Recreating a Medieval Mill as a Virtual Learning Environment

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Figure 1: The photo of the original mill (left) and a screenshot of its virtual model (right)

ABSTRACT

Historic buildings shown in open-air museums often lack a good accessibility and visitors rarely can interact with them as well as displayed tools to learn about processes. Providing these buildings in Virtual Reality could be a great supplement for museums to provide accessible and interactive offers. To investigate the effectiveness of this approach and to derive design guidelines, we developed an interactive virtual replicate of a medieval mill. We present the design of the mill and the results of a preliminary usability evaluation.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; • **Applied computing** → **Interactive learning environments**.

KEYWORDS

virtual reality, immersive learning

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1 INTRODUCTION

Open-air museums, where historical buildings are reconstructed and presented, are a great way to learn more about life of the past. However, old buildings often are not easily accessible for mobility impaired people. Furthermore, it is difficult to fully represent the life of the past, since actors would be needed to portray the people living and working in these buildings. Finally, it is rarely possible to directly interact with the historic exhibits.

To avoid these problems, the buildings could be reconstructed as a virtual learning environment (VLE). VLEs enable users to immerse themselves into a virtual environment and experience the life of people of the past. Virtual reality (VR) also offers natural ways to interact with and to spatially explore the exhibits.

In this project, we created a virtual replicate of a late medieval mill in cooperation with the Franconian open-air museum in Bad Windsheim, to investigate how VLEs can be used to help people learn about history. We evaluated the VLE in a short usability study and collected feedback for the ongoing development. In the future, this application shall also be used to investigate the influence different factors, like immersion or interactivity, have on the learning outcomes of VLEs.

2 THEORETICAL BACKGROUND

There are different factors that can influence how VR is experienced by users. One of the most important factors is immersion. Slater and Wilbur [7] define immersion as the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant. Jensen and Konradsen [4] investigated several studies and found that immersive technologies can improve learning outcomes, especially when conveying visual or spatial information.

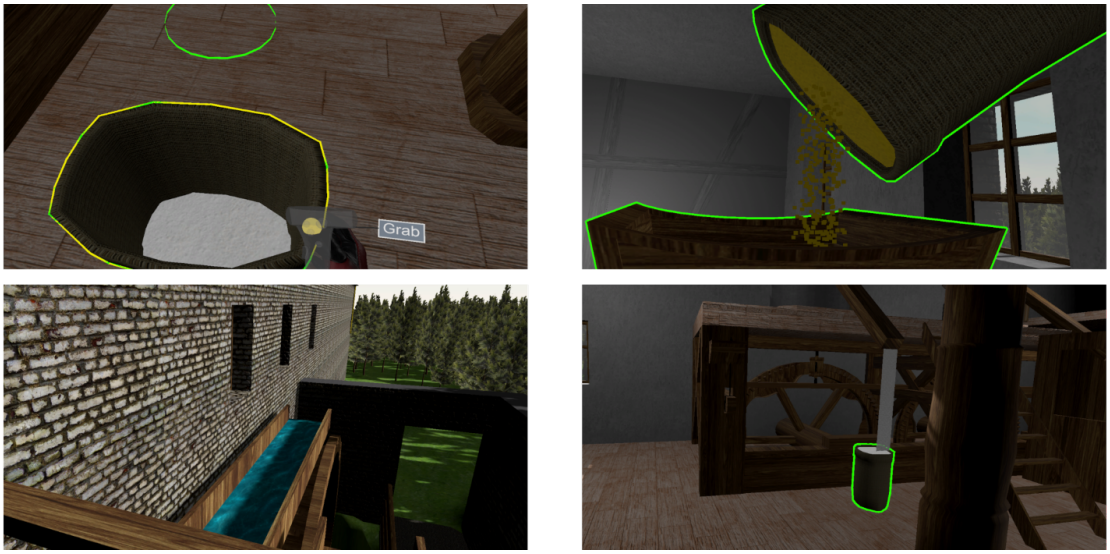

Figure 2: Example pictures showing the different steps of flour production performed in the virtual mill.

