Descriptive Geometry Learning with the Aid of Augmented Reality

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Abstract

This article presents the state of the art use of Augmented Reality in the teaching of Descriptive Geometry and also presents a new application, the VSTARGD – Viewer of Torus Surfaces of Descriptive Geometry Through Augmented Reality. It is also presented and analysed the contribution of VSTARGD to the teaching of Descriptive Geometry.

Key Words: Virtual Reality, Augmented Reality, Descriptive Geometry, Torus Surfaces.

Introduction

Descriptive Geometry is an essential discipline for the professionals who need solving problems in space. Due to the difficulties encountered by many students to
understand it, it is justifiable to use Augmented Reality as an alternative to appeal to teaching/learning.

**State of the Art**

*Construct 3D*, (Figure 1) an Augmented Reality tool in the teaching of Geometry, was developed in Austria. This application is based on HMD. According to the authors, Construct 3D was not created to be a professional 3D modeler, but "a simple tool for building 3D, without animation, in an environment with immersive educational purposes." [1].

Supported by the pedagogical theory of Constructivism and, in the field of Psychology that deals with researches of spatial abilities, [Ibid] the authors conducted several tests with Construct 3D and High School and University students. They concluded that male students tend to solve the problems of space in a holistic way, while the female ones solve them in holistic or analytic ways or combining the two strategies [1]

The basic configuration of Construct 3D consists of two users with HMD, sharing a virtual space. Its current version allows the construction of points, three-dimensional geometric figures. It enables measuring and analyzing the structures of geometric elements studied. The authors also point out that: "Any operation in Construct 3D consists of relocating a point or element and reassessing its new resulting configuration " [1]
"Students working directly in 3D space can understand problems and spatial relationships better and faster than the traditional methods". But the authors say that Construct 3D was not created to replace the traditional teaching or based on the CAD, but to add to these.

In Brazil, at the Federal University of Para, card markers reconfigurable on Environment of Augmented Reality were developed (Figure 2). Such markers of the ARToolKit system (an open source free digital library, created for the development of applications in AR), can have its entirety altered by the user when its configuration is changed, following a legend, and therefore, the virtual models also change in real time. Its first application was for the teaching of Space Geometry.

Figure 1: Students studying DG through Construct 3D – [2]
As an advantage of this system you may have the dispensation of costly equipment for the creation of the environment of AR and the great interactivity available, the user simply consults a caption [3].

In 2005, at the School of Fine Arts of UFRJ, the prototype Viewer of Conic Sections of Descriptive Geometry Through Augmented Reality was developed with the support of the Virtual Reality Group (GRVA) from The Computational Techniques in Engineering Laboratory (LAMCE) by COPPE [4].

Developed through DART - Designer's Augmented Reality Toolkit, which works in the Macromedia Director MX program, the viewer is an example of an AR based Monitor.

In the prototype, you can choose which conic section you want to see: circle, ellipse, parable or hyperbole (Figure 3), and you can choose for their respective descriptive projections, or the prospect of the three-dimensional solid, or by combining the two.
Figure 3: Interface of the first prototype where we see a hyperbolic conic section in an environment of augmented reality.

VSTARGD

In 2007, continuing the researches, a new application, more comprehensive and with more resources than the first prototype was developed: The VSTARGD - Viewer of Torus Surfaces of Descriptive Geometry Through Augmented Reality (Figure 4).
Figure 4: Interface VSTARGD.

The viewer of Conic Sections offers twelve different modes of viewing available, while in VSTARGD, there are twenty-one different options, of which three are animated with movement, enabling the user to see in detail the result of different cuts in an open torus, including the view of the theorem of the bitangent section of Ivon Villaceu.

Figure 5: Visualization of the theorem of Ivon Villaceu through Augmented Reality.

VSTARGD is also an AR based Monitor, developed through DART. In the prototype, it is possible to choose which torus area you want to see: open, closed, reentrant, or you can choose from three different cases of torus section: horizontal, tangent to the generatrix circumference or bitangent. (Figure 5), and also the opportunity to choose for their respective descriptive projections, or the prospect of three-dimensional solid, or by combining the two, as in the previous prototype The option exploded in this
sudy brings the simultaneous animation of solids and their corresponding projections as an important innovation. (Figures 6 and 7)
Figures 6 and 7: Two moments of animation, showing a toric section through Augmented Reality.

The testing of these different modes of complementary viewing allows the development of the so-called Space Intelligence, category defined in the Theory of Multiple Intelligencies, ABREU [5] which can be understood as being vital for the total dominion of the Descriptive Geometry.

We believe that the Traditional Teaching favors the so-called Linguistics Intelligence, and Logic-Mathematics, neglecting the Space Intelligence, resulting in the difficulty for the students to learn the subject.

Final Considerations

The current phase of this research project includes the implementation and evaluation of applications developed in Augmented Reality. This will be done by the availability of prototypes for use in classrooms, in the computers lab, and later on the launching of the results by the portal Espaço GD (GD Space) (www.eba.ufrj.br/gd).

The interaction of the students with the application of Augmented Reality will be directed with the aim of identifying possibilities and limitations of the technique used. Moreover, interviews will be conducted in order to detect features of the perception of the student, such as: increased interest and motivation, degree of difficulty encountered, among others.

Another aspect to be evaluated concerns the minimum requirements of hardware, in relation to the configuration average of didactic laboratories of UFRJ for full use of the application developed.

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[2] www.ims.tuwien.ac.at/research/spatial_abilities/


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