Historical 3D Visualisations of Starý Světlov Castle Using Blender and Unreal Engine

Pavel Pokorný[1] and David Falešník[2]

[1] Department of Computer and Communication Systems
Tomas Bata University in Zlín, Faculty of Applied Informatics
Nad Stráněmi 4511, 760 05 Zlín, Czech Republic
pokorny@utb.cz

[2] Department of Computer and Communication Systems
Tomas Bata University in Zlín, Faculty of Applied Informatics
Nad Stráněmi 4511, 760 05 Zlín, Czech Republic
david.falesnik@seznam.cz

Abstract. The main task of this paper is to describe a visualisation method for Starý Světlov Castle. This castle was probably founded in the first half of the 14th Century when the massive castle core was built. Until the mid of 15th Century Starý Světlov Castle was an important residence of the local aristocracy. At the end of the 15th Century, the castle lost its importance and was gradually abandoned. Research by historians has made it possible to create sketches and paintings of the castle at the time of its greatest importance –in the first half of the 15th Century. The 3D complex model of the castle was created based on mentioned sketches and other resources from this period. All buildings and accessories were separately modelled and textured using UV mapping techniques. The rendered outputs are performed by a visualization application. The Blender software creation suite was used for modelling. Quixel Mixer was used for texturing and the final application was developed in Unreal Engine.

Keywords: 3D Visualisation, Modelling, Historical Visualiszation.

1 Introduction

The visualisation process is usually defined as the communication of information using graphical representation. This communication mechanism was formed much earlier than the formalisation of written language. A single picture can contain a wealth of information, and can be then processed much more quickly than a comparable page full of words. Pictures can also be independent of local language - just as a graph, chart or map may be understood by a group of people with no common tongue. [1]

Nowadays, visualisation is very often associated with data obtained from various fields. Visualisation Research at SCI [2] has focused on applications spanning computational fluid dynamics, weather data analysis, medical imaging and analysis, poetry, biomedical data analysis, healthcare data analysis, network and graph analysis, and

financial data analysis, etc. This data generally has numerical representation in nature – they have a value and meaning when the data is processed and analysed. Nowadays, these processes are performed by computers. [3]

The Computer Graphics field is a typical example of the creation of successful visualisations. In line with developments and improved computer technologies performance, the limits and possibilities of computer graphics continue to increase. The core 3D graphics system – the rendering pipeline – moved on from software to raster graphics hardware via the development of geometry– and pixel–processing chips; and demanding computing operations gradually took over from graphics cards (GPU). [4]

One of these fields is historical visualisations. Based on historical documents, maps, drawings, photographs or plans; using 3D models, one can create reconstructions of virtual objects that no longer exist in their original form.

This article describes the 3D visualisation method used for Starý Světlov Castle. Using modern 3D software modelling tools, we have tried to achieve a very credible appearance of the castle buildings and its vicinity in the first half of the 15th Century.

2   A Short History of Starý Světlov Castle

The Starý Světlov ruins are those of a castle that stood (and still stands) in Eastern Moravia in the Czech Republic. Its exact location was 10 km southwest of Vizovice Township and about a km northwest of the Podhradí village near Luhačovice. It has been protected as a cultural monument since 1964. [5]

The foundations of this castle - with its original name Světlov, date back to the second half of the 13th century. The oldest mention of the castle - later called Starý Světlov, comes from 1275; although there is no mention of the castle´s owner. Another historical document, dating from 1360, mentions that Světlov Castle was then in the possession of the Lords of Šternberk. At that time, the castle had a strategic importance and housed a large military garrison. [6]

Based on the findings, we can get a pretty clear idea of the historical castle´s form and its surroundings in this period. The castle core was built in the 14th Century, and surrounded by a fence and a massive moat and ramparts during the ownership of the first Šternberk family. Part of these fortifications was the Upper Fort - built of quarried stone.

From 1423, the castle was held by King Zikmund and, in the fourteen forties, (15th) Century, the mortgaged Světlov estate passed into the hands of the lords of Cimburk, who undertook marauding raids in a wide surrounding area. At this time, the Světlov Estate was probably densely populated by a large group of inhabitants - poor families, merchants, and craftsmen. The castle itself probably housed the Lord of the Castle, with some of their most loyal warriors; and the lower sub-castle was built and inhabited by other warriors.

