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VIRTUAL REALITY TOOLS FOR GOODS, FOOD AND BEVERAGE IRRADIATION AT IPEN'S FACILITIES AS A NUCLEAR TECHNOLOGY TEACHING MOTIVATION

Patricia Andrea Paladino[1], Gaianê Sabundjian[2] Eduardo Lobo Lustosa Cabral[3] and Arthur Pires Julião[4]

[1]Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP, Brazil
patricia.paladino@ipen.br

[2] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP, Brazil
gdjian@ipen.br

[3] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP, Brazil
elcabral@ipen.br

[4] Faculdade de Tecnologia de São Paulo (FATEC– SP)
Av. Tiradentes, 615
01124-060 São Paulo, SP, Brazil
pjarthur@fatecsp.br

ABSTRACT

In this research a full-fledged and complete Virtual Reality (VR) environment will be wholly developed and then deployed as a kind of innovative means of widespread divulgation of one topic of nuclear science and nuclear technology most interesting application and its teaching; viz, that related to goods, beverages and mainly food irradiation practices, simulating a virtually guided visit to some of IPEN's facilities and its already installed and operational scientific equipment, namely, the GAMMACELL irradiator, firstly targeting undergraduate and last year high school students and then, later, the interested general public. In this way, several programs and whole VR platforms, such as Unity, are used as powerful, professional tools for games and videogames development and it is expected that the final product will be made available packaged as an instructive videogame to the community of committed and interested users. Therefore, in doing so, some contemporary reasoned and still debated pedagogical recommendations will be handled and met, hopefully increasing students' curiosity and good aptitudes towards the disseminated use of nuclear technologies nowadays. It is hoped that perhaps a modest contribution against the many undeserved prejudices and odd misconceptions still remaining nowadays regarding nuclear science development, results and applications, will be abated.

1. INTRODUCTION

During the last two decades many public policies have been deployed aiming the digital inclusion processes increase, mainly in public schools and non-presencial education. An expressive part of the so called XXI Century "New Generation" was born to a global digital

context, strongly marked by several technologies and has access to a huge amount of information. In Brazil, this led to reformulations and recommendations culminating in the "Parâmetros Curriculares Nacionais" [1] (National Syllabus Standards) which preconize the classroom use of technologies, fully integrated with the pedagogical projects adopted in schools, and the so many "Tecnologias Digitais de Informação e Comunicação (TDIC)" (Information and Communication Digital Technologies, ICDT) pose both a paradigm challenge and ample debate nowadays.

By means of virtual visitation to IPEN´s goods, food and beverage irradiation facilities, some of these ICDT will be handled via Virtual Reality (VR) tools.

Nowadays, due to safety precautions, controlled access and children protection guidelines, even widespread use of information tools may difficult proper divulgation of research results in places like IPEN (Nuclear and Energy Research Institute). Not to mention the many related prejudices, mostly due to some accidents, the social benefits and advantages of nuclear energy hardly met the same divulgation level.

So, Virtual Reality, with all of its potential may indeed become a powerful learning tool and also an interesting one.

2. THEORETICAL FOUNDATIONS

2.1 Virtual Reality (VR)

By means of user immersion in a controlled virtual environment, this technology allows an interactive user to experience and mimic a real or phantasy world. 3D imaging systems such as those used in Augmented Reality, an alternative form of VR, also nowadays demand some types of tablets or some smartphones models and can also deploy headphones, etc.

Immersivity, interactivity and involvement are all characteristics of VR [2].

When a VR experience is designed it is necessary real attention to:

- World scale: The environment 3D space scale is important;
- First-person controls: There are various techniques which can be used to control the movement of the avatar (first-person camera), gaze-based selection, game controllers, and head movements;
- User interface controls: Unlike conventional videogames (and mobile videogames), all user interface components are in world coordinates in VR, not screen coordinates;
- It is important explore ways to present notices, buttons, selectors, and other user interface (UI) controls to the users or players so that they can interact and make selections;
- Physics and gravity: Critical to the sense of presence and immersion in VR is the physics and gravity of the specific world;
- Animations: Moving objects within the scene is called "animation". This can be done either along predefined paths or by means of AI (artificial intelligence) scripting which follows a logical algorithm in response to events in the environment.

Software tools are deployed to model and handle all avatar actions in 3-D VR environments,

dealing with all the necessary hardware to control head moves, sounds and physics constraints.

