Tai Chi In The Clouds: Using Micro UAVs To Support Tai Chi Practice

Joseph La Delfa

Exertion Games Lab

RMIT University

Melbourne, Australia

joseph@exertiongameslab.org

Robert Jarvis

Exertion Games Lab

RMIT University

Melbourne, Australia

bob@exertiongameslab.org

Rohit Ashok Khot

Exertion Games Lab

RMIT University

Melbourne, Australia

rohit@exertiongameslab.org

Florian 'Floyd' Mueller

Exertion Games Lab

RMIT University

Melbourne, Australia

floyd@exertiongameslab.org

Abstract

Tai Chi uses smooth movement and a focussed state of mind to support mental and physical health. Tai Chi teachers use metaphoric imagery such as "wave hands like clouds" to help students integrate smooth movements with a focussed mind. Current interactive technologies applied to Tai Chi take a very literal approach, focussing on body position and centre of gravity. In contrast, "Tai Chi In The Clouds" is a system which uses micro unmanned aerial vehicles (UAVs) as "clouds" to lead or follow the movements of the hands, giving live feedback on smoothness of movement via LEDs. We used UAVs to aid the experience of living out the metaphoric imagery used in Tai Chi. With our work we aim to contribute to new design language to support movement based, mind-body practices.

CSS concepts

• **Human-centred computing → Human Computer Interaction → Interaction paradigms;**

Author Keywords

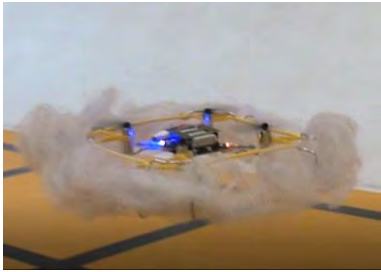Tai Chi; Human Drone Interaction; Whole-body interaction;

Figure 1 The UAV "cloud"

Introduction

Tai Chi is considered an effective activity for mental and physical health. Through smooth movements and a focussed mind, Tai Chi has delivered these benefits for thousands of years [9]. People who practice Tai Chi follow literal instruction and metaphoric imagery. The literal instructions (such as 'keep the knee over the ankle') is used to correct technique. The metaphoric imagery (such as 'wave hands like clouds') is used to help students integrate the body and the mind. The smoothness of the movements are improved by reaching a state of mind where one almost believes their hands are clouds [9].

Current systems that support Tai Chi practice appear to take a very literal approach (e.g.[2,5,10]), using methods such as replicating bodies in virtual space which allow students to compare and correct their own body position. Another approach displays a centre of gravity gauge to correct balance. These approaches leave an opportunity for the incorporation of the rich metaphoric imagery often used in Tai Chi into an interactive experience.

We used UAVs as they can suspend a "cloud" in 3D space (see Figure 2 The UAV "cloud") and can move smoothly. This, propose, leads to a more engaging experience of the metaphoric imagery used in Tai Chi, helping students reach a state of mind where they almost believe their hands are the UAVs (clouds). Current examples of bodily control of UAV's demonstrate innovative ways in which different parts of the body can control a UAV [4][7][6], which when used in the context of Tai Chi, creates an opportunity for unique experiences of integrated mind and body.

"Tai Chi In The Clouds" is a system which uses micro unmanned aerial vehicles (UAVs) as "clouds" to lead or follow the movements of the hands. The clouds react positively to the smoothness of the student's movements via an on-board matrix of LEDs, giving the experience of living out the metaphor of "waving hands like clouds". With our work we aim to contribute to new design language to support movement based, mind-body practices.

Figure 2 Literal Instruction (left) Metaphoric Imagery (right)

Related Works

We learn from four areas of prior work, interactive systems that support Tai Chi practice, Bodily Control of UAVs, Interactive Dance Technologies and Interactive eBike Technology.

