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# Gladiator training in XR

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Figure 1: Gladiator virtual training

## ABSTRACT

The aim of the work in progress presented here is to design, implement and evaluate a multisensory virtual environment representing a gladiatorial practice context in order to understand the effects of immersion on the training of technical skills related to the field of armed singular duelling. This work, carried out in collaboration between a virtual reality research team, a biomechanics research team and a historian, has produced a virtual environment that puts gladiatorial combat into context. This environment offers training in typical attacks on a specific combatant, the provocator. The aim is to test certain hypotheses about the conduct of gladiatorial combat in Roman times and the impact of external conditions on the performance of these fighters.

**Index Terms:** Virtual reality, experimental archaeology, gesture training, intangible heritage.

## 1 INTRODUCTION

In 264 BC, the first gladiator fight was organized by Decimus Junius Brutus to honor the memory of his late father, Decimus Junius Brutus. This fight was the beginning of a practice which lasted until the 4th century AD. The origin of this practice has its roots in the Homeric tradition, and more particularly in the funeral ceremony of

Patroclus. This martial tradition has been studied in various disciplines, such as experimental archaeology or the history of gesture, to name but a few. Since 2018, previous work has sought to better understand the fighting techniques used by gladiators during fights through a biomechanical approach combined with motion capture [10, 12]. In this current work, the aim was to design, implement and evaluate a multisensory virtual environment representing a gladiatorial practice context, proposing a training session of gladiature within a representation of the wooden amphitheatre installed in the Roman Forum in the middle of the 1st century BC. The Provocator kit was chosen to initiate the first experiments. This armour is the first to be taught in a gladiator's curriculum, allowing the acquisition of technical knowledge that can facilitate the learning of more complex martial techniques used in other equipment.

## 2 RELATED WORKS

Virtual reality (VR) and more generally extended realities (XR), are increasingly used to represent intangible cultural heritage with many different human activities such as crafting [11], [13], artistic expression, [2], or traditional sports [14]. This last work proposes a framework for the preservation of traditional sports through gamification, applied to traditional Gaelic sport and Basque pelota, based on low cost motion capture to train users to perform correct movements. In the same idea, Lo et al., [8] used VR to create a virtual exhibition showcasing traditional Chinese martial arts. The exhibition allowed visitors to engage with the martial arts through interactive simulations, such as practicing martial arts moves with a virtual instructor.

In addition, XR simulations make it possible to document, recover and present historical contexts [1],[3] of intangible heritage,

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and to improve access to these representations for a wide audience through entertaining experiences, e.g. [15], which present a tour of the archaeological site of Olympia with an augmented reality system that simulates some antique sport activities, and [6], which propose a didactic environment for the preservation of historical "Jeu de paume".

Virtual reality experiences of this kind are now available to the general public, including on the subject of gladiatorship, with e.g. two experiences proposed for touristic visits of Rome, Virtual Rome<sup>1</sup>, a 3D 360 animation, and Gladiators<sup>2</sup>, a 360° video. These very interesting experiences lack of interactivity and do not allow to practice gladiator fights.

In the domain of VR games, several games base their scenario on gladiators' combats, such as Gladius from VirtualAge (<https://virtualage.io/gladiusvr>). In this case, these are fighting games that emphasise brutality and bloodshed, with very little basis in historical reality.

### 3 CONTEXT OF THE WORK

The objective of this work is to design, implement and evaluate a multisensory virtual environment representing a gladiatorial practice context, with a view to understanding the effects of attention on the acquisition of technical skills related to the domain of armed singular duelling.

The work was conducted in an interdisciplinary collaboration between a research team on XR, another one in biomechanics, and one Historian specialized in the Gladiature History.

The initial phase of the work presented in this article focuses on the design of a didactic environment that presents a particular class of gladiators, the provocator, their panoply, and how to fight with them.

A particular focus was placed on the reconstruction of the movements of attacks and defences, with the assistance of a team of gladiatorial fighters. Additionally, the scripting of the training environment was undertaken using a scenario engine that is specifically designed for the development of virtual reality training environments.

Understanding the sequence of motions and the role of attention in mastering these gestures was a key research question, motivating the development of an interactive, multisensory approach to historical education.

### 4 DESIGN AND IMPLEMENTATION

The design and implementation is constituted of three main parts, (i) the 3D visual context, (ii) the virtual characters and their animations, and (iii), the scenario of the VR experience.

The VR application was developed using the Unity 3D game engine and deployed on HMDs and in a large immersive facility.