Thus, regarding the user interactions, some kind of equivalence with the real world is essential to accomplish human actions in virtual environments; therefore, any kind of such representation demands a degree of faithfulness.

Modelling tools are used to build sceneries mainly controlling rendering, illumination and texture generation [3].

Game engines (some already used in popular and famous videogames) deal with animation and programming chores, thus enabling an effective development by a team of experts of all levels.

For instance, DUNIA, ANVIL and UNITY3d are excellent game engines. [2]

Commercial or free head mounted displays and some kind of recent smartphones are required in the sequel for an effective virtual visit.

2.2 Virtual Reality and Teaching

Besides being one of the most promising horizons for VR, teaching may greatly benefit of VR immersive experience, enabling the learning and grasping of some concepts.

As an important example of this, the *Immersive Education Initiativ*e (IED), established in 2005 and with over 7000 associates in the whole world, such as Harvard University, MIT, etc., is actively collaborating in training programs and users training communities, besides developing standards [4].

IED activities aims to build VR systems for ample educational purposes, thus propelling any level of education, irrespectively of common global constraints.

VR may be the next great change technology will bring to the life of the people.

VR's main advantages in education are [5]:

- the growth in some students motivation;
- to increase the illustration power of processes and objects;
- the visual inspection of faraway objects;
- the visual inspection of really near objects;
- the execution of tasks by handicapped people, otherwise impossible;
- the offering of several experiments simulations;
- to allow the student own pace in his/her work development;
- not to restrain the execution of experiments to the regular class local and its duration;
- interactivity enabling, therefore stimulating student active participation in his/her knowledge construction.

Thus, VR adoption turns out to be a kind of more dynamical and creative education form by placing the student in the center of the learning processes. Specific areas of application of VR in education comprehend [5]:

- real world task execution by remote operation;
- virtual training of chores needed in the real world;
- learning and knowledge acquisition;
- cooperative projects execution;
- entertainment;
- communication;
- motor and perceptual capacities exploitation.

2.3 Nuclear Reactors and Food Irradiation

The CTR "Centro de Tecnologia das Radiações" (Radiation Technology Center) deploys ionizing radiation for food preservation (among other applications). No contamination implied here and no radioactive or toxic wastes produced in the process.

In the irradiation method, foods are exposed to carefully controlled dosages of ionizing radiation with good penetration, so that this process will not only affect the microorganisms situated on their surfaces, but in the food as a whole. The irradiation treatment may further be applied to prevent sprouting in bulbs and tubers, postponing maturation or aging in fruits and vegetables, thus sterilizing ready-to-eat foods, allowing these goods to be stored at room temperature, etc. [6].

Ionizing radiation is also used for sterilization of transfusion bags for blood components, a critical process to avoid graft versus host disease (GVHD), a condition in which white blood cells – lymphocytes – from blood products attack cells and tissues of the recipient organism. Although there are other procedures, such as the use of leukocyte filters and delamination, the only known safe way to approach GVHD is prophylaxis through gamma irradiation of blood components [7] [8]. The irradiator used in the sterilization procedure of transfusion bags of blood components is the GAMMACELL model, shown in Fig. 1.

Figure 1: GAMMACELL model

1. METODOLOGY

For the development of this work, some of the techniques and documentation available for building virtual games were deployed. To achieve this goal, the chosen methodology demanded mastering the skills provided by some free software packages available in the Internet, such as ScketchUp, Autodesk 3dS Max, Unity Games Engine and Google VR components.

ScketchUp, one of the most popular modeling tools in the world, is used for creating 3D models. It allows replica creation with detail and precision. The tool is intuitive and offers a list of handy textures and volume handling routines.

Autodesk 3dS Max was another option chosen for modeling objects, machines, panels and some other interactive components; formerly known as 3D Studio, it is a powerful software package developed for anyone who works with 3D Modeling, Rendering, Animation and 3D Composition, that is to say, it is more specifically used in the fields of games or video games creation, and in animations used in cinema, TV commercials and specific animations for television needs. It is one of the most used programs for creating visualizations of 3D modeling and animation freely available over the Internet.

A Game Engine is a library of packaged features and tools, conceived to ease the development of a game, in such a way that not everything should be crafted from scratch.

Many commercial game engines developed for original game titles released their programming structures for the construction of other games. Among them, one of the most regarded in this market and freely available for small developers, the Unity 3D game engine was the chosen one here.