Higher immersion can also increase students' motivation when using VLEs [3]. Ritterfeld et al. [6] found that interactivity can increase the success of educational games. It can be assumed that interactivity also increases the learning outcomes of VLEs.

3 IMPLEMENTATION

To answer our research questions, we created a true to scale virtual replicate of a medieval mill. This building not only was recommended by the museum's employees, but also is well suited to present various aspects of medieval life. The parts of the mill were modeled in Blender and combined into a VLE using the Unity Game Engine, version 2019.3.15f1. To investigate the influence of immersion on the learning outcomes, we developed two versions that differ in the level of immersion: One version for Head-Mounted Displays (HMDs), using the SteamVR framework, and one for desktop computers.

We further provide interaction techniques to control the mill and to virtually produce flour. By enabling or disabling them, we intend to investigate the effects of interactivity on the learning outcomes. In the VR version, users can move around by teleportation and interact with objects by grabbing or pulling them with their controllers. In the desktop version, they can move around using their keyboard and interact by clicking on objects with their mouse.

The initial version of the application guides users through the basic steps needed to create flour in the virtual environment. The information were communicated via text boxes explaining the next steps and highlighting of the objects that have to be interacted with.

4 EVALUATION

We conducted a preliminary evaluation of the application with two objectives. The first objective tested the usability of the application using the System Usability Scale (SUS) [2]. The second objective targeted the collection of feedback for the further development of the application.

We conducted the study remotely via Zoom due to the restrictions caused by the COVID-19 pandemic. Therefore, only students who had access to the required VR hardware at home where recruited as participants. In total, ten participants (7 males, 3 females) volunteered to take part in our study. The mean age of the participants was 24.66 years (SD = 3.53). Each participant tested both versions of the application in a randomized order. During the study, the participants were told to follow the instructions inside the application and to think-aloud [5] while using it to gather feedback.

According to Bangor [1], the results of the SUS show that the usability of the VR version was good (M = 73.00, SD = 13.87) and the usability of the desktop version was excellent (M = 81.50, SD = 10.32). The SUS scores did not differ significantly between the two conditions; $t(9) = 1.764$, $p = 0.111$. Therefore, both versions seem to be comparable in terms of usability. The main points participants liked are the natural interaction in the VR version and the realistic visual presentation. The main points the participants wanted to see improved are the explanation of the interactions and further background information about the tasks. As an additional feature, most participants wanted more general information about the flour production in the Middle Ages.

5 CONCLUSION

In conclusion, we created and evaluated an interactive simulation of a medieval mill. In the next developmental steps, we intend to add agents to the application and to embed it in a learning concept. This concept shall allow teachers to integrate the system in their teaching and the museum to use the VLE as a supplement. The application shall also be evaluated for its effectiveness in learning and presenting historical information. This also includes an investigation of the influence of different VR-specific factors, like immersion and interactivity. Ultimately, design guidelines and recommendations shall be derived from this project for future VLE development.

REFERENCES

[1] Aaron Bangor, Philip Kortum, and James Miller. 2009. Determining what individual SUS scores mean: Adding an adjective rating scale. *Journal of usability studies* 4, 3 (2009), 114–123.

[2] John Brooke. 1996. Sus: a "quick and dirty'usability. *Usability evaluation in industry* 189 (1996).

[3] Christopher J Dede, Jeffrey Jacobson, and John Richards. 2017. Introduction: Virtual, augmented, and mixed realities in education. In *Virtual, augmented, and mixed realities in education*. Springer, 1–16.

[4] Lasse Jensen and Flemming Konradsen. 2018. A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies* 23, 4 (2018), 1515–1529.

[5] Clayton Lewis. 1982. *Using the" thinking-aloud" method in cognitive interface design*. IBM TJ Watson Research Center Yorktown Heights, NY.

[6] Ute Ritterfeld, Cuihua Shen, Hua Wang, Luciano Nocera, and Wee Ling Wong. 2009. Multimodality and interactivity: Connecting properties of serious games with educational outcomes. *Cyberpsychology & Behavior* 12, 6 (2009), 691–697.

[7] Mel Slater and Sylvia Wilbur. 1997. A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence: Teleoperators & Virtual Environments* 6, 6 (1997), 603–616.