THE APPLICATION OF OBJECT-ORIENTED PROGRAMMING AND GAME ENGINE TO PROMOTE CULTURAL AND HISTORICAL HERITAGE

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Abstract

Programs that model three dimensions, work with different sets of data. These sets are usually just a list of X, Y, and Z coordinates in the space. The program “crawls” objects one by one and draws up the projection on the plane we are looking at, i.e. the computer screen, then draws the images. Three-dimensional transformations are generally the transformations of homogeneous coordinates into 3D translation, scaling, and rotation

Object-oriented programming (OOP) is a paradigm in programming. In this type, a computer system is presented as a set of objects that interact with each other. OOP gives more flexibility and therefore is widely popular in software engineering of large-scale projects.

In this paper, we present the combination of the two technologies for creating complex 3D objects through explicit description and use in Game engine programs. Our results are presented in the Unreal Engine program and the built-in object-oriented C++ language. The results of the complex analysis and demonstration of our achievements are under the project “Application of mixed reality in the education and promotion of cultural and historical heritage (CHH) in a university information environment”, with Contract KP – 06 – OPR 05/14 from 17.12.2018.

In this paper, we present the creation of complex 3D primitives through explicit description and their use in computer game creation programs. Here we show the original design for creating a virtual museum that can be visited by many people in a mixed reality system.

In this research, we use multithreaded programming and parallel algorithms. We give a brief overview of this technology and analyse its capabilities in creating real models of ancient cities in today's Bulgarian lands.

Keywords: Game engine, cultural and historical heritage.

1 INTRODUCTION

According to ICOM (2007) [1, 2], museums fall into three main categories: Museums of Art, Archaeology and History; Museums of Science and Technology; and other museums. Their importance is recognized as much greater than the simple display of objects or works of art, their preservation and study. The very definition of museum represented by ICOM, actually goes in that direction [1]. According to some statistics, such as Eurostat, the total number of museums exceeds 24 000 in Europe.

We all notice that museums are changing. The development of information technologies has called into question the traditional model of museums and libraries. They are no longer just passive “learning spaces” for public access to “knowledge” as an exchange between teacher and trainee, or in this context a curator and visitor. The new 3D technologies allow them to offer more immersive and interactive ways of transfer[2, 3].

This paper examines the methodology for creating a 3D model built from ancient excavation plans and transferring it to a Game Engine for independent navigation around the “virtual building”. It can allow visitors to see the model as an augmented reality by using the site when visiting a museum or viewing the physical remains themselves. The possibilities are endless. The only thing stopping us is our fantasy.

The remains, for which 3D model will be created, are based on the ancient city of Skaptopara. Found in 2017 near Blagoevgrad during the construction of the “Struma” highway. Little information about the city:

In the 3rd century AD, the Thracian settlement Skaptopara exists within the current framework of Blagoevgrad. It becomes known after the finding of the so-called Skaptoparen inscription in 1868, currently located in the History Museum of Blagoevgrad in the Varosha neighbourhood. This is a please/request of the inhabitants of this settlement in 238 AD to the emperor Gordian III. From it we learn that the village is located in a very attractive place – among forests, fields and warm, healing mineral springs: "warm waters, most suitable not only for luxury, but also for health and body care ...". Not far from it there is an annual "famous fair" which lasts more than 15 days. Merchants, soldiers, deputies and prosecutors flock to it. This fair gives the name of the village: from the "skepta" – upper, local and "para" – meeting place, venue, market. Hence the etymology of the Thracian name "scaptopara" – upper market[1].

The results we are going to present are under the project "Application of mixed reality in the training and promotion of cultural heritage in university information environment", headed by Prof. DSc. Irena Peteva.

Figure 1. Excavations and the highway that went through them. (from google maps)

Figure 2. Excavations of ancient Skaptopara. (from https://www.dnes.bg/stranata/ 2018/04/29/razkopki-moje-da-zabaviat-s-2-g-stroeja-na-am-struma.375078)

The ancient settlement was not preserved during the construction of the highway. Only part of it remained. At the start of the project, the excavations were at the beginning, but the management for construction of the highway considered that it would be much more expensive if they went around it and that's why they went through the site. In Fig. 1 and Fig. 2 we show the excavations and the small part left of them.

[1] https://www.nasamnatam.com/ekskurzia/SBOGOM_SKAPTOPARA-226833.html

Building a 3D model of the ancient city is of particular importance. This will preserve it for the future generations and promote our cultural and historical heritage as a land of ancient monuments – the home of Orpheus.