This game engine allows game and apps creations suitable for diverse operating computer systems running various browsers, mobile devices and VR platforms.

The access to Unity 3D is totally free for companies with revenues up to US$ 100000.00 by year. Besides that, a vast documentation, models, textures, codes and free or paid training modules are available for serious developers. C# language constructs are however required.

Low cost cardboard VR goggles projects made available by Google aid in simulating stereoscopic human view. Some VR head-mounted displays (HMDs) bear many kinds of sensors, individual eyes screens and displays and many more components to simulate human stereoscopic view.

As shown in Fig. 2, human ability to view with both eyes is crucial to stereoscopic vision.
The very same principle is used for the construction of VR images: two cameras with slight angular differences are deployed, as shown in Fig. 3.

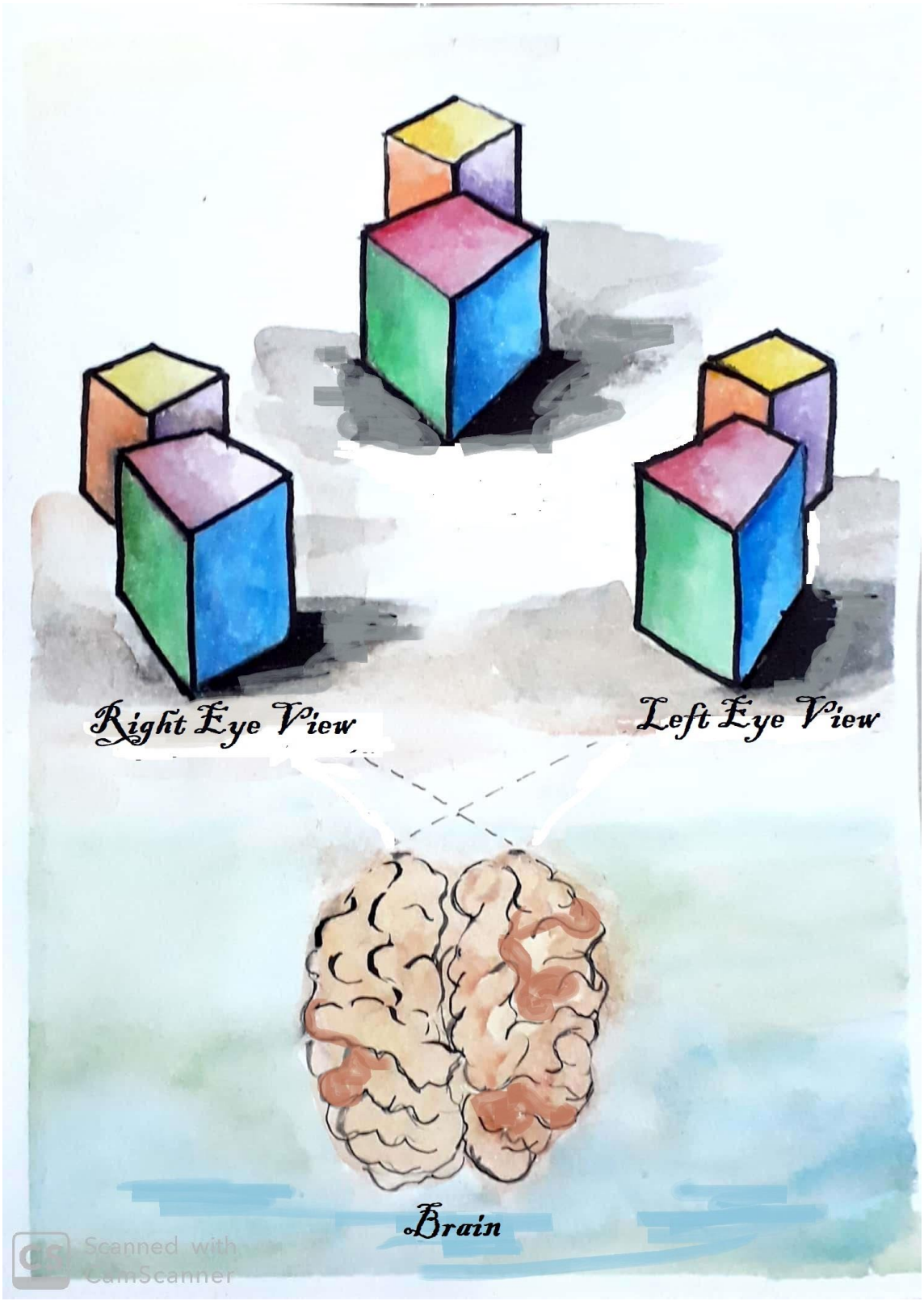

Figure 2: Stereoscopic vision

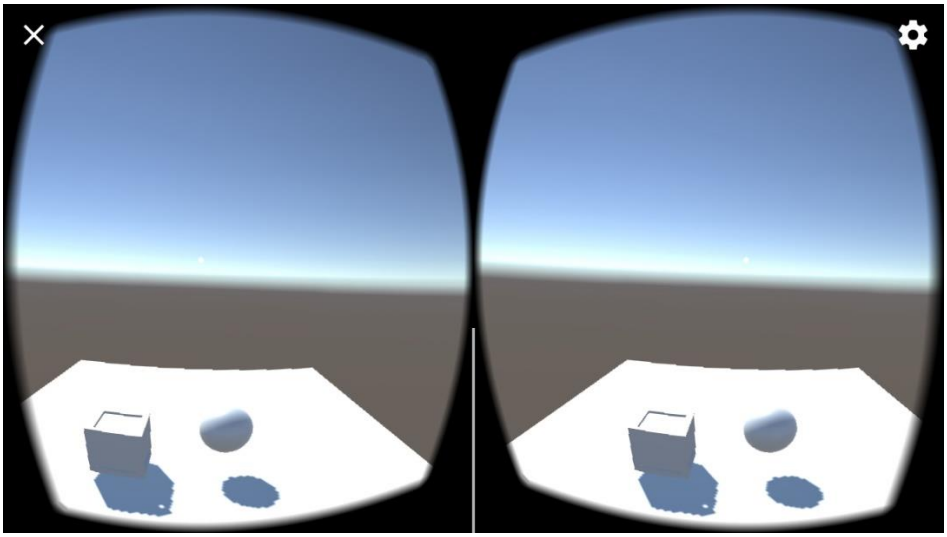

Figure 3: two cameras views

2. CONCLUSIONS

This is a work in progress. The part already accomplished in it indeed confirms that ICDT is a formidable tool for scientific knowledge dissemination. There are powerful VR packages freely available for researches and teachers interested in the field but, due to this theme complexity, theoretical and practical assessment demands both time and genuine efforts in many parts of the task. Interdisciplinary integration of artistic model presentation and its proper rendering and the scientific inner workings of GAMMACELL irradiator will deserve deep game development theory and skillfully programming.

