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A Quality of Experience assessment of haptic and augmented reality feedback modalities in a gait analysis system

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Abstract

Gait analysis is a technique that is used to understand movement patterns and, in some cases, to inform the development of rehabilitation protocols. Traditional rehabilitation approaches have relied on expert guided feedback in clinical settings. Such efforts require the presence of an expert to inform the training (to evaluate any improvement) and the patient to feed in the data. However, potential opportunities exist to employ the use of digitalised "feedback" modalities to help a user to "understand" improved gait technique. This is important as clear and concise feedback can enhance the quality of rehabilitation and recovery. A critical requirement emerges to consider the quality of feedback from the user perspective i.e. how they perceive, understand and react to the feedback.

In this context, this paper reports the results of a Quality of Experience (QoE) evaluation of two feedback modalities: Augmented Reality (AR) and Haptic, employed as part of an overall gait analysis system. The aim of the feedback is to reduce users' gait misalignments, which can cause various orthopaedic problems. The QoE study includes subjective (engagement in task alignment) and objective (posture/alignment improvement) user metrics in 20 participants, as part of a within subject design. Participants completed 12 questions on QoE aspects such as utility, usability, interaction and immersion of the feedback modality via post-test reporting. In addition, objective metrics of participant performance (angles and alignment) were also recorded as indicators of the utility of each feedback modality. The findings show statistically significant higher QoE ratings for AR feedback. Also, the number of knee misalignments was reduced after users experienced AR feedback (20% improvement with AR feedback relative to baseline when compared to haptic). Cluster analysis showed significant differences in performance by number of misalignments and time to correct gait misalignments for users when they experienced AR feedback. The female group self-reported higher utility and QoE ratings for AR when compared to male groups.

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A Quality of Experience assessment of haptic and augmented reality feedback modalities in a gait study via system

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Abstract

Gait analysis is a technique that is used to understand movement patterns and to assess users to inform the development of rehabilitation protocols. Traditional rehabilitation approaches have relied on expert guided feedback in clinical settings. Such efforts require the presence of an expert to inform the training (to evaluate any improvement) and the patient to react to the cues. Non-invasive, personal approaches exist to enable the use of digital 'feedback' modalities to help a user to 'understand' movement/gait techniques. This is important as clear and concise feedback can enhance the quality of rehabilitation and recovery. A critical requirement emerges to consider the quality of feedback from the user perspective i.e. how they perceive, understand and react to the feedback.

In this context, this paper reports the results of a Quality of Experience (QoE) evaluation of two feedback modalities: augmented reality (AR) and haptic, combined as part of an overall gait analysis system. The aim of the feedback is to reduce users' fatigue and improve, which can cause serious orthopedic problems. The QoE study includes subjective (perceived) and objective (physiological responses) user metrics in 20 participants, as part of a within subject design. Participants answered 12 questions on QoE aspects such as utility, usability, interaction and immersion of the feedback modality via post-test reporting. In addition, objective metrics of participant performance (angle and alignment) were also recorded as indicators of the utility of each feedback modality. The findings show statistically significant higher QoE ratings for AR feedback. Also, the number of knee misalignments was reduced after using augmented AR feedback (20% improvement with AR feedback relative to haptic when compared to haptic). Correlation analysis showed significant differences in performance for number of misalignments and time to correct angle misalignment for users when they experienced AR feedback. The female group self-reported higher utility and QoE ratings for AR when compared to male group.

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