During the Czech-Hungarian wars, the castle faced several devastating raids, during which at least a dozen villages around the castle disappeared. In the course of these wars, the castle itself was severely damaged in the years 1469–1470. However, Starý Světlov remained inhabited at least until the early 80s of the 15th Century.

After the end of the Czech-Hungarian wars, the location of Světlov Castle began to prove more and more unfavourable. This castle found itself on the very edge of the manor and relatively far from new important roads. Its then owners were the Šternberk brothers, who decided to build a new seat there and moved to Bojkovice in 1490. The Castle was then left to its fate and ever since then, Starý Světlov was always mentioned as desolated in period documents. [6]

The abandoned ruin was mainly damaged by its dismantling for building material from the second half of the 18th Century. Although the castle has become a ruin, it is still a bearer of interesting information and there is evidence of remarkable architectural details - such as, for instance, the unique construction of the outer castle gate, the castle walls´ surface finish or several construction peculiarities in the palace.
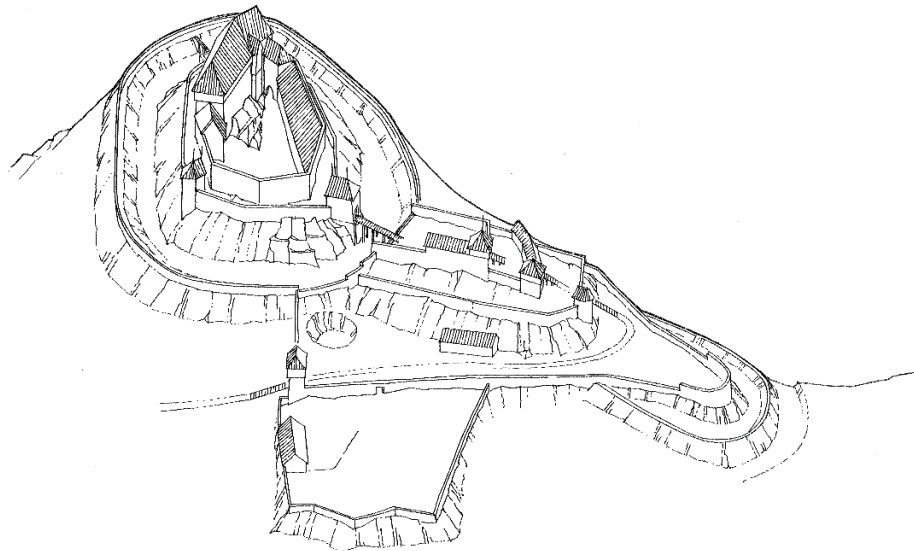

Fig. 1. Starý Světlov Castle - artwork from the mid-15th Century; Author: Radim Vrla [7]

3 Resources and Software Used

The first phase was to collect all suitable, available historical materials related to Starý Světlov Castle and to select the adequate visualisation creation software.

3.1 Acquiring Resources

This work´s overall progress was the collation of any available historic materials and information about Starý Světlov Castle, down through the centuries. The main resources were found in the National Heritage Institute in Kroměříž [7], the Castle´s webpage [6], as well as a book on this subject [5].

Its attention was mainly focused on drawings and sketches. We also visited the castle ruins and created a number of photographs to accurately capture its current appearance.

The most useful drawings obtained were those sourced from Radim Vrla, a Kroměříž National Heritage Institute employee. Based on archaeological excavations, he created nice drawings of Starý Světlov Castle´s appearance in the mid-15th Century. Some of these drawings are shown in Figs 1 and 2.

