Golf Training System Using Sonification and Virtual Shadow

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Figure 1: An overview of the system

Figure 2: Schematic diagram of the system

ABSTRACT

This paper proposed a golf training system using real-time audio-visual feedback. The system captures user's motion with an optical motion tracking system and projects his/her posture as a virtual shadow on the ground. Unlike other golf training systems, our system enables the user to keep his/her gaze on the ball. The model swing motion of the expert golfer is also overlaid so that the user can understand the difference between his/her motion and expert's. Moreover, the system provides audio feedback using sound image localization. It enables the user to understand the position and orientation of the club face, which is often out of sight of the user during his/her swing motion.

CCS CONCEPTS

• **Human-centered computing** → *Auditory feedback; Information visualization.*

KEYWORDS

sports training, shadow, golf, sonification, multimodal feedback

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1 INTRODUCTION

In most sports, including golf, skills can be improved by imitating the motion of experts. Many systems have been proposed to teach users the correct swing form with real-time visual feedback. These systems, however, require the users to move their head to see the display, which disturbs the users focusing on the ball. Ikeda's system [Ikeda et al. 2018b] projected the virtual shadow on the ground, which enables the user to obtain feedback with natural head orientation. In addition, the Shadow Drill is often used in golf training.

One of other remaining issues is that user cannot visually recognize the position and orientation of the golf club when the user swings back. Sigrist et al. [Sigrist et al. 2015] reported that audio feedback is more effective than haptic feedback when used in conjunction with visual feedback in trunk-arm rowing.

This paper proposed a golf training system using real-time audio-visual feedback.

2 PROPOSED SYSTEM

The proposed system projects the forms of both the user and the expert on the ground in real-time like a shadow as in Figure 3, and

Figure 3: Real-time visual feedback with virtual shadow.

also provides the audio feedback to correct the posture of the club. The shadow visualization enables users to recognize the difference between their form and the expert's. Moreover, the audio feedback makes users understand the differences of the angle and rotation of the club which are difficult to understand only with 2D visual feedback. Our system uses sound image localization which makes users feel as if the sound came from the club face, so that the user can intuitively recognize the position of the club face even if the club is out of sight.

Figure 2 illustrates the system configuration of the system. The system captures the user's form using Optitrack¹ and projects the virtual shadow using a short-focus projector. The audio feedback is given to the user through the Bluetooth earphone.

2.1 Visual Feedback

The virtual shadow of the user is made from the silhouette of SMPL[Loper et al. 2015] model which is a realistic 3D model of the human body. The model is adjusted to the user's form in real-time. In addition, the system projects the outline of the expert's form on the shadow. The form of the expert is selected from one motion acquired in advance. DecayedDTW [Ikeda et al. 2018a] is used for this selection.

2.2 Audio Feedback

Based on the form of the expert selected above, audio feedback is generated. The audio feedback is provided to the user based on the roll and yaw of the golf club as shown in the Figure 4.

We used white noise and whining noise as audio feedback based on our previous study [Tanaka et al. 2018]. Specifically, based on the sawtooth wave (basic sound), the white noise is added if there is a difference in the roll. The whining noise is added if there is a difference in the yaw. In addition, for sound image localization, the audio feedback is converted to binaural sound through the head-related transfer function [GARDNER 1994].

3 CONCLUSION

This paper proposed a golf training system with real-time audio-visual feedback, which does not require the users to shift their gaze direction. The visual feedback is projected on the feet of the user and imitates the shadow. The audio feedback is provided to understand

Figure 4: Transition of sound source position by sound image localization and measurement method of two angles (yaw, roll).

the position and orientation of the club face, and compensates information that is lost in 2D visual feedback. In the future, we will conduct a user study of the proposed system and evaluate the effectiveness of this multimodal feedback

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¹<https://optitrack.com/>