VisAr3D: An Approach to Software Architecture Teaching Based on Virtual and Augmented Reality

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ABSTRACT
This paper aims to present an approach entitled VisAr3D to support software architecture teaching by means of virtual and augmented reality. Thus, it intends to define a 3D visualization environment which includes exploration, interaction and simulation resources to establish a practical and attractive learning, focusing on large scale systems.

Categories and Subject Descriptors
D.2.11 [**Software Engineering**]: Software Architectures

General Terms
Design.

Keywords
Software Engineering Education, Software Architecture, Virtual Reality, Augmented Reality.

1. INTRODUCTION
Our society is increasingly dependent on software, with a great demand for quality. In search for solutions, it requires better ways of producing systems. As systems become larger and more complex, software engineering, as well as its teaching, becomes vital. This is part of the pressure experienced by professionals of Software Engineering education, which over the years has mobilized the community to meet these demands. Particularly, Software Architecture discipline plays an important role in this scenario, incorporating reuse and its advantages in software development processes and allowing software engineers to understand and make decisions about design alternatives.

In recent years, the academy has invested much effort in developing new ways of teaching Software Engineering. New education proposals have been introduced in the classroom, especially those that make teaching more attractive to the student. Recognizing that visual communication can be a key factor in the process of teaching and learning of future software architects due to their high expressiveness and power to be adapted to student preferences, this thesis research has invested in the emerging technologies of 3D visualization, such as virtual reality (VR) and augmented reality (AR). Recently, interests in these technologies have increased both in entertainment and training applications (e.g., games and theater industry).

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The main purpose of this work is to define an approach called Visar3D (Software Architecture Visualization in 3D), in order to mobilize teachers and students in software architecture teaching/learning, using VR and AR technologies. It poses the following research question: Can VR and AR technologies contribute to support software architecture education through a more effective and attractive approach to students?

The remainder of this paper is structured as follows: Section 2 presents some related works. Section 3 describes the VisAr3D approach. Section 4 addresses some final considerations, Section 5, the acknowledgments and, finally, references are presented in Section 6.

2. RELATED WORKS
Some studies in literature notice the need to innovate when it comes to mobilizing students. The works presented in [1], [2], [3], [4] have influenced in the development of our work, especially for the identification of characteristic that are attractive to students. In [1], there is a focus on the need of a practical experience and stimuli for face-to-face interaction, facilitating the construction of a collective reasoning to understand concrete situations and use of games and simulations. *WriteOn* [3] invests in the interaction between the teacher and students in a classroom. Several tools (including the ones described in [5] and [6]) are similar to this latter approach, investing in the application of graphical interfaces to encourage students and to reduce the learning curve. These tools can also work as an assistant to the software architect.

3. VisAr3D APPROACH
By developing a 3D visualization system for the display of architectural models in a new perspective, it is possible to deal with more elaborate and complex designs, similar to those developed by the industry. The idea is to allow an intuitive exploration and interaction by software architecture students, using the resources and facilities such as the manipulation of models in a simulated learning environment, by means of virtual elements. At first, it must provide a static view of a large scale system model, emphasizing the static structure of the system. Before using VisAr3D, the software architecture in study must have been created and documented within a software architecture editor. Since large and complex system diagrams are presented,

detailing the features, components and connectors, in different levels of abstraction, and possibly using various architectural styles, VisAr3D first uses AR to capture a 2D projected or printed software architecture and VR to view, interact and simulate expected behavior in a three-dimensional virtual environment.

The development of an architectural design often produces a large amount of documentation, as well as records of the initial decisions about the project to ease the communication between stakeholders. This information is very important for software architects, especially for the novice ones (i.e., students) to understand the whole process of creation and software development. By using VisAr3D, 3D architectures are automatically generated from 2D and displayed with contextualized information, containing a multimedia documentation in audio, image and video forms. While navigating through the architecture students will have access to this superimposed information, as they move through the model space.

Another facility provided by VisAr3D is a search agent that allows looking for documents by keywords or filters. The result can be a link list or a graphical visualization through colors or flags. This sub-system allows quick and easy access to all kinds of information associated to the software architecture in study.