2 METHODOLOGY

With the development of the 3D technology, virtual walks have become an important factor in exploring cultural and historical heritage (CHH). They provide a realistic way to more fully represent architectural sites, museums and galleries in the digital space. The 3D representation of models should include the necessary information so that users receive the same knowledge as when they actually visit the site.

The goal of this paper is to show the possibilities of virtual and augmented reality, the so-called mixed reality in the training and promotion of CHH among consumers. The presentation of cultural and historical heritage based on virtual technology (VR) and Augmented Reality (AR) will enable visitors to interact with the content in an intuitive and exciting way. This is a technology that extends the reality of human being at the expense of complementing the visible and tangible world with digital information in real time [3, 4].

The approach to creating a virtual model of an ancient city involves a library of procedural rules that generate the basic typologies of buildings when modelling Greek and Roman cities. The approach also includes multithreaded programming and parallel algorithms.

Parallel algorithms are algorithms that can perform multiple operations at the same time. Multithreaded programming allows creating programs that control the computer's processor. The central computer processor (CPU) provides multiple threads to perform various processes or operations. Multithreaded programming controls these threads of the processor, which means that in the implementation of parallel algorithms through multithreaded programming, we will perform several operations at the same time. After performing the operations, the algorithm combines the results and solves the main problem. This technology enables the realization of complex virtual models such as the 3D model of the ancient city of Skaptopara [3, 5].

The main challenge of this working process is to integrate the empirical data with procedural methods. Therefore, procedural rules rarely exist in a static state for a long time and are constantly rewritten as the need for new parameters arises. This in itself is a self-improvement exercise 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 [6].

This approach is intended to be a method of clarification the logic of architecture, as well as an effective means of creating fully realized data models for ancient cities. The sections that follow will outline the steps that make up this working process and how the procedure rules are written.

The creation of virtual objects from the cultural and historical heritage goes through two stages – development of the most detailed three-dimensional model and generation of visualization variants of the model.

3 RESULTS

Previous research shows the complexity of analysing the advantages and disadvantages of the virtual environment in formal and non-formal learning situations, such as those presented in museums, art galleries and libraries (Connolly et al. 2012 :). A review of research on the subject suggests that such games lead to an improvement in “creative thinking and visual perception skills”. Other authors say that there is limited evidence for the effect of this approach in education. These authors acknowledge the difficulties in classifying learning outcomes because of their diversity due to their areas of application.

Wrzesien and Raya (2010) come to a different conclusion. They compare the achievement of the learning objectives with two groups of students, the first studying in the traditional way and the other in a virtual world. Statistical analysis does not find a statistically significant result in the effectiveness of learning in either of the two approaches, although the second students have a higher level of engagement and greater willingness to participate. Roussou (2010) concludes that the combination of digital environment and interactivity has a higher level of effectiveness in learning than those who do not have this enhanced functionality [5-8].

Pujol and Economou (2007) note that an important contribution of virtual realities to the protection of CHH is the ability to reconstruct and manipulate “elements or phenomena” that are no longer available,

suggesting that such interactive exhibitions are at the most a good case of complementing traditional exhibits or providing a service that cannot be achieved in the traditional way[5].

More and more time and resources are being devoted to developing virtual worlds and virtual museums with limited systematic efforts. Many researchers are trying to find out how best to use the capabilities and features of such systems to improve learning outcomes. Zin and Yue (2009) also identify a lack of clarity on the use of games as a means of transferring knowledge, and attempt to correct this gap by proposing a game design model incorporating educational goals [5, 7. 8-10].

