted with and experienced through many electronic devices such as the computer, tablet, smartphone or AR eyewear equipped with the software and camera.

In the educational and human computer interaction studies, many researchers have shown that AR can assist and improve learning as compared to traditional/conventional methods (Kerawalla et al., 2006; Chang et al., 2010; Lee, 2012). Although Lee (2012) stated that students may acquire knowledge and skills through different modes of instruction that include classroom lectures with

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textbooks and computers, AR is put to practice through different interfaces and the interaction between human and computers depends on computer interfaces. However, when using technology to address a particular educational material, user interaction is one of the highly debated areas. Many instructional designers in the past found that the user interface of a particular software hinders users from learning the contents effectively because the users are provided with too much of information and need to focus more on the interface rather than the contents (Jameson, 1995; Alpert et al., 2003; Ziefle & Bay, 2006; Georgiev & Georgieva, 2009; Wong, 2017).

The same problem was also experienced by instructors and students in Universiti Tenaga Nasional (UNITEN) to calculate and analyze the Four-Bar Linkage (4BL) mechanism problems because the problems are basically accomplished with diagrams, equations, charts, texts and formulas. The poor user interface makes it even more difficult for them to focus on the contents. Other researchers have also developed software tools to solve the 4BL mechanism problem but failed to engage the user in the learning and visualization process (Oleg, 2000; Kihonge et al., 2002; Manjit 2003; 2008; 2009; Huber and Dietmajer, 2010).

In AR technology, the two user interfaces debated in the literatures are the Tangible User Interface (TUI) interaction technique and the multiple function interaction technique (MFIT) as used in mobile applications, where the latter is frequently quoted to be an enhancement to TUIs disadvantages. In general, both user interfaces have close relation to usability issues in the field of Human-Computer Interaction (HCI). Therefore, both are frequently compared and evaluated using usability measures. This research highlights the recent works done in the field of TUI vs. MFIT competitive study. Besides, this study was carried out to find research possibilities that could refine competitive usability evaluation by emphasizing on the enhancement of the new interaction technique, MFIT.

This research compares the preferences of UNITEN engineering students in using augmented reality user interfaces 4BL problem solving applications. The context of the study was a third-year mechanical engineering course in UNITEN, Malaysia.

PROBLEM STATEMENTS

Reviews on several related works have raised some problem statements that have been determined in teaching and learning in engineering field especially mechanical engineering. For example, from the student’s view, it is difficult for students to interact and solve engineering problem with the present AR mechanism i.e. the users use markers (symbols that are recognized by the PC camera to overlay 3D objects on the display) to interact with the virtual model that is displayed on the screen. For example, in engineering problems many forms of information are presented to the students simultaneously such as text, charts, formulas/equations etc. which could cause difficulties for students to relate the information (Manjit, 2006; Yuen et al., 2011; Fang & Gou, 2016). In general, a few researches stated that these problems were also experienced by students in engineering education field (Ditcher, 2001; Linder & Flowers, 2001; Sidhu, et al., 2002; Ellis et al., 2004; Dym et al., 2005; Shakerin, 2006; Palmquist, 2007; Litzinger et al., 2011).

Besides this, there were problems that occurred among the lecturer (Ellis & Turner, 2003; Levy & Ben-Ari, 2007; Stieger et al., 2014) whereby that they need to explain and repeat the problems to the students several times before the students could understand (Milgram et al., 1994; Maqableh & Manjit, 2013). For example, the lecturer may need to draw the diagrams and write the formula repeatedly until the students can understand.

Another problem is attributed to the existing software in UNITEN. This is due to poorly design software particularly the user interface and inability to access such software due to cost/licensing. In the present AR user interface, only one function can be executed at a time which limits the user to interact effectively and absorb the content (Manjit & Kather, 2013).

Learnability is a significant usability characteristic used to gauge how usable an interface is. However, very few TUI versus MFIT research works used this metric as major measurements. The
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