DEMO: ”Stayin’ Alive”: An Interactive Augmented - Reality CPR Tutorial

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Abstract
Education is the Achilles heel of successful resuscitation in cardiac arrest. Therefore, we aim to contribute to the educational efficiency by providing a novel augmented-reality (AR) guided interactive cardiopulmonary resuscitation (CPR) "trainer". For this trainer, a mixed reality smart glass, Microsoft HoloLens, and a CPR manikin covered with pressure sensors were used. To introduce the CPR procedure to a learner, an application with an intractable virtual teacher model was designed. The teaching scenario consists of the two main parts, theory and practice. In the theoretical part, the virtual teacher provides all information about the CPR procedure. Afterward, the user will be asked to perform the CPR cycles in three different stages. In the first two stages, it is aimed to gain the muscle memory with audio and optical feedback system. In the end, the performance of the participant is evaluated by the virtual teacher.

Author Keywords
CPR;Augmented-Reality;Interactive Ubiquitous Teaching

ACM Classification Keywords
K.3.1 [COMPUTERS AND EDUCATION]: Computer Uses in Education

Figure 1: Teaching materials

Introduction

Efficient education of the performer in cardiopulmonary resuscitation (CPR) is the formula for survival after cardiac arrest. Current standardized face-to-face and online courses are falling short, and are providing a weakened expertise over time. There are multiple attempts to improve the CPR teaching, yet in many institutions, guidelines taught in courses do not have an optimal teaching approach [3]. Thus, we aim to bring a novel method to improve CPR teaching using augmented-reality (AR) based feedback enhanced interactive learning.

Related Work

With advancement in technology, many attempts were done to use contemporary learning technologies to provide a CPR teaching method that has most effective and long lasting outcomes. Many studies showed that self-instruction video based CPR training improved competence in resuscitation [6]. It has been also asserted that using an immersive and interactive game for CPR training had comparable learning outcomes compared to face to face training [9]. Boada et. al. [2] presented a game design that could help to promote CPR protocol. In the study done by Applegate et. al. [1], the results presented the fact that using direct feedback manikins and gamification of training session had a significantly positive effect on learner's attitude. Also, multiple studies showed that using feedback devices in CPR training provides a significant improvement in the CPR performance of bystanders and nurses [5, 4].

Demo - Methodology

In this demo to achieve a new kind of human-computer-interaction in the field of learning, a combination of tangible teaching materials and AR were utilized, yielding an intuitive and interactive teaching session. To maintain the augmentation and intractability, HoloLens, a mixed reality smart glass [8], and a standard CPR Manikin [7] were used as teaching materials (Figure 1). A server based approach was adopted to maintain the communication between manikin and HoloLens (Figure 2).

Figure 2: Abstract view of proposed setup for AR guided interactive CPR tutorial application.

Direct feedback manikin and data communication
Initially, the CPR dummy's chest was covered with a collection of pressure sensors to detect the applied compression depth and frequency. Depth calculation was done by measuring the applied pressure to the dummy's chest. Later, sensors were calibrated to the optimal range using a commercially available standard QCPR feedback device.
The pressure sensor was attached to an input pin of the Arduino pro mini board placed and fixed inside the manikin. The manikin was connected to a server host machine through serial port. An HTTP based server-client architecture was written in Python script and used to provide a communication on local network (Figure 3). During the Hololens teaching session, data readings from sensors inside the manikin will be send to the local server. This data consists of raw

Keywords
Begin
Ready
Yes
No
Skip
Repeat

Table 1: Implemented voice keywords list to interact with virtual teacher.

Figure 4: A participant experiencing practical phase of augmented-reality guided CPR tutorial

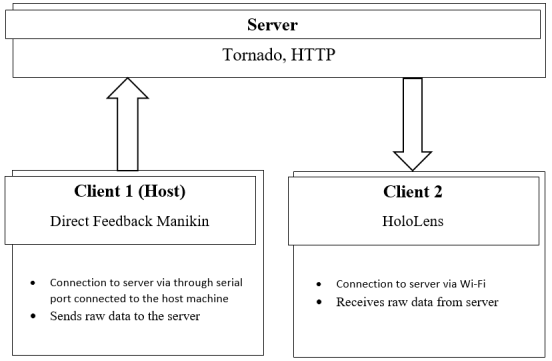

Figure 3: Server-client based architecture.

pressure amount applied to the manikin chest. Data available on the server is then fetched by the HoloLens.

Augmented teacher and feedback visualization
The HoloLens CPR Teaching application was designed in the Unity game engine. To provide a teaching scenario, as close as possible to the conventional method, a human character model was designed to perform the role of a teacher with the possibility of voice interaction from the user with specific key words (Table 1). The employed approach to teach consists of three stages.
In the second phase, the practical interaction, the user is asked to perform CPR on the provided manikin (Figure 4). The learner goes through three different stages. First, for gaining muscle memory and minimize cognitive load on the learner a very well-known CPR song is used. While the song is playing, the learner is asked to perform the CPR on the real manikin. After completion of 30 correct CPR compression, the trainer will go through the next step. In the second step, to refine a more accurate compression

Figure 5: First person view of theoretical phase of CPR tutorial application.

frequency the user is asked to follow a beep sound (frequency of 110 beeps/min). Through all these steps, the user is guided by visualization of their performance (depth and frequency) which is determined by the sensors on the manikin's chest. The application is running with 60 frames per second. In each frame new pressure data is fetched and visualized in a virtual feedback object providing a real-time visualization of user performance.
In the last stage the performance of the user will be evaluated. The learner will be asked to perform one more cycle of CPR while no visual or audio feedback from the application is presented to him/her. After completion of one CPR cycle, the performance results will be provided to user. If desire the user can repeat the learning procedure or test.

Discussion and Conclusion

There are some reports demonstrating the impact of interactive CPR learning methods using displays [3]. However, the main goal and advantage of using AR in a CPR teaching system is to maintain the natural posture while reducing the learner's cognitive load by superimposing feedback information with real world objects. This method could also

help people struggling struggling with social interaction problems and help them to gain confidence while doing CPR. In the future version of this application, more accurate performance analysis such as hand position, posture detection, etc. are aimed to be added. Although it is a very promising method, the question whether augmented/virtual teachers could be a complement to human teachers, will be answered in future studies.

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