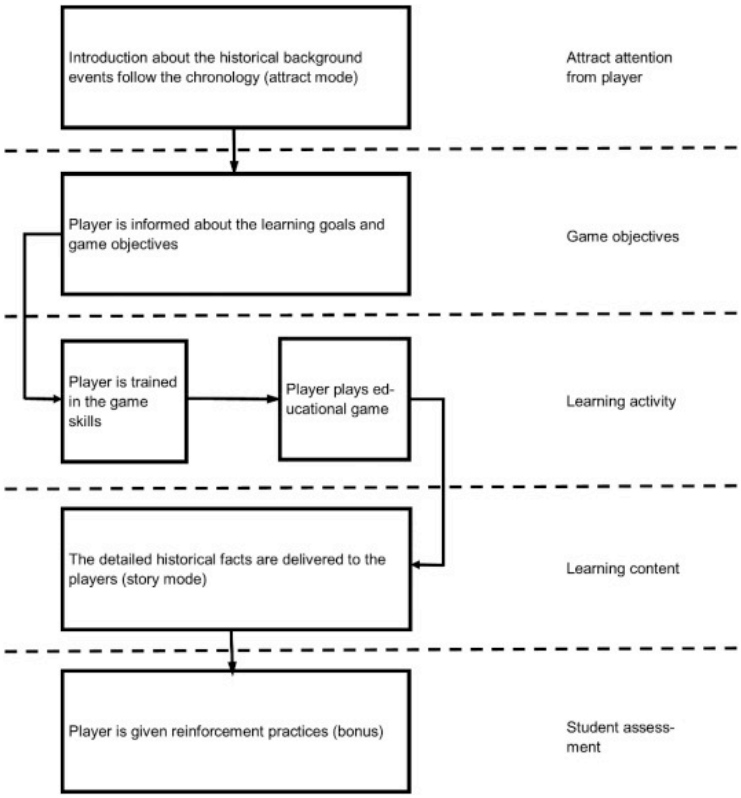

Figure 3. Embedding educational elements in game design process (adapted from Zin and Yue, 2009 copy from [7])

The main focus is on issues related to the creation of the 3D model of the ancient city of Skaptopara. One of the main priorities is the availability of source resources: the choice of modelling software, the choice of game engine, the definition of the process for comparing them, and the hardware capabilities for public use are important [9-11]. The individual stages are:

- Development of plans for the individual parts and cross sections;
- Site map of excavations;
- Modelling of 3D primitives in modelling software;
- Importing objects into the game engine;
- Creating a virtual model.

Our choice for modelling software is the industry standard Autodesk Maya software, which is widely used in the television, movie and gaming industries. The software has a built-in MEL programming language and also supports Python. In the development of our model we use open source software – Blender. The following figure presents the elements of building a temple. Students from the university participate in the development of the model. We use an Autodesk resource as a guide [9, 12-14].

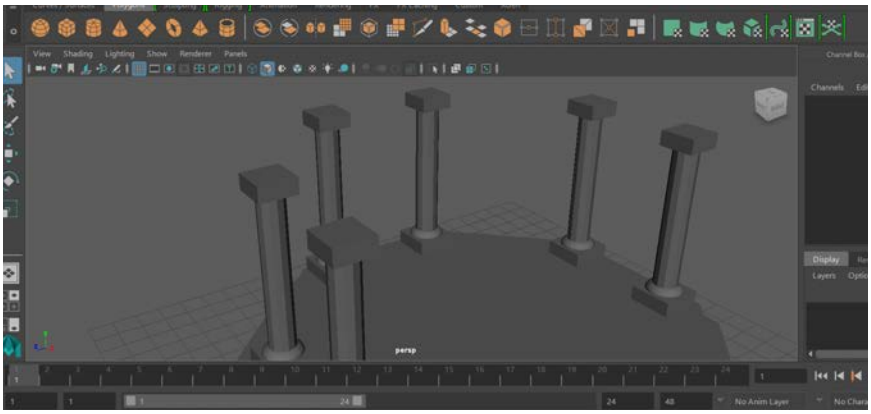

Figure 4. Excavations of ancient Skaptopara. (from https://www.dnes.bg/stranata/2018/04/29/razkopki-moje-da-zabaviat-s-2-g-stroeja-na-am-struma.375078)

Our choice for game engine is Unreal engine (UE). It is a game engine developed by Epic Games. The Unreal Engine software code is written in C++, which gives it a high degree of portability. Today it is used by many game developers. The engine is popular with its modular architecture and built-in scripting language, which makes it easy to modify. One of the main features of UE 4 is real-time lighting, which replaces pre-loaded lighting [11, 14-18].

This program supports two languages: C++ and Blueprint. Unreal Engine 4 provides two sets of programming tools that can be used together to speed up the working process. New gameplay classes, Slate and Canvas user interface elements, and editor functionality, allow C++ files to be created, and changes are reflected in Unreal Editor after compilation with either Visual Studio or XCode. The Blueprints visual scripting system is a stable tool that allows the creation of classes in an editor by linking function blocks and property directories[2] .

By using C++, developers add basic gameplay systems that designers can then upgrade or create custom level of gameplay or a game. In these cases, the C++ programmer works in a text editor (such as Notepad++) or IDE (usually Microsoft Visual Studio or Apple Xcode), and the designer works in the Blueprint editor in UE4. The gameplay and API classes are available for both systems, that can be used separately, but show their true strength when used together to complement each other[3, 6, 12, 17].

It is also able to export high quality videos and images. Engine play is easier for use than specialized software, which was important in a public-facing application, they are easily adaptable for a variety of purposes and can be used in a variety of hardware[18].

C++ is an object-oriented language. The basic principles of object-oriented programming are:

Abstraction;

- Encapsulation;
- Modularity.

