

Augmented Reality in Healthcare



Patrik Pucer

University of Primorska, Slovenia

Bostjan Zvanut

University of Primorska, Slovenia

INTRODUCTION

Healthcare is a service activity the goal of which is to protect and improve the health of individuals and populations (Steinwachs & Hughes, 2008). Due to the growing complexity of healthcare the provision of high-quality, affordable, healthcare services is becoming an increasingly difficult challenge (Bates & Gawande, 2003; Steinwachs & Hughes, 2008). Health services researchers are developing and evaluating innovative approaches by involving innovations in organizations, financing, roles of health professionals and use of technology in order to improve the quality of care (Steinwachs & Hughes, 2008). The main classes of technologically driven approaches that allow the increase in the quality of care include tools which can improve communication, make knowledge more readily accessible, assist with calculations, provide decision support, perform checks in real time, assist with monitoring, and provide key pieces of information (Bates & Gawande, 2003). Information and communication technology (ICT) can support such tools allowing them to structure actions, catch errors, and bring evidence-based, patient-centered decision support to the point of care (Bates & Gawande, 2003).

Healthcare professionals can in a simple and rapid way obtain most of the information that they need using ICT (Štern & Kos, 2009). Ease and speed of use at the point of care were initially problematic, however, they appear to be improving, and hand-held devices are being now widely used (Bates & Gawande, 2003). Devices like laptops, smartphones and tablets are used by healthcare professionals on a daily basis to take care of patients (Durham & Alden, 2008; Lewis Dolan, 2011a, 2011b, 2012; Pokorn, 2013). The aforementioned devices enable access to the patient's electronic health record (EHR) or to other electronically stored information in various formats (written, pictorial, audio or video), all of which help healthcare professionals to be more confident, productive and efficient (Case, Mowry, & Welebob, 2002; Gorman et al., 2000; Gurses, Xiao, & Hu, 2009; Lewis Dolan, 2013; Patel BK, Chapman CG, Luo N, Woodruff JN, & Arora VM, 2012). Healthcare professionals daily use and encounter such digital information forgetting (maybe) that all are virtual objects being part of a virtual environment.

Even if all of the required and needed information can now be available at the point of care as virtual objects, the time that healthcare professionals spend for patient activities at the point of care is shrinking due to the increased number of patients per healthcare professional (Ammenwerth, Rauchegger, Ehlers, Hirsch, & Schaubmayr, 2011). A solution that could increase the time per patient is to combine patient activities at the point of care with other patient activities that are usually not performed at the point of care, e.g. performing wound care and checking yesterday's wound condition (watch images, read documentation or listen to it) or documenting today's wound condition (record an audio document) simultaneously. Technologies that could support such behavior should combine real and virtual, allowing real and virtual objects to coexist in the same environment (Azuma, 1997). The reality, where users use and see the real physical world upgraded or superimposed with virtual (computer generated) objects is

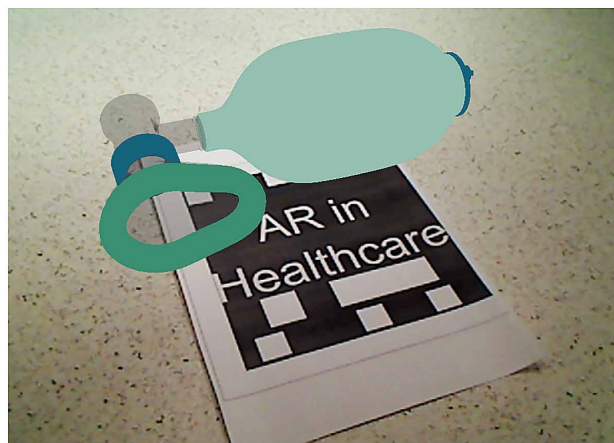
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called augmented reality (Azuma, 1997). The purpose of this chapter is to present augmented reality to healthcare specialists in order to improve its use in practice. The objectives of this chapter are (a) to describe the main properties that define a reality as augmented reality; (b) to present the various building elements of augmented reality systems; (c) to present practical applications of augmented reality in healthcare. In order to achieve these objectives a search of the literature was performed between May and August 2014. It included different references: e.g. monographies, articles, web pages, and videos. The following search engines were used: Google, Google scholar, EBSCOhost, Wiley Online Library, The Cochrane Library, ProQuest, Science Direct, SpringerLink, PubMed, and COBISS (Slovenian bibliographic catalogue). The following keywords and their combination were used: healthcare, technology, augmented reality, mixed reality, simulation, information and communication technology (ICT).

WHAT IS AUGMENTED REALITY?

Combining real and virtual gives rise to a mixed reality which spans between the fully real environment and the fully virtual environment. As such mixed reality is the “middle ground” between virtual environments (or more commonly called virtual reality) and real environments (Azuma, 1997), or the “link” between the real and the virtual world (Zlatanova, 2002). On the reality-virtuality continuum defined by Milgram, Takemura, Utsumi, & Kishino (1995), mixed reality is composed of augmented virtuality and augmented reality (AR). In augmented virtuality the surrounding environment is virtual and it is augmented by real-world objects, while in AR the surrounding environment is real and it is augmented by virtual objects (Azuma et al., 2001; Craig, 2013). Consequently AR is a reality that allows the user to perceive computer generated objects as a part of the real world (Craig, 2013), where it seems that virtual and real objects coexist in the same space (Azuma, 1997) (Figure 1). Usually these virtual objects display digital information (visual, auditory, regarding smell, taste, or touch) (Craig, 2013) that cannot be discerned by the five senses of a user (Azuma, 1997; Tang, Kwok, Teo, Sing, & Ling, 1998). Thus AR enhances the user’s perception and view of the real world with different types of virtual objects that can be applied to all senses, with sight and sound being the most common (Azuma, 1997; Azuma et al., 2001; Craig, 2013; Tang et al., 1998). Hence the most common virtual objects used in AR are computer graphics (e.g. photographs, 3D graphic models, computer simulations, animations), text and sound (e.g. digital recordings of sounds) (Craig, 2013; Yuan, Ong, & Nee, 2005).

Figure 1. Virtual and real objects coexisting in the same environment



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