APPLICATION OF THE GAME ENGINE IN THE PROMOTION AND TRAINING OF THE CULTURAL HERITAGE

S. Denchev, T. Trencheva, I. Trenchev

University of Library Studies and Information Technologies (BULGARIA)

Abstract

In conjunction with the current trends in the socialization of the cultural heritage, the role of information and communication technologies is increasing, which creates new opportunities for access to cultural values in the context of national policy in a priority area for the European Union. This policy is part of the global doctrine of sustainable development, which is based on the following basic principles: economic development, social balance, sustainability and environmental protection, incl. cultural heritage. As a result of the investments made for the socialization of the cultural heritage, the development of the regions is stimulated through economic activities related to the use of cultural resources for cultural tourism, the improvement of the territory and the human resource. In this sense, cultural heritage plays an increasingly important role in the current and the future regional development of the world.

In this paper, we present the current trends in the theories, methods, and technologies used in the development of computer games. Here we provide a brief overview of existing literature in this professional field. We present the strengths and weaknesses of different methods and technologies in the creation of games and their application in education.

We demonstrate the capabilities of photogrammetry – 3D modeling using realistic photographic images. We also show the use of this technology in creating complex 3D primitives and incorporating them into complex objects. Last but not least, we demonstrate different algorithms and software technologies for creating computer models of selected cultural heritage samples through the Unreal engine program. With the help of a lot of thread programming we show the possibility of building a virtual system that can be used by different users in real time. It can be either a virtual room or, for example, a virtual museum.

By presenting licensing agreements, we pay special attention to the fact that practically this type of technology is free of charge for universities. The paper concludes with a synthesis of the results of a scientific debate about whether it is possible to create virtual realities with this type of technologies and to what extent we can engage young people in their realization.

Keywords: Game engine, 3D, mixed reality.

1 INTRODUCTION

It was in 2013 -2014 when the US Academic Affairs Committee recommended the American Pharmacy Colleges Association to include serious games in the educational process, which could be used in education. This approach can encourage teachers' and students' innovations in the process of designing and application of the gaming approach for the training of future staff. Its implementation can be useful in raising the quality of education. In addition, the committees suggest that school management should urge teachers and students to use serious games for studying and professional development, if appropriate [1,2].

The serious game can be defined as the use of game principles for the purposes of training as well as acquisition of skills and knowledge. According to Cain and Peggy [2] the first military service organizations and emergency services did adopt and implement this educational strategy. They were aware of the benefits of games and the possibility that they can create a virtually real learning environment in which the consequences of mistakes are minimized.

In 1999, The American Armed Forces established the MOVES Institute. It conducted significant and applied research in modeling, computer simulations and mixed reality. Understanding that modern computers provide real-life training opportunities, the Army funded the Southern California Institute for Creative Technologies. It creates a collaboration between entertainment software, military simulation, training, operations and research. The result of this collaboration is an online game called America's

Army[1]. It was developed as an army recruitment tool and as a simulated rehearsal environment for military training and operations. So far, the US military have not published any research on these studies [2], [3], [4].

Orts [4] presents interesting examples of applications for computer games in higher education. The University of Pennsylvania's Wharton School of Business and Economics have adopted a similar approach to its students. This is a game called Tragedy of the Commons. The objective of the game is to learn to preserve the value of resources for the future. Essentially, the task of resource allocation is solved. The solution method is by using dynamic optimization and the Bellman principle. The mathematical description is through recurrent equations. In general, it is difficult for all students to learn this specific teaching material, but when presented in the form of a game, this process becomes much easier and more understandable.

Each individual student or group of students has a specific food resource for each individual country that is tuna fish in the game. It can be changed at the request of the player. Each player determines the size and strategy with which they compete to feed the core population. The group have to make the necessary decisions, the game calculates the catch, costs and checks and adjusts the global population. The simulations are on the Harvard Business Publishing for Educators website[2].

In Entrepreneurial Simulation: in the Startup Game, students play the role of founders, investors, and early employees of new companies. This creates concepts related to the success of startup companies and allows students to experience the uncertainty of starting a new company.

