

## Chapter 26

# Digital Twin for Amyotrophic Lateral Sclerosis: A System for Patient Engagement

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### ABSTRACT

*This chapter focuses on the context in which patients such as those with Amyotrophic Lateral Sclerosis (ALS) are placed and what possibilities information and communication technologies (ICTs) offer to keep them in touch with the world to reach Society 5.0. In particular, the authors intend to show how the healthcare sector can use digital twin (DT) through elements of augmented reality (AR) and building information modelling (BIM) to create interactive interfaces that can solve, in part, problems involving frail patients but at the same time allowing their monitoring. Interconnection is possible through a gamification approach. In addition, a solution that considers the user (patient) involvement and that aims at its increase through interaction with alternative places to their home so as to stimulate them to keep an active mind and the degree of fun in a limiting condition is proposed.*

### INTRODUCTION

In recent years, the adoption of innovative technologies for the development of Smart Cities and Smart Society has been studied by many researchers to refine the management of the built environment related to healthcare facilities. This goal achievement involves the use of interdisciplinary information considering both medical personnel for patient management and technical one for facility management. In this

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context, the concept of Digital Health can be defined as “*the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients leads to an equal level doctor-patient relationship with shared decision-making and the democratization of care*” (Meskó et al., 2017). This transformation involves the adoption of many technologies capable of handling large amounts of data that must then be interpreted by qualified personnel. The inclusion of such innovative methods and tools can often be counterproductive if not accompanied by an awareness of the goals to be achieved and the challenges to be met, such as the overcoming of digital divide.

The elaboration of virtual environments, able to provide scenarios of interaction between the user and the surrounding environment, poses several challenges related to technological innovation and human behavior. Gamification approach is one of the main strategies adopted. It can be defined as “*the use of game design elements in non-game contexts*” (Deterding et al., 2011). It is based on the use of technologies of the gaming world in contexts whose interest is to increase user involvement. The idea behind gamification is to exploit the motivational possibilities of entertainment games in other spheres (i.e., health sector, building sector) by leveraging the features of a certain application to make user engagement more motivating. Using a Gamification approach, it is possible to harness a predisposition to motivation in performing an action or a task. This is since games can put users in favorable conditions, stimulating them and increasing their involvement.

In the age of connection, the information society (society 4.0) needs to use technological advancement and ICTs to solve social problems and overcome the fragilities of people with disabilities through an integration of cyberspace and physical space. Through this paradigm shift, it is possible to speak of a Society 5.0 in which people are connected with cyberspace and, through artificial intelligence (AI) algorithms, can overcome the limitations of physical space to improve the quality of life for all citizens. Through an approach to gamification and Serious Games (SGs), it is possible to trigger this change by relating people with ICTs. (Narvaez Rojas, 2021).

Many researchers are investigating these arguments and a broad range of consumer applications for monitoring and managing one’s own health and well-being are available on the market. One important sector is SGs for health (Wattanasoontorn et al., 2013), games used to drive health-related outcomes. The majority of these are “health behavior changes games” (Baranowski et al., 2008) or “health games” (Kharrazi et al., 2012) affecting the health behaviors of health care receivers (and not e.g., training health care providers) (Wattanasoontorn et al., 2013). The activities on which developed applications focus concern physical activity, nutrition, and stroke rehabilitation, with an about equal share of (a) “exergames” or “active video games” directly requiring physical activity as input, (b) behavioral games focusing specific behaviors, (c) rehabilitation games guiding rehabilitative movements, and (d) educational games targeting belief and attitude change as a precondition to behavior change (Kharrazi et al., 2012).

## BACKGROUND

### Gamification in Building Sector

With the advancement of computer and information technologies in recent years, innovative methods such as Building Information Modelling (BIM) and visualization tools such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) have been applied widely across the Architecture, Engineering, Construction, and Operation (AECO) industry (Springer, 2022). In the context of the AECO

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