Haptic-Based Cardiopulmonary Resuscitation Training for Visually Impaired People

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***Abstract*— We present a system to train people with visual impairment to perform cardiopulmonary resuscitation via wrist-worn haptics. The system is composed of a head-mounted display system to track the performance of the massage in real time and a wrist-worn haptic device to render tactile feedback. We will experimentally evaluate the effectiveness of rendering audio, haptic, and multi-modal feedback.**

I. Introduction

Millions of people lose their lives every year due to heart attacks. According to the World Health Organization, 17.9 million people died due to cardiovascular diseases in 2019, and 85% of these deaths were caused by a heart attack. Proper training in cardiopulmonary resuscitation maneuvers (CPR) can save many lives and should be provided to every niche of human society. Many studies are developing CPR training systems that provide visual feedback to the users regarding their performance in real time [1]. To the best of our knowledge, there is only one application specifically developed for visually impaired people, but it is an educational mobile game rather than a complete training system [2].

In this work, we propose a CPR training system (CPR trainer) specifically designed for visually impaired people using computer vision for gesture tracking. We will explore different feedback modalities (audio, haptic on the wrist [3], or both) to guide users in moving at the correct speed during CPR and give real-time performance feedback. We plan to investigate the best feedback modality by evaluating the system's effectiveness on a population of blind individuals.

II. Methods

Fig. 1 shows the two main components of the CPR trainer: a tracking system and a wrist-worn haptic device.

a) ***Tracking System****:* The performance of CPR maneuvers can be evaluated in terms of compression depth (50 mm) and compression rate (110 bpm). To evaluate these metrics, users' hands must be tracked in real time through an Oculus Quest 2 head-mounted display (HMD) and its open-access tracking library. The compression depth is computed as the change in the hand position, whereas the rate as the time between consecutive compressions – the precision of this method is estimated to be around 4 mm [4]. HMD also allows us to extend the system for sighted users to (i) participate in the preliminary studies by being isolated from the real environment with a rendered black scene and (ii) visualize feedback directly on the scene in a mixed reality environment.

b) ***Wrist-worn haptic device****:* The tracking information will be sent to a wrist-worn haptic device. This device mainly consists of a custom-made voice-coil actuator and an electronic control unit. When actuated, the user will perceive a spike-like stimulus on their wrist with variable intensity and frequency. It can work up to 25 Hz frequency and 1.5 N force in the normal direction. In particular, the haptic feedback will be coupled with the error in compression depth (amplitude) and rate (frequency). We will investigate the user performance and experience while haptic feedback rendering (i) a constant reference or performance-based feedback and (ii) different mapping strategies between performance-based feedback and the intensity of rendered stimuli.

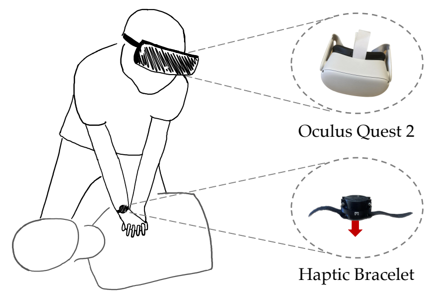

Fig. 1. CPR training process with Oculus Quest 2 and the Haptic Bracelet.

III. Discussion & Future Works

In this work, we propose developing a haptic-based CPR training system specifically designed for the use of visually impaired people. Future works will include user studies to provide a qualitative assessment and a system usability test with sighted and blind participants.

References

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* This work is funded by TUBİTAK 2232-B International Fellowship for Early Stage Researchers Program number 121C147.

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