The castle 3D models and created were mainly based on these drawings. Since there is no exact form of the castle from the past and these drawings capture only the main shapes, the details of these shapes were a matter of improvisation. Since it was well-known the castle was built in the Gothic Style, we attempted to retain all this of architectural style´s characteristics. In addition – so as to avoid any eventual historical inaccuracies, all works on these models were consulted with Radim Vrla - the above-mentioned historian.
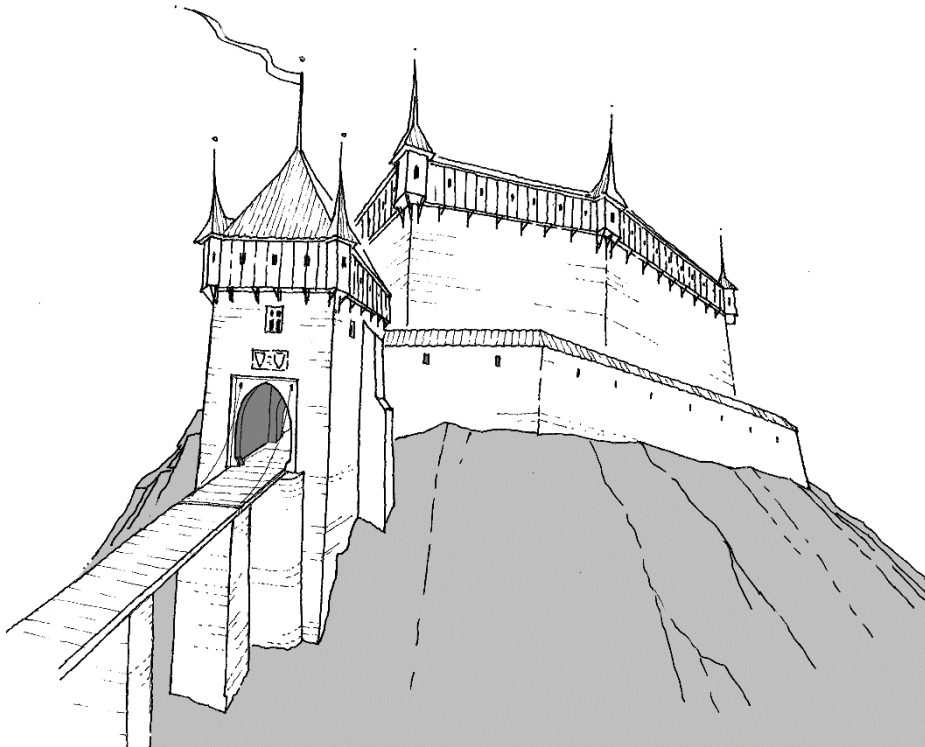

Fig. 2. More detailed Starý Světlov Castle artwork; Author: Radim Vrla [5]

3.2 Software Used

We compiled the requisite equipment to create high-quality visual outputs in order to select applications that we wanted to use. The whole process includes 3D model creation, texture mapping correction, and then to create a visualisation application that

imports the prepared models with their textures. All 3D models with appropriate UV maps were made in Blender. Textures were created in the Quixel Mixer software tool and the final application was developed in Unreal Engine.

Blender [8] is a free and open-source 3D creation suite. It supports the entirety of the 3D pipeline—modelling, rigging, animation, simulation, rendering, compositing and motion-tracking, video-editing and a 2D animation pipeline. This software is also available under GNU GPL License and users can use it on most common platforms – Windows, Linux, Mac OS, etc.

Blender opens up a world of creativity, which has been traditionally exclusive to those able to afford high-end graphics software. Its GUI is the arrangement of windows and panels containing the controls for operating the programme. Blender supports many tools that allow one to create and animate models and characters in scenes combined with stunning visual effects. Scenes may be rendered into photo-realistic images and animations into video clips. Video may be edited and compiled into movies. [9]

Quixel Mixer [10], this represents a revolutionary approach to asset texturing. One can texture one´s own assets with multi-channel 3D painting, scan-data, real-time 3D curvature, displacement sculpting, ID masking, procedural noises, seamless texture projection, Smart Materials and much more. It also provides instant access to the entire Megascans library – which guarantees photorealistic base textures or their effortless transformation into fantastic stylised assets. This software is extremely easy to use, and free forever, for everyone. [11]
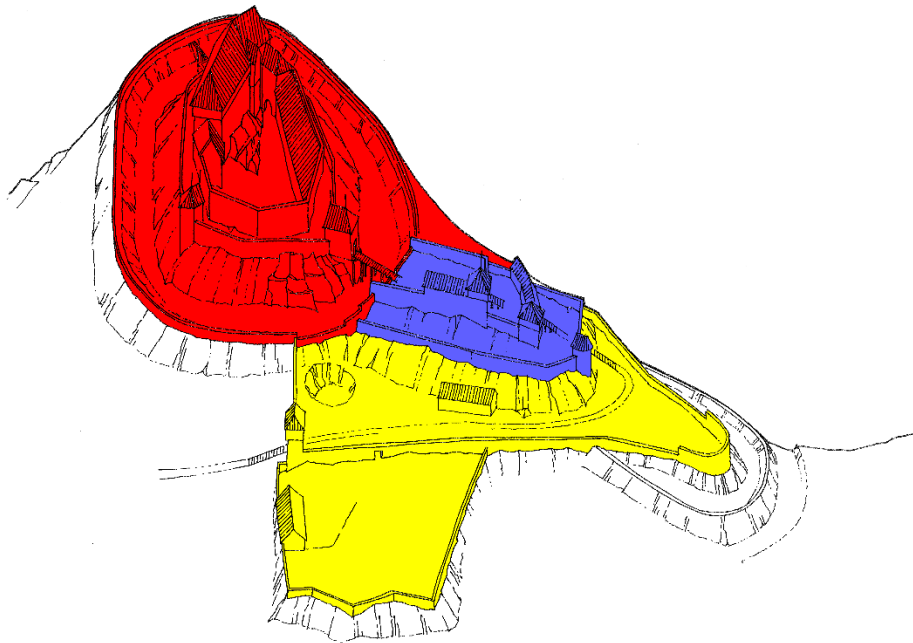