The application of computer games in healthcare education has been studies by Graafland M, et al. [6]. Their research shows that the use of the gaming approach in medicine has a future. The aim is to increase the involvement of health professionals in incentive training and to improve antimicrobial behavior [5], [6], [7], [8].

Published research in this area is still scarce, but several new studies are being conducted on serious games in the context of the application of games in the educational process.

Cultural and Historical Heritage (CHH) training is a complex and multidirectional process that requires interdisciplinary approaches to achieve in-depth knowledge of existing knowledge and at the same time create the capacity to discover, explore, preserve and promote new discoveries. Promoting CHH through information technologies is an extremely working formula for the proper use of technology in the process of perceiving and learning about Bulgarian cultural heritage. The opportunities offered by state-of-the-art technologies allow for a more attractive and correct way of enriching the options for access to elements of CHH.

Drawing on our previous experience, as stated above, within the framework of the project “Application of Mixed Reality in the Education and Promotion of Cultural and Historical Heritage in a University Information Environment”, we present our experience in the application of computer games to the teaching and promotion of CHH at the University of library Studies and Information Technologies in Sofia, Bulgaria [5], [8].

2 METHODOLOGY

Improvements in the acquisition and presentation of spatial data along with computer technology have taken computer graphics to a new level with engineers and users looking to be free from the limitations of analog cards, following the trend of creating and using maps in the digital world. There is a need for 3D models to create more realistic environments for users and even more realistic ones by using photorealistic 3D models [10], [11], [12], [13].

There are two basic technologies for generating three-dimensional information – photo panoramas and three-dimensional virtual models. The first approach can only be performed on real objects, while the second one can be applied to non-existent objects.

One of the project objectives is to expand the learning opportunities of the students by creating virtual sites of cultural and historical heritage. As part of the project, we are currently creating a real 3D model of the ancient city of Skaptopara, located in southwestern Bulgaria.

[1] https://www.americasarmy.com/

[2] https://hbsp.harvard.edu/educator/

The ‘recreation’ of an ancient city approach includes a library of procedural rules that generate the basic typologies of modeling Greek and Roman city buildings [12].

In the course of the realization of this 3D model, a workflow emerged, which is at the heart of the Roman graphic schedule [10]. The main challenge of this workflow is to integrate empirical data with procedural methods. For example, applying a summary description of a Roman temple to a temple site actually excavated in the Roman Forum shows trends where such generalizations are insufficient. Therefore, procedural rules rarely exist in a static state for a long time and are constantly rewritten as new parameters are required. This process of writing and rewriting the rules of procedure is likely to lead to the identification of elements that could be unexpectedly linked and therefore systematized [11], [12], [13].

This in itself is a self-fulfilling exercise, which is a research process that helps us create structural hypotheses to fill the gaps left by incomplete remains, while allowing us to distinguish ourselves with the specifics of the particularities and context, plausible alternatives. Therefore, this workflow is an ‘integrated’ approach to procedural modeling, since it aims at the complete rendering of architectural data, including geographic databases, published documentation, 3D models, semantic descriptive rules, and interactive displays [14], [15], [16].

This approach is intended to become a basic method of elucidating the logic of architecture, as well as an effective means of creating fully feasible data models for ancient cities. The sections that follow describe the steps that build up this workflow and the technology to create the specific procedural rules.

3 RESULTS

Vector graphics create complex primitives through geometric and structural models. Different modifications can be made to them, both linear and non-linear. Effects and even images can be applied to produce the desired result. The end product can be a decent bitmap [5], [15], [17].

The creation of a complex 3-dimensional scene involves three sequential steps (Fig. 1.):

- 3D modeling;
- Rendering;
- Visualization.

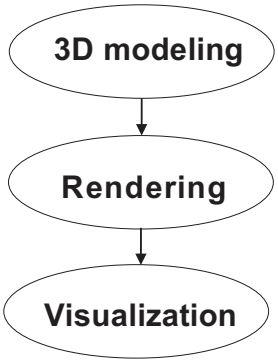

Figure 1. Steps in synthesizing a 3D model

The key to 3D modeling is the creation of the three-dimensional objects that make up the scene. They are complemented by the information needed to synthesize a realistic image such as a lighting model, cameras, materials, etc. In its essence, it is an explicit description of the 3D model of the scene submitted as input to the process of model transformation [18], [19].