#### 4.1 Graphical environment

The graphical context is based on an interpretation of the wooden amphitheater present on the Roman forum. This proposal was developed from an archaeological study of the Antique period [4] (Fig. 2) and 3D models from Antique Rome [5]. These different architectural elements have been integrated in a Unity scene to serve as a basis for the implementation of the VR environment. A second scene inside an Antique building was designed to present the equipment of one particular type of gladiator, the Provocator.

#### 4.2 Virtual humans and animations

To ensure historical accuracy, motion capture was employed to digitize provocator combat gestures.

<sup>1</sup><https://www.tworeality.com/en/roman-gladiators-virtual-reality-combat>

<sup>2</sup><https://faber-courtial.de/portfolio/gladiatoren-vr>

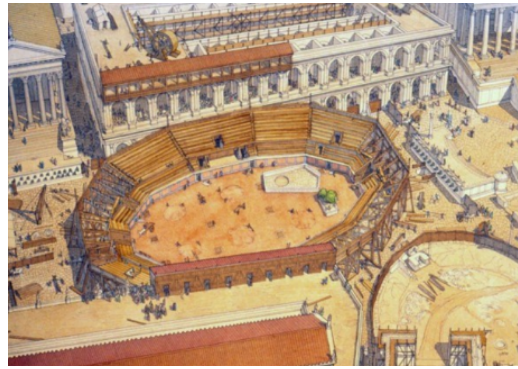


Figure 2: Representation of the temporary wooden arena built by Julius Caesars in the Roman forum © Jean-Claude Golvin [4]

As a 3D model of the virtual characters, we used a gladiator model bought on a 3D commercial site<sup>3</sup>, chosen for its historical relevance and VR compatibility.

In order to animate the gladiators, and in particular the sequence demonstrations from the instructor, we performed motion captures on two practitioners of gladiatorial combat, under the supervision of a historian specializing in the history of gladiature.

Motion captures were performed using a Qualysis system in three steps: first, the two fighters were only equipped with a dagger and simulated an attack on a real human, in order to record the dagger attack animations (Fig. 3, top); second, the two fighters were equipped with a dagger and a shield, and simulated dagger-shield sequences (Fig. 3, middle); then, the two fighters simulated sequences of combat together (Fig. 3, bottom).

The two fighters were equipped with the Qualysis Sport Marker set (41 markers on each body). The Qualysis QTM software was used to clean the captures and export the animated skeletons in FBX format.

#### 4.3 Scenario

The entire experience is divided into 2 stages, starting with an introductory scene in an antique-style room, where users discover the Provocator, its history and its arsenal, followed by a training scene in the arena, where they learn the combat moves of the Provocator.

The Provocator fights with combinations of 5 different moves, 3 dagger moves and 2 shield moves. The scenario implemented in the virtual reality environment aims to teach the user these moves with the help of a virtual instructor. The idea is to get the user to reproduce the movement performed by the instructor by touching targets placed according to the movement to be performed. The user must complete a full training session on the 5 basic movements and 2 combinations, each movement being repeated 3 times in random order, for a total of 21 sequences. Each sequence is performed following the steps presented in Fig. 6. The trainee is equipped with a dummy dagger and shield to match the size and weight of the provocator's weapons. These elements serve as tangible interfaces in the virtual scene, whether in a CAVE or on an HMD.

The validity of each sequence is validated through the collision of the correct equipment (dagger or shield), in the correct position (wrist and equipment position and orientation) with the corresponding target on the opponent, highlighted on their body.

The scenarios were implemented in Unity using Xareus, a scripting tool designed to streamline XR application development<sup>4</sup>.

<sup>3</sup><https://www.cgtrader.com/3d-models/character/man/provocator-gladiator>

<sup>4</sup><https://xareus.insa-rennes.fr>



Figure 3: Top: "Unus" dagger attack, Middle: "Tres" attack sequence, Bottom: Combat situation simulation



Figure 4: Introductory scene

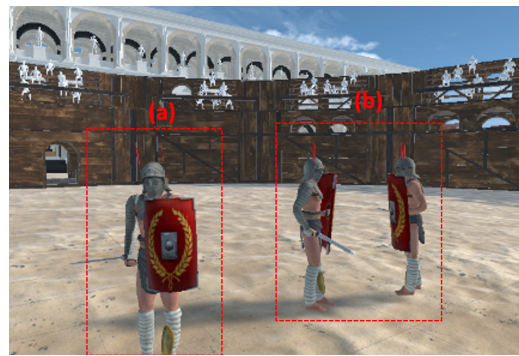


Figure 5: Training scene with (a) the virtual training partner, and (b), the instructor showing the sequence on a virtual gladiator