Fig. 3. Colorized Divisions of the Castle parts for the Modelling Phase

Unreal Engine [12] is the world's most open and advanced real-time 3D creation tool. Continuously evolving to serve not only its original purpose as a state-of-the-art game engine; today, it gives creators across industries the freedom and control to deliver cutting-edge content, interactive experiences, and immersive virtual worlds.

Unreal Engine is a complete suite of development tools for anyone working with real-time technology. From design visualisation and cinematic experiences to high-quality games across PC, consoles, mobiles, VRs, and ARs, Unreal Engine gives one everything they need to create very high-quality applications. This engine - with its own editor, offers complex tools for photorealistic rendering, dynamic physics and effects, life-like animation, robust data translation - and much more. A license for creators is free-to-use and 100% royalty-free; users can use it to create internal or free projects, or to develop linear content or custom projects for clients; but not for publishing off-the-shelf offerings. [13]
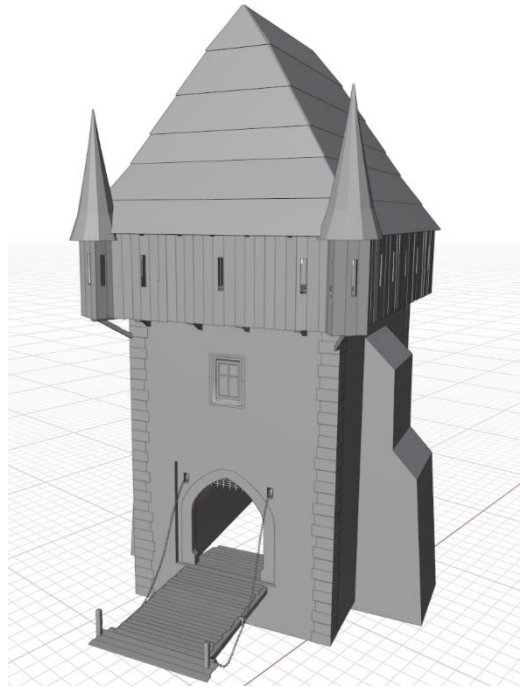

Fig. 4. The Outer-Castle Gate Mesh Model in Blender

4 Modelling

The Modelling phase began after gathering a sufficient amount of information and resources. Due to the size of the whole model, the castle was divided into three parts – the Sub-Castle, the Outer-Castle and the Inner-Castle itself. These parts are colour-coded in Figure 3. It was then possible to model and place the corresponding objects

within these parts. Timbered house and farm building models were created for the Sub-Castle; while the Outer-Castle was formed by models of a palisade tower and a wooden gate. The Inner-Castle was composed of models of a girder bridge - (that connects the Outer-Castle and Inner-Castle), towers, ramparts and the Castle building itself. Each main object was further split into smaller parts, which were modelled separately and later joined. For example, a house was separated into main walls, doors, windows and roof.

Only Polygonal Representation was used for all models – i.e. all models were recomposed from vertices, edges and faces. This representation is performed using the Mesh objects in Blender.

