Chapter 11
Augmented Reality-Based Training Systems for Teaching Health and Safety Procedures in Construction

Inma García-Pereira
Universitat de València, Spain

Cristina Portalés
https://orcid.org/0000-0002-4520-2250
Universitat de València, Spain

Sergio Casas
https://orcid.org/0000-0002-0396-4628
Universitat de València, Spain

María Vidal-González
Universitat de València, Spain

Jesús Gimeno
Universitat de València, Spain

ABSTRACT

Traditional teaching methods are not always efficient, especially in areas where the concepts to teach relate to physical work that must be done outside the classroom. This is the case of the construction sector, where the teaching of safety procedures is crucial to reduce the number of accidents, but traditional methods fail to highlight the importance of these procedures. The use of computer simulation through new technologies such as augmented reality (AR) can engage more students in order to better understand the concepts. In addition, they can visualize virtual elements superimposed on the real world to simulate the real situations they will later face in construction. This chapter deals with the simulation, by means of AR technology, of teaching procedures in the construction sector. It presents ARFAT, an application for mobile devices that makes use of AR to teach health and safety procedures about three elements: formwork, scaffolds, and falsework.

INTRODUCTION

The use of Augmented Reality (AR) for educational purposes can provide a great added value to the contents that are intended to be taught. For instance, when the target audience is not necessarily familiar with new technologies, AR can be a great ally since the interaction in this paradigm occurs in a simple and intuitive way, as it provides the ability to enhance/augment reality by means of a seamless interaction between virtual and real objects. In this regard, knowledge can be acquired in a more entertaining way, almost like in a game, helping users learn the contents easily, something that is very important in the construction sector where many workers lack a formal education.

Other interaction paradigms based on computer simulations, such as Virtual Reality (VR), can also provide interesting features in the education field, but AR has the ability to provide spatial cues by means of the distribution of computer generated elements that can be used to explain concepts in the real environment, without having to extract/teleport the user to a different simulated world (as occurs in VR). In this sense, AR technology allows visualizing virtual objects in a real environment when they are not really there. For example, a worker could visualize a virtual scaffolding blended with the image of a real facade, in real time and in situ, enhancing the sensation that the scaffolding really belongs to the real environment. It is even possible to interact with it and to move around in order to see it from different perspectives.

With a computer simulation, placing users in spaces where they are not currently located is increasingly easy. Although AR focuses on augmenting a real environment with specific virtual objects designed to enhance existing elements or particular situations, AR can be also a good tool to simulate completely hypothetical situations. This avoids having to move the user to real spaces when it is not possible (because they have not yet been built, because they are far away, because it would not be profitable, because the necessary material is not yet available, because some learning or training is recommended before going to the real space, etc.). This would be somehow similar to a VR application. However, in AR users will always be in contact with their current location, enhancing the sensation that what they are experiencing is believable.

On the other hand, in the construction industry it is essential to have a sufficient level of key competences, safety standards, and specific procedures to ensure both the safety of workers and the correct and efficient construction of buildings. To acquire this knowledge, the traditional use of books can be complemented with practical exercises in which AR can be used. In this way, users can consolidate and practice the knowledge learned by practicing in simulated environments. In this sense, AR technology can play an important role as practicing from a simulated and even a remote place (e.g. at home or at the classroom), is easier and safer than in a construction site. Indeed, the AR technology provides a simple and economical way to represent a construction environment, including its peculiar characteristics. Thus, a student or worker can make use of a tablet (provided with an AR application) to simulate that he or she is in a building site. The AR application would reproduce the necessary steps to safely provide the user with the necessary devices in the building site (fences, signs, guides, harnesses...). In the same way, situations such as changes in the weather or in the conditions of the ground can be simulated so that the student or worker understands better the different challenging and/or dangerous situations that can occur in the real life.

In this chapter, the authors will focus on how AR can help in designing training systems for qualified and non-qualified workers from the construction industry. These kind of systems will prospectively improve their basic competences, their knowledge of safety and of the assembly of certain elements of