The 3D model consists of four types of data: a vector description of the object itself, material, light sources, and a virtual camera [10], [20].

The modeling process itself can be performed in three stages (Fig. 2 – Fig. 4):

- Creating an object in a modeling program such as Blender, Maya, 3Ds max;
- Creating through mathematical formulas;
- Photogrammetry.

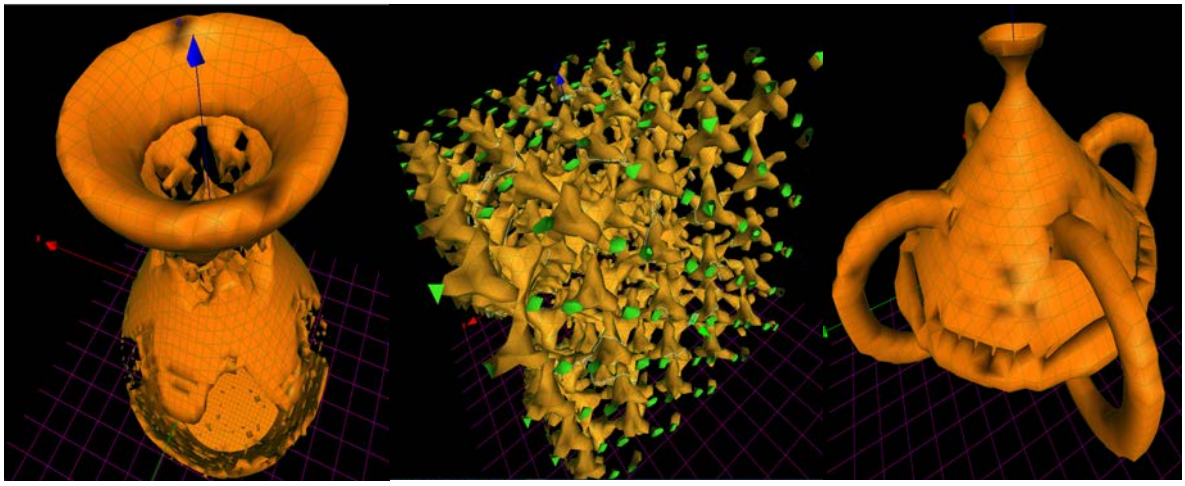

Figure 2. Figures created only through mathematical formulas without any manual processing

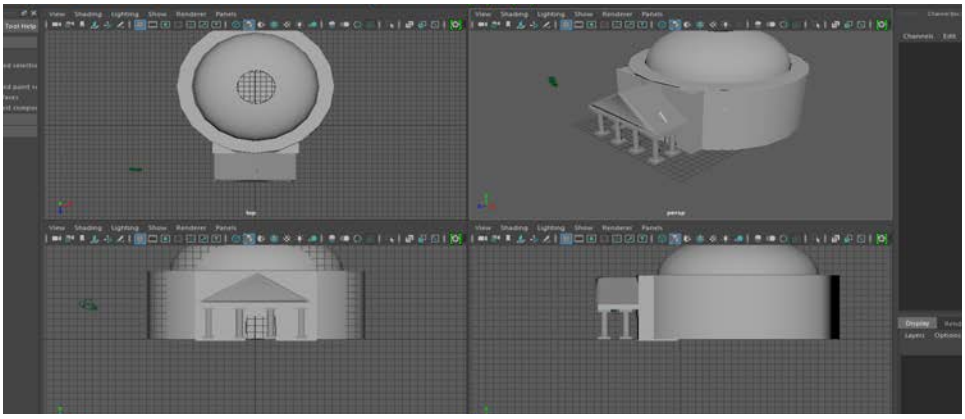

Figure 3. Model of a Roman temple, copy of https://www.turbosquid.com

The graphic model constructed by a set of vectors is called a vector model. The space of models is called world space. Building a 3D figure is generally 70% of all the work. This is done through polygons or curves, and a combined approach can also be used. Many of the figures can be found freely on the Internet, as evidenced by the previous two figures that we have quoted. The advantage of modern 3D programs is that they support different file formats. Objects created in Blender can be easily opened in Maya [11].

