Augmented Visualization for Practicing Tai-Chi Chuan with Drone-Enhanced Approach

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ABSTRACT

Tai-Chi-Chuan (TCC) is a famous physical exercise and well-known for being able to effectively promote physical well-being. Many people have been interested in learning it at the beginning, but eventually turned out to be failed in mastering it due to the lack of a constantly accompanying master on the side. We present a drone-enhanced human augmentation system for learning TCC. By wearing an optical see-through Head-Mounted Display(HMD), the user can have their own private coaches-on-demand and augmented mirrors in different placement, which allows the user mimic the movement and compare with the coach. In particular, augmented mirror is shown via a drone used to capture images of the user's posture.

Author Keywords

Physical Activity Learning, Mixed Reality, Drone, Augmented Mirror, Tai-Chi Chuan.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

In many physical exercise, the users are asked to perform a sequence of body movements with highly accurate positions. Somehow, traditional ways of learning such as observing coaches in class etc. are not ideal in terms of occlusion and direction problem. Trainees can only observe the coaches' posture in specific perspective because they are occluded by other students in class, and they can only observe the motion of themselves in specific perspective due to the fixed mirror. Besides, they cannot observe their posture by third person view which makes them hard to compare their posture with coaches'.

In this research, we propose a mixed reality system on see through head-mounted display for TCC self-practicing. After wearing an optical see-through HMD, the user can see eight virtual coaches with flying carpets below which could be seen from different perspectives, and the augmented mirrors show the images captured by drones. Unlike the traditional materials, users could get more exhaustive information on specified movements with these surrounding virtual coaches. Moreover, we proposed a novel approach to extend visual feedback by placing the augmented mirror that provide the user third person view of themselves. In particular, the augmented mirror is implemented by a fisheye camera of the drone with capability to transmit frames through wireless communication. The user can control the drone shooting from the front or the back of the user to observe their front or back posture via the augmented mirror.

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Figure 1. Scenario of this guiding system.

RELATED WORK

In this section, we discuss the systems which have an influence on our purposed system. First, physical activity training is the main core of our goal. Secondly, we discussed the different usages of multi-view. Finally, the usages of self-image in Augmented Reality (AR) and Virtual Reality (VR) will be introduced.

There have been some researches on movement guidance with AR or VR technologies. MotionMA (Velloso et al., 2013) uses Kinect to analyze and model experts' motion. The result from model analyzer will show the feedback information on screen. YouMove (Anderson et al., 2013) uses AR Mirror to enhance the user's movement training. Posture guides and movement guides are designed to allow users to learn both static and movement gestures. During learning, these Kinect skeleton systems are used to display the differences in movements from the trainer. Chua et al. build a full-body training system in VR environment and create the role of teacher in front of students. And then, students can watch teacher's movements beside the teacher and compared to the movement of themselves'. However, users can not observe their self-motion by first and third person view simultaneously in different perspective.

Another category of related work is research on multiple field of view. With extra normal RGB cameras or even depth cameras, uses' view could be extended in various way such as watching in HMD or the projection in indoor environment. Parallel Eyes developed a paralleled first person view sharing system which consists of multiple video see-through HMD. OutsideMe (Yan et al, 2015) enable dancers see their body movement as external observers through HMD. SpiderVision (Fan et al, 2014) augment a user's awareness of things happening behind one's back also through HMD. However, users can not observe their self-motion by first and third person view simultaneously in different perspective except OutsideMe. But for OutsideMe, users were still affected by the wires which is not familiar to the user while practicing.

SleeveAR (Sousa et al, 2016) is a novel approach to provide real-time, visual feedback, using multiple projection surfaces to provide effectiveness visualizations. Cyber Tai-Chi (Iwaanaguchi et al., 2015) developed CG-based video materials for Tai Chi Chuang self-practice. All the motion data of an instructor's performance which was captured by motion capture system could be displayed on PC monitors, smartphones or in HMD. Practitioners are able to adjust the perspective whatever they want. Using self-image as an auxiliary to help trainees refine their body has been proposed by, and which were both using external self-image as an effective way to improve users' ability in a mixed reality system. But systems of these research mentioned above were not easily portable.

DESIGN

Our system comprises of two augmented visualizations for guiding user body movement: (a) virtual coaches and (b) augmented mirrors. For each design, there are several considerations need to be discussed.

Virtual Coach

We propose surrounded virtual coaches with flying carpet which can accompany with the trainees while they are practicing TCC. With virtual coaches on flying carpets, trainees can not only observe the standard movement through coaches but also easily recognize the foot movement via flying carpets. The flying carpet can move according to the opposite displacement vector of the virtual coaches. However, the placement and the face direction of the virtual coaches is another consideration on physical activity learning due to the different observation perspective, the more different observation perspective trainees can have, the more completed information they can get. Additionally, in some of the TCC motion, trainee need to move around. Therefore, the virtual coaches need to follow the user.

Augmented Mirror

In generally, mirrors are widely used for trainees to observe and revise their motion while practicing physical exercise. To allow the user observe and revise their motion by third person view in see-through HMD, we design an augmented mirror in front of the user. As the virtual coach, the placement of the augmented mirror is an effect need to take into consideration on physical activity learning e.g. while trainee compare their posture in the mirror with the virtual coach.

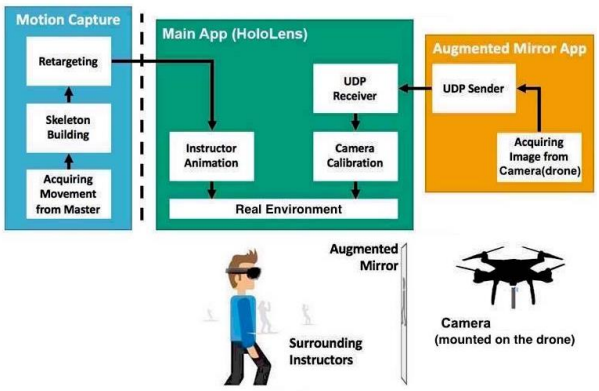

Figure 2. System Overview

SYSTEM OVERVIEW

There are three main parts of our system: Main App running on see through head-mounted display, Motion Capture and Augmented Mirror App, as shown in Figure 2. The purpose of motion capture was to transmit the live performance of TCC master into a digital performance for observing in HMD. We used VICON T160 to capture the skeleton information of TCC Master, and retarget to our virtual coaches. For the core of our system, the main app running on HMD, receives the images from the fisheye camera of the drone through wireless communication. Then an augmented mirror will be generated in front of the user. At the same time, it applies the motion data to the virtual coaches.

CONCLUSION AND FUTURE WORK

We propose a physical activity training system which provide surrounded virtual coach with augmented mirror. The trainee can utilize this system for observation and revise their posture. Additionally, this system can let trainee observe their self-motion by first and third person view simultaneously via see-through HMD and a drone. In the future work, we will enhance the control of the drone that can move the drone to shoot in any direction the user want to or the wrong part of the user's posture and conduct a further user study.

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