The Castle Model Creation Process always proceeded in the same way. In dependency of basic shape, appropriate mesh primitives - (e.g. Planes, Circles or Cubes), were inserted into the 3D scene. This object was then transformed in order to reach the correct position, orientation and sizes. After that the model was switched into the Edit Mode, where is possible to modify the object geometry – user can transform any vertex, edge of face. Additionally, Blender offers many editing tools (Extrude, Knife, Subdivide, Loop Cut, etc.) which improve model geometry – they add new vertices, edges and faces and then is possible to model smaller and more detailed models' parts.
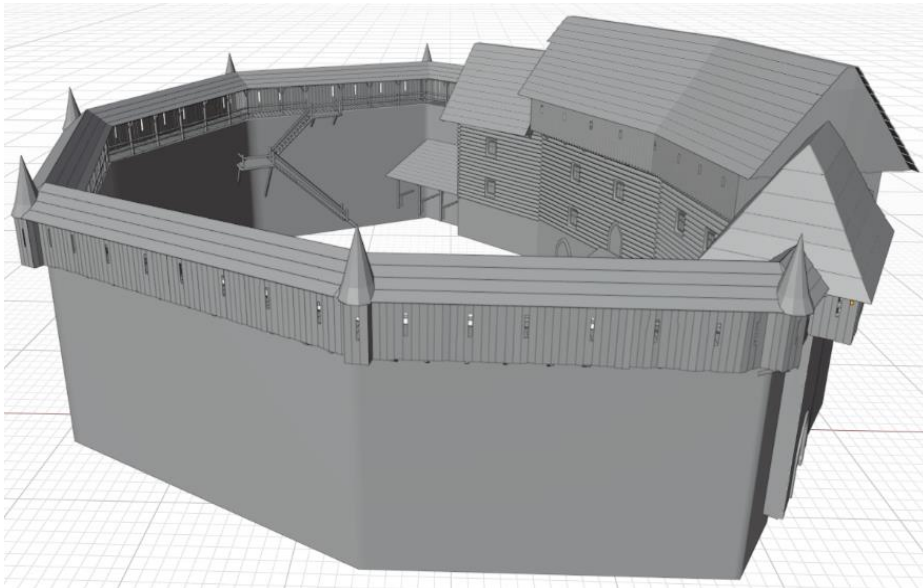

Fig. 5. The Inner-Castle Mesh Model in Blender

Modifiers are another class of Blender tools. They can improve/transform any shapes of selected objects into other ones. The Boolean Modifier was often used - which can make new shapes using logical operations among selected objects (Union, Intersect, and Difference). Finally, the Array Modifier was used for the creation of repeat objects - (it can rapidly make any number of transformed copies).

Fig. 4 shows a 3D model of the Outer-Castle gate with a girder bridge created in this way. This whole model contains approximately thirty thousand vertices. Another example is Fig. 5 – this is a model of the whole Inner Castle and contains approximately one hundred and forty thousand vertices.

5 Texturing

The Texturing Phase began when all of the models had been created. UV-mapping techniques were used for texture mapping in Blender. This process begins with the decomposition of each object into 2D sub-surfaces - (e.g. a UV map). Blender supports the Unwrap tool with several settings for these purposes.

After completing the UV mapping process, the models are ready to apply textures. The above-mentioned Quixel Mixer programme was used for this process. Exporting an object from Blender to Quxiel Mixer was performed by means of the FBX graphic format [14]; which Quxiel Mixer supports.
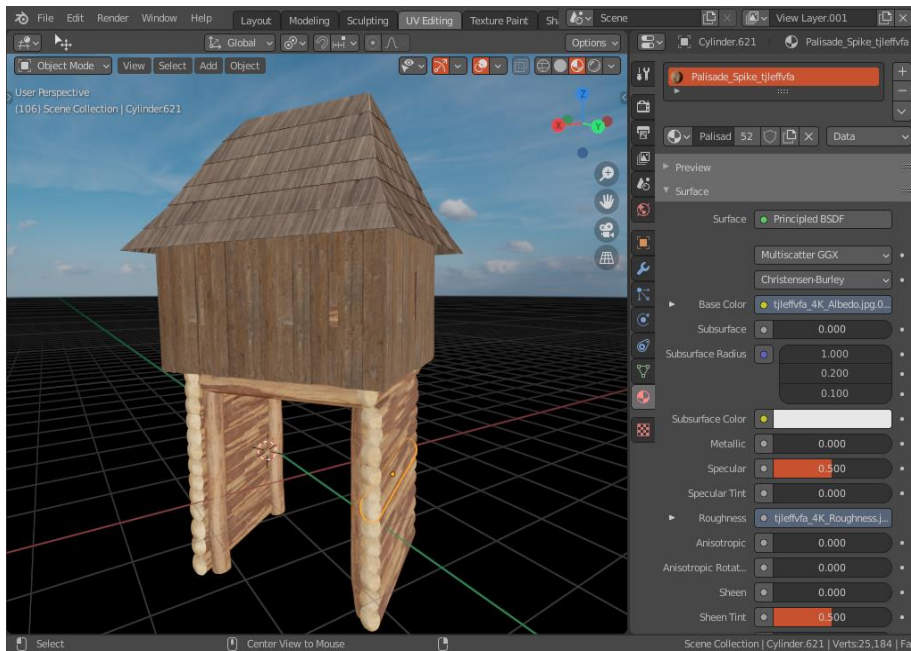