Another method of object creation is photogrammetry. This is the method of creating or describing a 3D object in its photographs. The programs we mainly work with are Meshroom and Colmap. The advantages of the former are that the finished object can be used immediately by a 3D program.

In our seminars and lectures, the software we use is mainly Autodesk. It has a policy of granting a free three-year license to its selected products – for example, Maya, 3Ds Max, Revit, etc. Blender software is also a good choice. It is free and very flexible. Maya and Blender's scripting language is Python. The two programs can be installed on different operating systems such as Windows, Linux, Unix, etc.

Once we have created the primitives, they must be merged and visualized. This may be realized with both previous programs, but they have limitations that have been avoided by the Unreal Engine program developed by Epic.

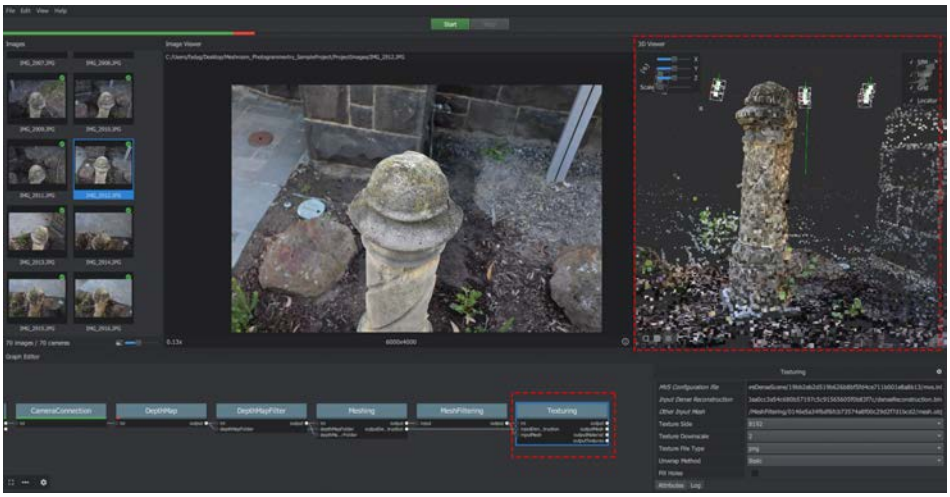

Figure. 4. Creating a model of relay column through photogrammetry and the meshroom program, copy of https://msd-makerspaces.gitbook.io

This software is provided free of charge for academic purposes, if a commercial product is developed a fee is charged. The embedded language in it is C ++. It is an object oriented language and allows programming at both high and low levels.