Regarding stereoscopic view one should note that some people do have, sense and feel real difficulties and this not only has to do with dealing with the required hardware: it is a clinical condition for them. Consequently, to attend this public, 2D old fashioned platform games still remain an interesting and valuable option for scientific knowledge dissemination.

REFERENCES

1. Brasil. Secretaria de Educação Fundamental, *Parâmetros Curriculares Nacionais: terceiro e quarto ciclos do ensino fundamental: introdução aos parâmetros curriculares nacionais*, Brasília: MEC/SEF (1998).
2. Cnop, A. C., *Simulação Virtual de Visita Técnica no Reator Argonauta para Fins de Divulgação Científica*, Dissertação de Mestrado, CNEN/IEN – Rio de Janeiro, (2016).
3. Calciolari, F. *3ds Max 2012 - Modelagem, Render, Efeitos e Animação* 1. ed. Editora Erica, São Paulo (2011).
4. "*Imersive Education,*" <http://immersiveeducation.org/> (2019).
5. Braga, M. *"Realidade Virtual e Educação*". Revista de Biologia e Ciências da Terra [en linea] 2001: <http://www.redalyc.org/articulo.oa?id=50010104> (2019).

6. Cattaruzzi, E.B. "*Análise sobre a predisposição do consumidor em arcar com o custo do alimento processado por radiação ionizante*", Tese de Doutorado IPEN – São Paulo, (2012).
7. Oliveira, P.M. *Avaliação de dose nos sistemas de irradiação de bolsas de sangue para esterilização* Dissertação (Mestrado em Tecnologia Nuclear) Instituto de Pesquisas Energéticas e Nucleares, São Paulo (2014).
8. Ronsini, G.H.; Colenci, R. *Importância da irradiação de bolsas de transfusão de concentrado de hemácias na prevenção de reações adversas.* Tekhne e Logos, v.8, n.2, p.121-130 (2017).