Fig. 6. Textured Wooden-gate Model in Blender

Quixel Mixel software was used in a new project to texture each model - a corresponding model was then imported into this project. The texture process always proceeded in the same way. At first, suitable textures were selected – they were performed

via previously mentioned Megascans library or Internet resources [15]. These textures were then mapped on imported object surfaces using various types of brushes.

Three texture layers were used for the models' surfaces – one affected the colours - (Diffuse Map); the second glossiness - (Roughness Map); and the third, irregularities - (Normal Map).

The mapping process was complete when all layers were integrated into corresponding contacts, and thus work in the Quixel Mixer programme was concluded. The resulting textures were then exported via the standard raster graphic format – JPG, which can easily be imported into Blender and Unreal Engine environments.

An example of a 3D model with mapped textures in Blender is shown in Figure 6. This is the model of a wooden gate that is placed between the Outer-Castle and the Sub-Castle.

6   Application Creation

This visualisation application was created in Unreal Engine. In this application, it was first necessary to create a new 3D project. In the following step, the whole environment should be created. The Starý Světlov Castle - with textures model was ready, but the main object was missing - the terrain model. It was not created in Blender since Unreal Engine contains all of the necessary tools for its creation.

Unreal Engine provides the Landscape command in the Modes menu in order to create a landscape model. Here it is possible to set the size of the model, as well as the number of segments from which the landscape model is to be created - or the position where model will be generated. After generation, it is also possible to make manual modifications in order to attain the required shape. To do this, a user can use the three graphic tools - Sculpt, Flat and Flatten; which modify the shapes according to the set parameters. The final shape of the landscape was therefore, created manually according to the real altitudes obtained from the source [16].

The above-mentioned FBX graphic format was used to import castle objects since, in addition to the model´s geometric shapes, it also supports all other requisite information - like UV coordinates for the correct application of textures [17]. After the importation of all partial models of the castle, these models were then placed in the correct position and then the terrain model was slightly modified in order to allow all models to follow each other correctly and the most realistic form be achieved.

Another task was to add materials - (textures), to the landscape model. Unreal uses so-called "Smart Materials". Using them, it is possible to link more textures to these materials; the implemented algorithm can recognise inequalities on the object and then automatically applies a suitable texture according to these inequalities. Grassy textures are then automatically applied to flat surfaces, while stony textures are applied to inclined surfaces. Afterwards, it is then possible to draw in various details - paths, and so on, directly on the surface of the object using special brushes.

In order to further increase the realism, it was necessary to add some vegetation to the scene - trees, grasslands, etc. These types of objects do not need to be modelled, they can be obtained from the Unreal Marketplace or Quixel Bridge.

Some of them are free - others for a fee. We selected free models and after integrating them into our project, it was possible to apply this to the 3D environment by means of special brushes. These brushes can have settings for many parameters like size, density, location; or variability of objects to be generated. These objects were added to the scene to selected places, and in the same way, a wooden palisade was created in the vicinity of the castle grounds.

The next step was to illuminate the whole scene in a suitable way. Unreal engine offers several types of light sources with adjustable parameters that can be combined in any way. In order to achieve the most realistic simulation of sunlight, a combination of sky light with directional light, which can also create shadows, was chosen for the castle visualisation scene.

To create rendered images and animations, there was still a need to add extra cameras to the scene. These images and animations are then rendered according to their location and direction-of-view. The Render command is located in the Viewport window under the "High Resolution Screenshot" button. Here, users can select the size of the generated image and then create the render. Examples of these rendered images are shown in Figs. 7 and 8. In the case of animation, the camera moves and this movement is set by the so-called "keying frames" technique. This technique means the setting of the camera position in the selected animation frames.