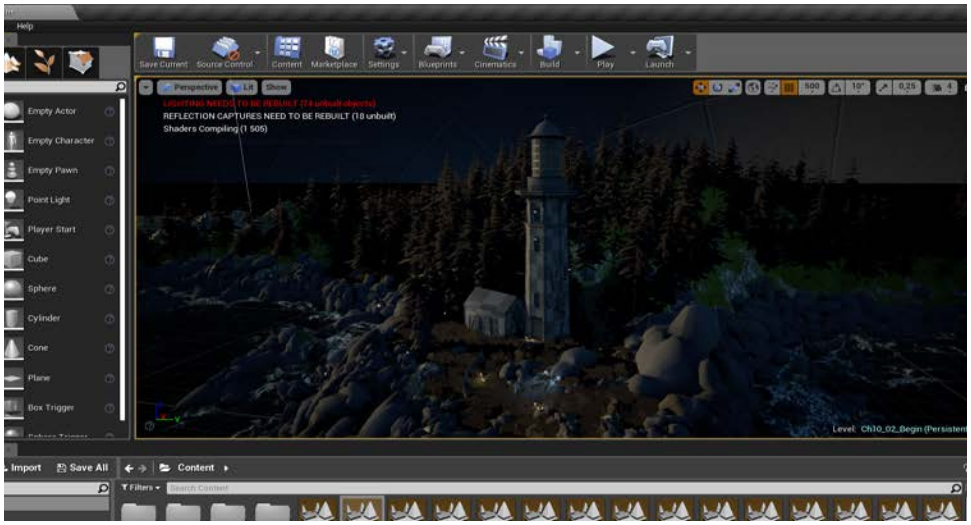

Figure 5. Marine light in the program Unreal engine

This software is one of the basic ones for developing computer games for entertainment. Over the last five years, the company has invested heavily in it. Except for games it can be used to develop Models in mixed reality.

One of the program's features is the creation of virtual museums in which many people can view different cultural and historical sites. The technology of creating server games in which there are many PC users with ID and password who either play or browse a museum, for instance, is the same. This technology is called multi-threading programing (Fig. 6).

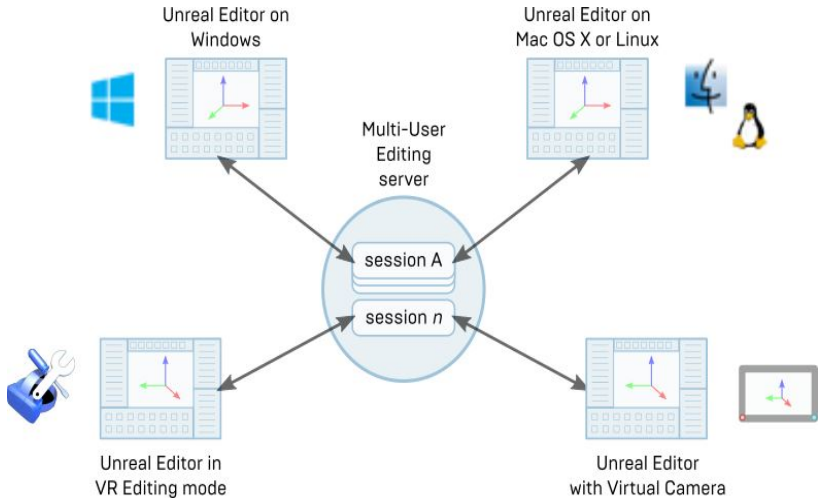

Figure 6. Scheme of work for many users, a copy of https://www.unrealengine.com

The advantage of the program is that we are platform independent i.e. we can develop mobile, server applications or our own applications. The 'communication' between Unreal engine and Maya is at a very good level. It is possible for both programs to work simultaneously i.e. you make changes to the model in Maya, and they are reflected in Unreal.

Another advantage of Maya is the possibility for the developed models to be published in the social network called Second Life.

4 CONCLUSIONS

Using different approaches to create 3D models for CHH is an example of good practice. But object-oriented programing provides unlimited opportunities for the promotion of cultural and historical sites. One of the trends that part of the project team is working on is creating a visual environment that can change itself.

Our main development is related to heuristic approaches or the use of artificial neural networks. The artificial intelligence approach is quite difficult to implement, while the probabilistic approach can be easily implemented through virtual classes and polymorphism.

ACKNOWLEDGEMENTS

This research would not have been possible without the financial assistance of the following project: "Application of the mixed reality in the training and promotion of the cultural heritage in a university information environment" financed by National Science Fund of the Ministry of Education and Science of the republic of Bulgaria with Contract KP 06 OPR 05/14 from 17.12.2018, led by Prof. DSc Irena Peteva.

REFERENCES

[1] J. Cain, J. Conway, M. Divall, et al. "Report of the 2013-2014 Academic Affairs Committee", Am J Pharm Educ. In Press. 2015.

[2] J. Cain, P. Piascik, "Are Serious Games a Good Strategy for Pharmacy Education?"American Journal of Pharmaceutical Education; 79 (4) Article vol. 47, pp. 23-31, 2015.