The idea of abstraction is to extract the most basic parts of a complex system and describe those parts in a simple and accurate language. Usually the description of the parts of the system includes naming and explaining their functionality. Applying the abstraction paradigm to the design of data structures generates abstract data types (ADTs). ADT is a mathematical model of a data structure that defines the type of stored data, the operations supported on them, and the types of operation parameters. Another programming approach is encapsulation, i.e. the various components of the software system must not show the internal details of their respective implementation[3, 6].

One of the main advantages of encapsulation is that it gives the programmer the freedom to apply the details of the system. The above lines have briefly explained some of the major benefits of C ++.

One of the means we use is polymorphism – the ability of the same code to perform different functions. This is done by inheriting different classes. The following figures present different views of summer and winter – Fig. 5 - 7. This approach is very interesting because the program may generate a different natural environment depending on the user's desire [6, 8, 12]. In order to achieve this goal and to quickly

[2] https://docs.unrealengine.com/en-US/Programming/index.html

switch from one model to another, multi-threaded programming is used to implement a parallel algorithm.

Figure 5. Computer generated image in autumn

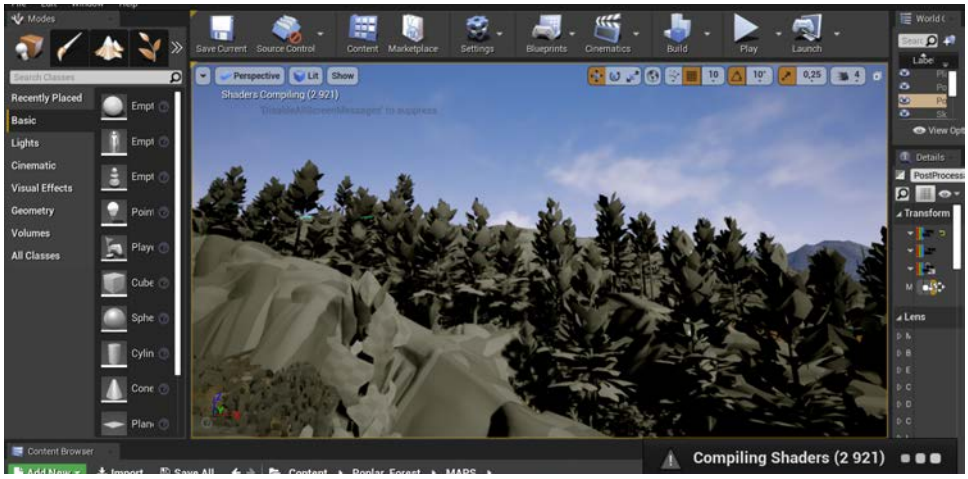

Figure 6. Computer generated forest and sunrise in autumn

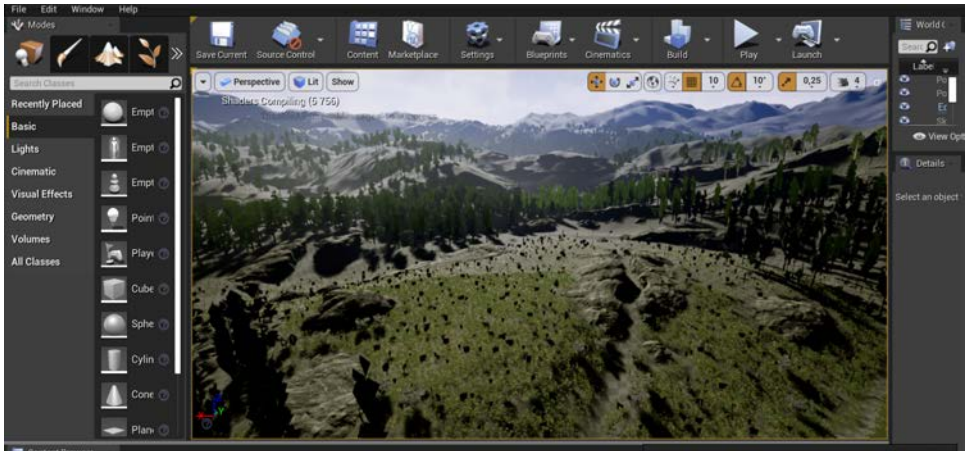

Figure 7. Computer generated day in the summer

Our results have been tested in practice in the Computer Games Development course at ULSIT. Students are very creative and willing to work. A great difficulty is the combination of the two languages.

4 CONCLUSIONS

The development of a model of the ancient city of Skaptopara will help to promote CHH. Our project development continues. Here we briefly describe the methodology we use to build the model.

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