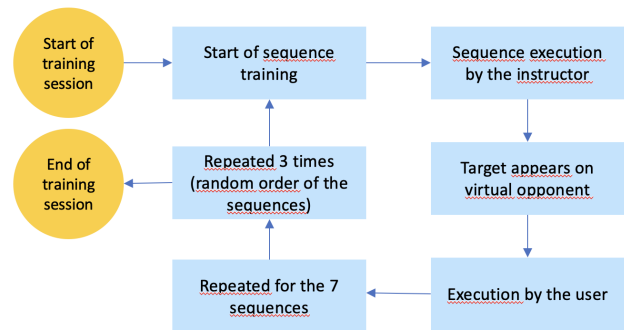


Figure 6: Scenario of the training session

Xareus enabled goal-oriented scenarios that guided users through learning phases while allowing some flexibility in task completion.

#### 4.4 Additional resources

To complement the virtual environment, audio resources and an animated crowd were integrated.

The audio resources consist of the sounds of the collisions between the shield and the sword and the oral instructions given by the virtual instructor during the training session. These oral instructions consist of a recording of the voice of the historian involved in the project.

The crowd in the arena is constituted of animated neutral humanoids (Fig. 7). The animations are controlled by the scenario engine that applies three animations, *wait*, *watch*, and *celebrate*, at random, over a random duration, for each character in the crowd.

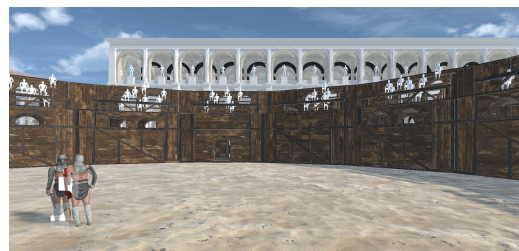


Figure 7: Animated crowd in the arena

## 4.5 Data recording

In order to analyse and validate the trainee's movements, two types of data are collected during the session: the trajectory of each movement and its duration. The trajectory data recorded consists of the position and rotation of each wrist, the position and rotation of the dagger end and the lower point of the shield.

These data will serve as a basis to assess the quality of trainee's movements with respect to a referential. This part is not yet implemented and will require further work.

## 5 DISCUSSION

The VR simulation was presented to the research team members in a large CAVE-like structure (Fig. 1). Visitors were equipped with a marker on the left wrist to control the shield and a dagger handle extended with a tracking marker to manipulate the virtual dagger. The feedback has been very positive, and this has served to motivate the continuation of the initiative.

The virtualization of the environment and martial techniques constitute a fundamental step in the study of technical gesture. This makes it possible to criticize the hypotheses put forward following the analysis of the sources before the experimental phase with participants. This offers a significant saving in time, financial and human resources due to the possibility of quickly discarding insufficiently supported hypotheses. But this environment can also be used in the context of learning martial techniques by means of an avatar that can facilitate the acquisition of these techniques by means of a period of theoretical teaching followed by appropriate training. It can also be used as part of an inclusive immersion during a museum exhibition. This virtual space promotes the sensory immersion of visitors. This visual stimulation allows you to experience gladiatorial practice without risk but also by fighting against prejudices. Associated with haptic means, this experiment allows participants to feel the weight of the equipment, the consequences of the strikes delivered and suffered. It is a relevant educational tool in sharing knowledge with an uninitiated public.

Key dimensions of the virtual reality experience will need to be assessed to ensure that these different uses are effective. In particular, immersion and interaction fidelity [7, 9] will be central elements to assess, to ensure that gestures performed in the virtual environment are realistic and transferable to the real world.

## 6 CONCLUSION

The present paper proposes a virtual reality environment for the purpose of historical reconstitution, namely the training of gladiators in ancient Rome. The environment is based on a rigorous visual design of the historical context and motion capture of realistic gladiators sequences.

This work contributes to the development of the study of gladiatorial techniques. The integration of the olfactory and auditory dimensions is also sought in order to develop a sensory immersion capable of fostering the study of this martial heritage mistreated by the prejudices conveyed by the collective imagination.

## FIGURE CREDITS

Figure 2 image credit: Jean-Claude Golvin / Representation of the temporary wooden arena built by Julius Caesars in the Roman forum © Jean-Claude Golvin (<https://jeanclaudegolvin.com/en/>) [4].

## ACKNOWLEDGMENTS

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