[3] America's Army News. America's Army medic training helps save a life. http://news.americasarmy.com/americas-army-medictraining-helps-save-a-life/. 2014.

[4] U.S. Army. U.S. Army and Project Lead the Way partner on technology education program. http://www.prnewswire.com/newsreleases/us-army-and-project-lead-the-way-partner-on-technologyeducation-program, 2014.

[5] E. Orts, "Tragedy of the tuna". http://simulations.wharton.upenn. edu/solutions/tragedy-of-the-tuna/, 2014.

[6] M. Graafland, J. Schraagen, M. Schijven. “Systematic review of serious games for medical education and surgical skills training”. Br J Surg., pp. 99, no. 10, pp. 1322-1330. 2012.

[7] B. Kerfoot, N. Kissane, “The use of gamification to boost residents’ engagement in simulation training”. JAMA Surg. vol. 149, no. 11, pp. 1208-1209, 2014.

[8] E. Castro-Sanchez, E. Charani, L. Moore, M. Gharbi, A. Holmes, “On call: antibiotics”-development and evaluation of a serious antimicrobial prescribing game for hospital care. Games for Health 2014: Springer, pp. 1-7, 2014.

[9] B. Schouten, S. Fedtke, T. Bekker, M. Schijven, A. Gekker “Games for Health”. Proceedings of the 3rd Conference on Gaming and Playful Interaction in Health Care, pp. 121 -134, 2013.

[10] T. Empler “3D Modeling of an Archeological Area: The Imperial Fora in Rome”. In: Rossi M., Buratti G. (eds) Computational Morphologies. Springer, Cham pp. 185 -895, 2018.

[11] M. Nicholls, “Classics and 3D digital modelling at the University of Reading”. In: Fung, D. (ed.) A connected curriculum for higher education. UCL Press, London, pp. 52-53. ISBN 9781911576334, 2017.

[12] R. Mavrevski, M. Traykov Visualization software for Hydrophobic-polar protein folding model Scientific Visualization, vol. 11, no. 1, pp 11 - 19, DOI: 10.26583/sv.11.1.02, 2019.

[13] S. Dimitrova, E-content – intellectual property aspects // International Conference on education and new learning technologies, EDULEARN19 Proceedings, 1 st-3 rd July, 2019, Palma, Mallorca, Spain, Vol. 11, pp. 6061-6065.

[14] E. Tsvetkova, I. Peteva, I. Pavlova. 2018. Attitude of Bulgarian Library Specialists Towards Use of Library Resources for Mobile Learning // ICERI 2018 Proceedings, November, IATED Academy, Seville, Spain pp. 838-842, 2018

[15] Borisova N., An approach for Ontology Based Information Extraction (OBIE), Information Technologies and Control (ITC), Vol. 12, no. 1, pp 15–20, Publication 2017.

[16] E. Stavrova, , M. Trencheva , E. Koletca, B. Kostadinova, ,“System for monitoring the economic situation, development and the contribution of the tourist industry to increase the welfare”, International Scientific Conference „The cultural corridors of south-eastern Europe: cultural tourism without boundaries”, Santorini - Greece, 02-10 October 2018, pp. 88-97, 2018.

[17] M. Trencheva. Development of accounting principles in Bulgaria, In Proceedings of 100th Anniversary of the Accountancy and Analysis Department International Conference on “Accounting and its Contribution to the Economic Science” University of National and World Economy 20 February 2020. In press

[18] E. Zdravkova Media literacy as a key competency for the safe and effective use of media, Proceedings of ICERI2019 Conference 11th-13th November 2019, Seville, Spain, pp. 7467 – 7473

[19] K. Planska-Simeonova. Copyright Protection of Photographic Information in Compliance with the New Regulations of The European Union. // 11th annual International Conference on Education and New Learning Technologies Palma de Mallorca (Spain), pp. 5040-504. 2019.

[20] R. Manolova, Study of the Key Factors Impacting the Motivation of Bulgarian Students to Select Higher Education, ICERI 2018 Proceedings, November 2018, Seville, Spain, 2018, pp. 340-344, 2018.