Research Title: Virtual and Mixed reality for medical education and training

Funded by DAUIN

Supervisors
Prof. Andrea Bottino – DAUIN, Politecnico di Torino
Prof. Pier Luigi Ingrassia – SIMNOVA center (Centro Interdipartimentale di Didattica Innovativa e di Simulazione in Medicina e Professioni Sanitarie), Università Piemonte Orientale, Novara

Contact
Andrea Bottino, DAUIN
Tel: +39 011 090 7175
Mail: andrea.bottino@polito.it
http://www.polito.it/cgvg

Context of the research activity

Virtual and Mixed Reality (VMR) are transforming the way medical students and healthcare providers are learning. The training of medical/surgical procedures requires high levels of perceptual, cognitive and sensorimotor skills. Medical education encompasses basic knowledge acquisition, operation of equipment, communication skills with patients and much more. The standard approach to master such complex skills relies on workplace or class learning. However, these practices can involve safety, cost and didactic issues. Here is where VMR technologies can provide a valuable contribution. VR allows creating simulated 3D interactive scenarios, providing safe (and entertaining) experiential learning environments where individuals can practice skills and procedures. MR allows augmenting user perception with valuable information about the educational context. VMR simulations facilitate self-directed learning, as trainees can develop skills at their own pace with unlimited repetition of specific scenarios. Furthermore, these systems do not require the presence of an instructor (thus, helping reduce training costs) and they can support teaching institutions and learners with standardized computer-based
However, fully exploiting the possibilities offered by VMR in medical education requires addressing a number of important research questions related to usability, learning paradigms, management of team activities and validation of the developed approaches.

The objective of this research is to propose and validate novel and promising solutions that can positively affect the quality and the effectiveness of VMR based medical training. In particular, this project aims at tackling the following challenges.

**Usability and User eXperience (UX).** When exploiting VMR for training and education in a medical context, the target end users are heterogeneous and likely to have few (or null) previous experiences with the specific technologies. This poses a challenge for the UI designer in many learning scenarios (e.g., basic skill training and acquisition) where the potential users must be enabled to operate the system efficiently in the shortest time possible. Thus, the interaction design should reduce the user’s cognitive load and foster learnability, intuitiveness and ease of use. It is worth noting that improving usability and UX can also help overcome users’ resistance to new technology, with positive effects on the learning outcomes.

**Team activities.** In medical context, many learning and training activities must be performed in teams, whose members jointly cooperate to the management and execution of the procedures. To this end, the spatial dimension and multimodal capabilities of multi-user VMR environments offer new possibilities for designing, deploying and enacting collaborative activities. However, there are issues that must be carefully addressed. First, enabling an effective user collaboration might require the implementation of shared environments capable of:

1. guaranteeing multiple forms of collaboration among users (i.e., co-located, distributed or mixed),
2. enabling a seamless integration of multiple interaction and visualization devices (in both MR and VR) and,
3. supporting the adaptation of the visualized information to the different user roles (e.g., doctors, caregivers and patients should be provided with different views of the same object, or with different information associated to it, and should be allowed to interact with the same object in different ways).
Second, in shared environments, the available interfaces affect the way users collaborate with each other and organize their joint activities in the common (co-located or remote) working space. This raises a variety of empirical questions and technical issues: how do users coordinate their actions? How can they monitor the current state and activities of other users? How to establish joint attention? Which interaction paradigms are most effective for groups of local or/and remote users?

**Learning paradigms.** Most of the VMR-based learning and training activities in medicine require the development of experiential learning environments, whose design must be grounded on sound learning theories and approaches. In particular, recent research recognize the educational potential of “serious games” (i.e., digital games designed for a primary purpose that goes beyond the pure entertainment) and their capabilities to convey new knowledge to people. However, fully exploiting the capabilities of serious games (SG) and gamification elements in this specific context requires answering several research questions, such as: how to maximize the learning impact of SGs? Which are the SG design model and framework most suited to achieve these objectives?

**Validation studies.** The developed approaches must be validated at different levels. First, any use of technology within a medical scenario must be proven to work, particularly when patients are involved. Second, as far as a learning tool is concerned, its effectiveness (in terms of learning outcomes and transfer to the professional context) must be validated. Finally, when dealing with VMR applications, it is clear that their usability and UX must be carefully assessed as well.

**Skills and competencies for the development of the activity**

Candidates should have knowledge of the main principles of VMR and HCI, a good background in programming (in C#/C++ languages) and basic expertise of VMR development tools. Other relevant competencies are the capability to work in team and good English writing skills. It should be underlined that, since the research program is intrinsically multidisciplinary, the candidate will benefit of the expertise of the two tutors (and their research groups) in the fields of Virtual and Mixed reality and in the application of these technologies in the medical field.