Interactive Systems That Support Tai Chi Practice

We first looked to interactive technology that supports Tai Chi practice. "Master Motion" [2] is a full-body virtual reality experience for Tai Chi students. Using a head mounted display and a motion capture system, students can overlay the movements of their digital selves with that of their teachers. Areas of the body that are out of place are highlighted in red. In addition to this, a gauge is shown at the bottom of the display to help students manage their centre of gravity. This work did not focus on the metaphoric imagery given by a Tai Chi instructor which is as important as the literal instruction to realise the benefits of Tai Chi.

"My Tai-Chi Coaches" [5] is an augmented learning tool for practicing Tai Chi, employing a "virtual mirror" created by a circling UAV to project the users body position next to a virtual instructor. Students can compare their body position with their virtual instructor from any angle, without having to turn to face a real instructor who would otherwise be standing at the front of the class. While solving some practical problems of teacher location and orientation when learning Tai Chi, "My Tai-Chi Coaches" only covers the physical position of the body, leaving an opportunity to incorporate metaphoric imagery into future works. To do this, we proposer representing these metaphors in a tangible fashion, which leads us to bodily control of UAVs.

Bodily Control of UAVs

"Bit drones" [4] is an office productivity tool which enables people to display and manipulate spatial information through the handling of 3D pixels that are made from micro UAVs. It demonstrated several innovative interaction methods including "throw", "drag", "follow" and "resize". We believe these actions have great potential in a playful context. As such, we see an opportunity to couple these interaction methods with the metaphors used in Tai Chi.

"Aeroquake" [7] is an augmented dance system that coordinates dance movements with up to four UAVs to amplify the effect of a stomping movement. Dancers can explore creative ways to stomp, inducing a wave pattern of movement by the UAVs. From this we learn that live feedback form UAVs can encourage exploration of movement. However, what we still do not yet know is how to achieve a feeling that the UAVs are not controlled by the person but are a part *of* the person.

To learn more about this feeling we looked at work which assessed the effectiveness of controlling UAVs with the orientation of the pilot's eyes [6]. Participants said they had to "look more carefully" when directing the UAV with their eyes, because wherever they looked at an obstacle, the UAV would go towards that obstacle. Thus we believe that mapping the movement of a UAV to a body movement (such as eye movement, but also arm movement) presents people with an opportunity to focus more effectively on the movement and heighten their awareness of it.

What we learnt from bodily control of UAVs is also implemented in interaction technologies outside of UAVs, we look to those examples to learn how to implement them in a single experience.

Interactive Dance Technologies
Interactive Dance Technologies are systems that aid in the performance and experience of dance. They often translate the metaphorical concepts found in dance choreography to digital media. Concepts such as "painting with the body" are relevant to the movement performed in Tai Chi. The following works demonstrated the ways in which live feedback influenced the dancer's attention between mind and body.

"Towards Bi-Manual 3D Painting" [3] is an immersive system which allows dancers to generate 3D surfaces by using their hands as metaphoric "paint brushes". Initially, dancers were "following the screen" where their dance moves where dictated by the effect it created in the 3D space. After some time, the dancers "lead the screen" focussing inwardly and only checking the screen to see the result of their movements. From this we learn two ways (lead/follow) in which one can interact with a 3D space which offers live feedback, influencing the design a the UAV.

Tai Chi is like dance where the attention is balanced between the mind and the body, where it is important to keep this balance. The "Dance.Draw" [8] system converts choreographed motion to colourful and dynamic lines projected to a large screen, giving the interpretive dancers live feedback on their movements. What we learnt from this system is the need to balance the attention of the dancers between the movement of their bodies and the effects on the screen. When the

screen was overly colourful and dynamic, the dancers would have a lower awareness of their own bodily movements. When the screen was not colourful enough, the live feedback was lost. "Tai Chi in the Clouds" faces the same challenge, an overly animate cloud may distract the student from performing their movements properly, throwing the experience of mind and body out of balance.