In this sense, students can analyze software architecture in a new perspective, discover similarities within a set of architectures, and understand complex relationships and the use of different techniques or styles that are justified, documented and easily made available. From the user movements, it is possible to exploit and visualize architectural models from different angles and dimensions.

Zooming technique is also available, providing more details of the data shown on a certain view, or another level of abstraction is displayed.

Through spontaneous situations and sometimes even playful, the student can explore, create, and especially communicate with other students or the teacher to obtain new information and to build his own learning process by sharing findings, doubts, or simple messages (e.g. the stimulus of competition in using "Case Studies" or the challenge of refactoring a piece of architecture).

VisAr3D also offers some opportunities for the use of interactive devices such as special glasses and data-gloves, making the users' access to software architecture elements more flexible. The teacher can also use stereoscopy projection.

This work is built on top of previously defined resources and functionalities to practical exercises developed by the Reuse group at COPPE/UFRJ. It exploits the learning of a set of metrics and architecture restructuring suggestions made by a tool for reorganization of candidates for class components, and the students' perception about the presented spatial relationships, also allowing the interpretation and understanding of the evolution of architectures by comparing the different versions in a 3D environment.

4. FINAL CONSIDERATIONS

VisAr3D, an approach to software architecture education, is still under development with its supporting tool being fully detailed. The obtained results so far include: (i) an extensive review of the literature was conducted (i.e., a quasi-systematic review [7]) to identify existing initiatives in software architecture teaching; (ii) the study of languages, tools and environments for VR an AR application development; and (iii) the construction of two prototypes.

The prototypes were helpful for the learning process of the AR and VR technologies and represented a source of motivation to this work. Each prototype implemented an application for understanding the structural behavior of qualitative models to enhance the learning of novice students in architecture and engineering courses. The first one was an AR application and the second one a VR application. They provided the students with a better perception of the displacement tendency of beams, in a qualitative manner, and also allowed them to gain knowledge about the structures responses to a concentrated load at different points. Currently, a prototype implementation and a planning evaluation are being conducted.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] BAKER, A., NAVARRO, E. O., VAN DER HOEK, A., 2005, "An experimental card game for teaching software engineering processes", Journal of Systems and Software, v. 75, n. 1-2 (Feb.), pp. 3-16.

[2] DE LUCENA, V. F., BRITO, A., GOHNER, P., 2006, "A Germany-Brazil Experience Report on Teaching Software Engineering for Electrical Engineering Undergraduate Students", In: Proceedings of the 19th Conference on Software Engineering Education & Training (CSEET'06), pp. 69-76, Turtle Bay, Apr.

[3] TRONT, J. G., ELIGETI, V., PREY, J., 2006, "WriteOn: A tool to support teaching software engineering", In: Proceedings of the 19th Conference on Software Engineering Education and Training Workshops (CSEETW'06), pp. 8-11, Turtle Bay, Apr.

[4] MOHRENSCHILDT, M. V., PETERS, D. K., 1998, "Draw-Bot: A project for teaching software engineering", In: Proceedings of the 28th Annual Frontiers in Education Conference, pp. 1022-1027, Tempe, Jun.

[5] WANG, W. L.; SCANNELL, D., 2005, "An architecture-based software reliability modeling tool and its support for teaching", In: Proceedings of the Frontiers in Education Conference (FIE), pp. T4C-15, Indianapolis, Oct.

[6] MCGREGOR, J. D., BACHMAN, F., BASS, L., BIANCO, P., KLEIN, M., 2007, "Using an architecture reasoning tool to teach software architecture", In: Proceedings of the 20th Conference on Software Engineering Education & Training, pp. 275–282, Dublin, Jul.

[7] BIOLCHINI, J., MIAN, P. G., NATALI, A. C. C., TRAVASSOS, G. H., 2005, Systematic Review in Software Engineering, Technical Report ES 679/05, COPPE/UFRJ, Rio de Janeiro.