Fig. 7. Rendered Visualisation of Starý Světlov Castle in Unreal Engine

The application itself was created from the 3rd perspective. This type of application is provided by means of a selected blueprint in Unreal Engine, which ensures the basic movement of the character. The camera is linked to this character and their movement

is performed based on user input from keyboards and peripherals. After setting up the camera, it was still necessary to set where the character can go - for example, it cannot pass through the solid walls of objects. So-called "Collision Objects" solve this. They are basically cube-type objects that are not visible but specify places that cannot be entered.

After the application testing phase in Unreal Engine, a separate project for the Windows operating system (64-bit) was then generated and can be run on all common personal computers and laptops with an "average" current hardware configuration.

Fig. 8. Rendered Visualisation of Starý Světlov Sub-Castle in Unreal Engine

7 Conclusion

This article briefly describes the visualisation method used for depicting Starý Světlov Castle artwork from the mid-15th Century – at the time of its greatest glory. Although the castle is currently a mere ruin, historians' research has helped to create the probable form of the castle at the time. The results of this research have become the main source for creating this visualisation.

All models and their UV maps were created in the Blender software suite and the textures were prepared and mapped in Quixel Mixel. When all these assets had been completed, they were then imported into Unreal Engine, where - as mentioned above, the visualisation application was made.

The future goal is to improve and expand these models. This process will include modelling more detailed parts of the castle and adding period accessories in order to make the scene more realistic. Further improvements can be performed by application optimisation, improved interactions and customisation for the Virtual Reality suite. This will enable any users to get to know the historic environment of this castle.

References

1. Ward, M.: Interactive Data Visualization: Foundations, Techniques, and Applications. 1st Ed. A K Peters, Ltd., India (2010). ISBN 978-1568814735.
2. Visualization, http://www.sci.utah.edu/research/visualization.html, last accessed 2021/01/18.
3. Srinivasa, K. G., Siddesh, G. M., Srinidhi, H.: Introduction to Data Visualization. In: Network Data Analytics - A Hands-On Approach for Application Development, pp. 321-331. Springer International Publishing, AG (2018).
4. Hughes, J. F., Van Dam, A., Foley, J. D., McGuire, M., Feiner, S. K., & Sklar, D. F.: Computer graphics: principles and practice, 3rd Ed. Addison-Wesley, USA (2014). ISBN 978-0-321-39952-6
5. Michálek, L.: Starý Světlov, 1st Edition, Putujme (2014). ISBN 978-80-87891-06-3.
6. Historie hradu Starý Světlov: Podhradí, https://www.obec-podhradi.cz/historie-hradu-stary-svetlov/ds-1085, last accessed 2021/01/18.
7. National Heritage Institute in Kroměříž, https://www.npu.cz/cs/uop-kromeriz, last accessed 2021/01/18
8. Blender.org – Home of the Blender project, https://www.blender.org/, last accessed 2021/01/18.
9. Blain, J. M.: The Complete Guide to Blender Graphics, 3rd Edition, CRC Press (2016). ISBN 978-1-4987-4647-2.
10. Quixel Mixer, https://quixel.com/mixer, https://www.textures.com/, last accessed 2021/01/18.
11. Quixel ships Mixer 2020.1.6, http://www.cgchannel.com/2020/11/quixel-ships-mixer-2020/, last accessed 2021/01/18.
12. The most powerful real-time 3D creation platform - Unreal Engine, https://www.unrealengine.com/en-US/, last accessed 2021/01/18.
13. Plowmanm J.: 3D Game Design with Unreal Engine 4 and Blender, 1st Edition, Packt Publishing (2016). ISBN 978-1-78588-146-6.
14. FBX – Adaptable File Formats for 3D Animation Software, https://www.autodesk.com/products/fbx/overview, last accessed 2021/01/18.
15. Textures – Textures for 3D, graphic design and Photoshop!, https://www.textures.com/, last accessed 2021/01/18.
16. Daftlogic – Google Maps Find Altitude, https://www.daftlogic.com/sandbox-google-maps-find-altitude.htm, last accessed 2021/01/18.
17. Blender to Unreal: How to Import Models for Unreal, https://all3dp.com/2/blender-to-unreal-engine-import-models-unreal-ue4/, last accessed 2021/01/18.