Interactive eBike Technology
"Ava, the eBike" [1] uses the position of the rider's body to control the bike's acceleration. The forward position used to accelerate the bike is one that occurs naturally to the rider in the current mode of interaction (cycling). The result of this interaction "fuses the riders body to Ava's", the bike is not controlled by the person but *is* a part *of* the person.

This fusion of bodies might be due to the "natural feedback" loop of the interaction, we look to create a similar feedback loop within our system. In this instance, however, the context of the student is not on a bicycle, but in the air amongst the clouds. Therefore our work attempts to answer the research question: "How do we design interactive technology to support the experience of metaphoric imagery found in Tai Chi?"

The "Tai Chi In The Clouds" System

"Tai Chi In The Clouds" is a system which uses UAVs as "clouds" to mimic the movements of the hands. The clouds react positively to the smoothness of the student's movements via an on-board matrix of LEDs, giving the experience of living out the metaphor of "waving hands like clouds". The system will operate in two modes, Leading Cloud Mode and Following Cloud Mode.

Leading Cloud Mode

In Leading Cloud mode, the clouds are instructed to lead the student as they practice their movements. This is designed to encourage the student to imagine they are amongst the clouds, moving with grace. the speed and position of the student's hands are learned by copying the smooth movements of the UAV. This helps the student reach the feeling that their hands are clouds. The belief in this metaphoric imagery plays a crucial role in integration of the body and the mind. [9]Following the clouds has the added benefits of learning the rhythm and pace of the movements as well as potentially making the adoption of Tai Chi more enjoyable for new students.

Following Cloud Mode

In Following Cloud mode, the clouds are instructed to follow the student as they practice their movements. The clouds track the movement of the student's hands in real time. Over time, the clouds will become brighter, projecting more brilliant and striking animation, but only if the movements are smooth. If the movements are too rough or stop all together, the brightness begins to fade, and the animations recede. This feedback system is designed to focus the user on maintaining the smoothness of a given Tai Chi movement through practice.
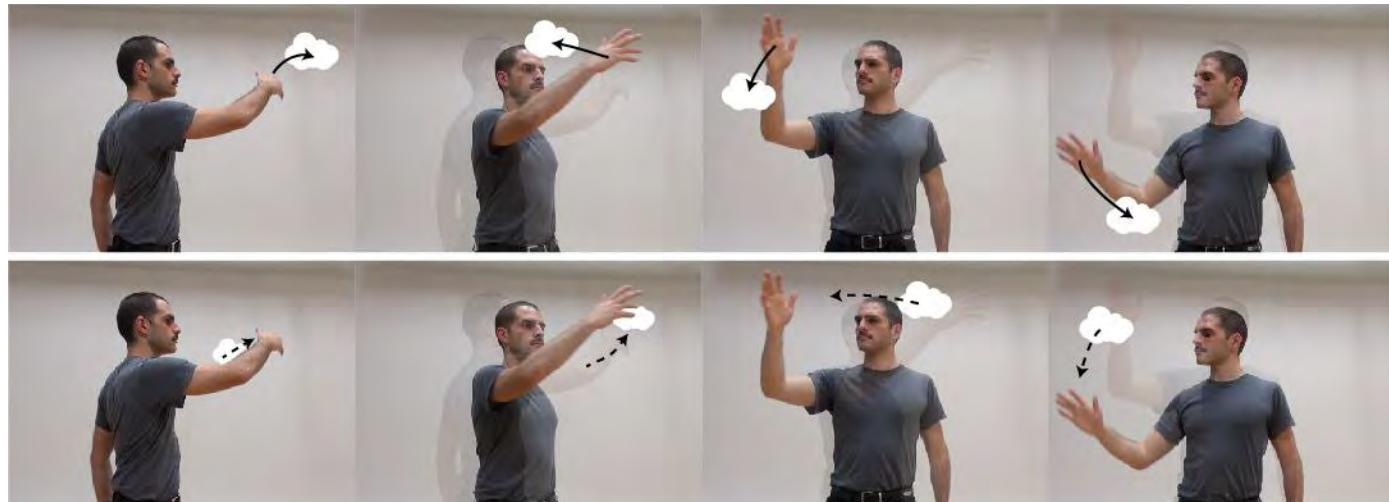

Figure 3 A depiction of the Leading Cloud Mode (Top) and Following Cloud Mode (Bottom)

Proposed Technology

The prototype consists of a Qualysis motion capture system which tracks the body and the UAV clouds. The UAV's are Crazyflie 2.0s that are python scripted.

