APPLY VIRTUAL REALITY TECHNOLOGY IN LEARNING TAI CHI MOVEMENT

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Abstract- Tai Chi exercise is a series of low-intensity mind-body physical activities. It has been known for centuries that regular practice leads to move vigor and flexibility, better balance and mobility, and a sense of well-being. VR is one powerful tool which allow people to go beyond the limitations of physical tools. This paper is going to use a VR program to simulate Tai Chi exercise from Tai Chi master to promote Tai Chi to the younger generation. In this paper the design and interface of VR system are clearly described. Motion capture system and fast Fourier transformation is utilized to get the simulation model of Tai Chi movement.

Keywords- Tai Chi, Pushing-Hands, Virtual Reality, VR Groves, Head Mount Display.

I. INTRODUCTION

Tai Chi exercise is a series of low-intensity mind-body physical activities. It has been known for centuries that regular practice leads to move vigor and flexibility, better balance and mobility, and a sense of well-being [1-4]. Pushing-Hands is a fundamental form of the Tai Chi exercise, easy to learn and it is the gateway for participants to experience the martial aspects of the internal martial arts: leverage, reflex, attention, concentration, movement rhythm, coordination and shifting focus of body balance.

Virtual Reality (VR) [5-6] has been as an idea with us for many decades. However, the technology has now reached its full successful development. A lot of VR devices have been launched and the prices continue to drop. VR allows us to master our environment, to extend our agency and to go beyond the limitations of physical tools through using a headset and motion tracking to let us look around a virtual space as if we are actually there. Nowadays, many sport scientists and coaches apply VR to assist sports training and to analyze sports performance [7].

In 2013, HICPE built a 1st version computer-controlled robot to simulate the Tai Chi movement [8]. The robot arm can repeat the trajectory consistently. As a result, the beginners can follow the movement and learn Tai Chi more easily and efficiently. However, the simulator can only perform one hand fixed step pushing-hands. To cope with the problem, VR technology is one of the promising answers.

In order to promote Tai Chi to the younger generation and to help it flourish in this modern era, a collaboration project between Hanlun Tai Chi Exercise Machines Limited (HTEM), Hong Kong Institute of Vocational Education (IVE) and Macau Polytechnic Institute was initiated in November 2016, to develop a VR robot arm system in learning Pushing-Hands. The 1st version of VR robot arm system built on HTC VIVE was completed in February 2017 and preliminary user experience feedback was obtained.

We will describe our VR Tai Chi System in the next section. Conclusions and recommendations of future research are on the last section.

II. VR TAI CHI SYSTEM DESIGN

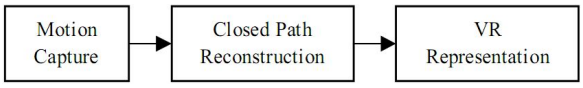

Figure 1. The processes involved in the VR Tai Chi System Development

The development of the VR Tai Chi System involves a three-step process (Fig. 1). The first step involves capturing the master Raymond Chows' Tai Chi Movements. The motion capture system was built based on three kinect devices (Fig. 2). With the assistant of iPi biomech software, time series linear coordinate data of the selected wrist bone was obtained [8-10].

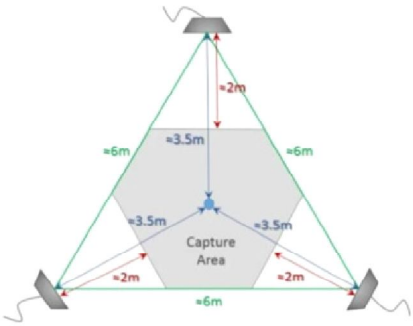

Figure 2. Three kinects setup for the motion capture

In order to program the robot arm to perform the master movement, a closed smooth path was

reconstructed in the second step. Using fast Fourier transformation [11-13], the noisy unrepeatable time-domain movement data was transformed into the frequency domain of which the principal component with its harmonics were selected for backward reconstruction [12-13]. Consequently, the noise is filtered. Finally, data is rescaled to match the same power spectrum average of the original movement.

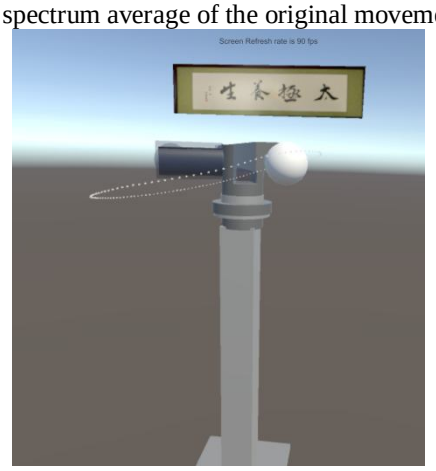

Figure 3. The scene of the VR Tai Chi system

The third step comprises of the virtual environment's presentation. A 3D robot arm model (Fig. 3) was built in Maya and was imported into HTC VIVE SDK scene [14-15]. The movement trajectory was displayed by a series of dot objects placing on data point positions. Using the frame rate as a time control reference, the speed of the robot arm can be synchronized with real time motion for different graphics card speed [14-16]. When holding the wireless controllers, two lighthouse motion sensors mounted on the tripods will track the hand position and rotation accurately, user movement and the virtual controller display in the computer will move simultaneously. With the aid of Haptic Technology, when touching the machine handle, user can sense the vibration generated by the controller. If they follow the Tai Chi motion correctly, the handle will change to red color and the controller will vibrate continuously. To simulate playing Tai Chi exercise in different environment, a laser pointer controlled user interface was designed for selecting different scenes, Tai Chi forms and background music (Fig 4).

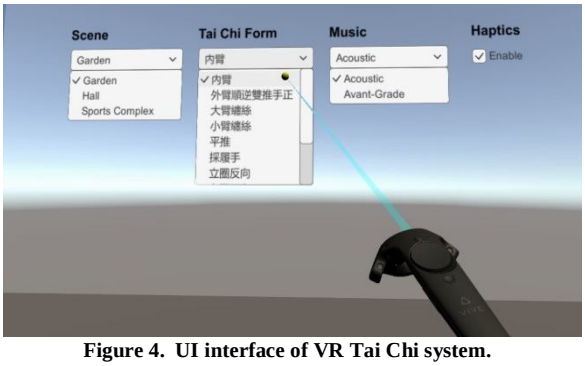

Figure 4. UI interface of VR Tai Chi system.

CONCLUSIONS

In summary, this paper describes a new idea of developing VR Tai Chi system to combine traditional Chinese martial arts exercises with advanced technology. By using motion capture system, the movement path from Tai Chi master is got. For the data analysis, fast Fourier transformation is applied to filter noise and get a smooth path for the VR system. Therefore, the simulation model is achieved by the previous two steps. Finally, by combining the VR interface with simulation model, the whole VR system is achieved.

User must hold the controller to interact with the virtual objects is a big problem in virtual reality. We will change the controllers into a VR gloves to simulate the hand and fingers movement in the future. Also, we will change the wired HMD (head mount display) to a cordless one so that user can move around in the living room in VR.

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