AN AUGMENTED REALITY APPLICATION FOR STUDYING ATOMIC ORBITALS: *ORBITÁRIO*

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ABSTRACT

Virtual environments seem to facilitate the formation of correct conceptual models. The main contributing factor is interaction. Augmented reality is a new sort of virtual reality with a new form of interaction. We present *Orbitário*, an augmented reality application for studying atomic orbitals.

KEYWORDS

Augmented reality, interaction, orbitals.

1. INTRODUCTION

According to Gardner (1983), among the various natural learning styles a prominent one is the visual-spatial one (*i.e.*, understanding the world through the eyes and expressing ideas through graphical arts). Visual-spatial aptitude is the ability to form and control a mental image, i.e., the ability to juxtapose, manipulate, and orient an object mentally and to create mind structures from written and verbal directions.

Computer-based worlds are useful to visualize physical processes allowing for better conceptual understanding. New approaches of computer based educational tools include simulations, multimedia presentations and, more recently, virtual environments.

Virtual environments, based on 3-D graphics, may facilitate the formation of conceptual models since they provide the capabilities to develop applications addressing higher skills (Trindade *et al.*, 2002). The main contributing factor is interaction. Educators have always asserted that a student has to interact with some environment in order to learn. When interactive systems are used to learn, students move from passive observers to active thinkers. Interactions with objects of a suitable virtual environment may provide an effective and meaningful response.

Between the edges of reality and virtual reality lies mixed reality, in which views of the real world are combined in some proportion with views of a virtual environment. Augmented reality is an example of mixed reality that consists primarily of a real environment, with graphic enhancements or augmentations. The display is of a primarily real environment, which is enhanced, or augmented, with computer-generated imagery. Using, for example, a see-through head-mounted display it is possible to make ghost-like images of anything we desire to appear in a fairly-well specified location in space. These images can display information, or can serve as interactive tools (Drascic and Milgram, 1996).

2. THE *ORBITÁRIO*

Motivated by these ideas, we have built *Orbitário*, an educational program based on augmented reality to support the study of some concepts of Quantum Mechanics at the first-year university level (included e.g. in general chemistry). In this application we combine (virtual) models of atomic orbitals with (real) patterns that are captured by a web cam and are associated with models (Figure 1). The graphic enhancement can be displayed in a computer monitor or another device like glasses or head-mounted display. Our application has been developed with the free package *ARToolkit*[1]. Innovative aspects of our augmented reality application are: the use of different patterns for the same model to increase the level of interactivity and the possibility of using sound for explaining the actions.

Figure 1. The representation of the $2p_x$ orbital through *Orbitário*: a) the pattern image (for example, a real image from a book) is captured by a web cam and interpreted by the software; b) the associated *2px* orbital (a virtual model) is displayed (statically or dynamically) combined with views of a real environment

3. CONCLUSION

We presented *Orbitário*, an augmented reality application for studying atomic orbitals. A great advantage of this software is to provide a new kind of interaction with multiple patterns associated to the same virtual model. The software is under evaluation with students, looking for the relationship between visual-spatial ability and conceptual understanding.

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[1] Available for download at http://www.hitl.washington.edu/artoolkit/download.htm.