World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:14, No:08, 2020

Exploring the Use of Augmented Reality for Laboratory Lectures in Distance Learning

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Abstract : In this work, we explored the use of Augmented Reality (AR) to support students in laboratory lectures in Distance Learning (DL), designing an application that proved to be ready for use next semester. AR could help students in the understanding of complex concepts as well as increase their motivation in the learning process. However, despite many prototypes in the literature, it is still less used in schools and universities. This is mainly due to the perceived limited advantages to the investment costs, especially regarding changes needed in the teaching modalities. However, with the spread of epidemiological emergency due to SARS-CoV-2, schools and universities were forced to a very rapid redefinition of consolidated processes towards forms of Distance Learning. Despite its many advantages, it suffers from the impossibility to carry out practical activities that are of crucial importance in STEM ("Science, Technology, Engineering e Math") didactics. In this context, AR perceived advantages increased a lot since teachers are more prepared for new teaching modalities, exploiting AR that allows students to carry on practical activities on their own instead of being physically present in laboratories. In this work, we designed an AR application for the support of engineering students in the understanding of assembly drawings of complex machines. Traditionally, this skill is acquired in the first years of the bachelor's degree in industrial engineering, through laboratory activities where the teacher shows the corresponding components (e.g., bearings, screws, shafts) in a real machine and their representation in the assembly drawing. This research aims to explore the effectiveness of AR to allow students to acquire this skill on their own without physically being in the laboratory. In a preliminary phase, we interviewed students to understand the main issues in the learning of this subject. This survey revealed that students had difficulty identifying machine components in an assembly drawing, matching between the 2D representation of a component and its real shape, and understanding the functionality of a component within the machine. We developed a mobile application using Unity3D, aiming to solve the mentioned issues. We designed the application in collaboration with the course professors. Natural feature tracking was used to associate the 2D printed assembly drawing with the corresponding 3D virtual model. The application can be displayed on students' tablets or smartphones. Users could interact with selecting a component from a part list on the device. Then, 3D representations of components appear on the printed drawing, coupled with 3D virtual labels for their location and identification. Users could also interact with watching a 3D animation to learn how components are assembled. Students evaluated the application through a questionnaire based on the System Usability Scale (SUS). The survey was provided to 15 students selected among those we participated in the preliminary interview. The mean SUS score was 83 (SD 12.9) over a maximum of 100, allowing teachers to use the AR application in their courses. Another important finding is that almost all the students revealed that this application would provide significant power for comprehension on their own.

Keywords : augmented reality, distance learning, STEM didactics, technology in education
Conference Title : ICVRAR 2020 : International Conference on Virtual Reality and Augmented Reality
Conference Location : Moscow, Russia
Conference Dates : August 27-28, 2020