In Leading Cloud Mode the teacher first performs the movements in 3D space, where the path set by the hands is converted to a flight path for the UAVs. This path is then followed by the students.

In Following Cloud Mode, the path the students' hands take through space are converted to a flight path for the Crazyflie in realtime. The acceleration of the hands will determine the "smoothness" of the movements and therefore the brightness and animation of the LEDs.

Future Work

In future work we will aim to validate the effectiveness of this system at supporting the metaphoric imagery in Tai Chi. We will first incorporate "Tai Chi in the Clouds" into a 30 minute lesson with the help of an experienced Tai Chi instructor.

Then we will recruit 9 participants to attend the lesson. The participants will be in three groups of three, each group will be screened for different levels of previous levels of Tai Chi experience (0 years, 2-3 years and 5+ years). A semi structured interview will focus on uncovering information on the system's potential effectiveness in improving a student's technique, focus and willingness to continue learning. Through the evaluation of these criteria we will be able to determine the system's effectiveness in supporting the experience of metaphoric imagery found in Tai Chi.

Conclusion

The "Tai Chi in the Clouds" system is opening a new domain of Tai Chi where game design and play can contribute. The presented work is an example of how merging metaphoric movements and technology can bring more engaging experiences within Tai Chi and specifically, movement based mind-body practices.

We plan use Tai Chi In the Clouds in a public space to facilitate playful and creative movements. We believe this can bring many health and wellbeing benefits to a broad audience. Ultimately with our work we aim to contribute to new design language to support movement based mind-body practices.

Acknowledgements

References

1.   Josh Andres, Julian De Hoog, Marcus Brazil, Julian Berk, Bach Le, and Xizi Wang. 2016. Exploring Human - eBike Interaction to Support Rider Autonomy. *CHI PLAY Companion '16 Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts Pages 85-92*: 85–92.

2.   Philo Tan Chua, Russ Schaaf, and David Ventura. MasterMotion : Full Body Wireless Virtual Reality for Tai Chi ∗. *2002 in SIGGRAPH Abstracts and Applications*: 214.

3.   Alexis Clay, Jean-christophe Lombardo, Julien Conan, Nadine Couture, and F- Sophia Antipolis.

2004. Towards Bi-Manual 3D Painting : Generating Virtual Shapes with Hands. *SUI'13, July 20–21, 2013, Los Angeles, California, USA. 79-79* 2001: 2001.

4.   Antonio Gomes, Calvin Rubens, Sean Braley, and Roel Vertegaal. BitDrones : Towards Using 3D Nanocopter Displays as Interactive Self-Levitating Programmable Matter. *CHI '16 Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems Pages 770-780*.

5.   Ping-hsuan Han, Yang-sheng Chen, Yilun Zhong, Han-lei Wang, and Yi-ping Hung. 2017. My Tai-Chi Coaches : An Augmented-Learning Tool for Practicing Tai-Chi Chuan. *AH '17 Proceedings of the 8th Augmented Human International Conference Article No. 25*: 3–6.

6.   John Paulin Hansen, Alexandre Alapetite, I Scott Mackenzie, and Emilie Møllenbach. 2014. The Use of Gaze to Control Drones. *ETRA '14 Proceedings of the Symposium on Eye Tracking Research and Applications Pages 27-34*: 27–34.

7.   Heesoon Kim and James A Landay. 2018. Aeroquake : Drone Augmented Dance. *DIS '18 Proceedings of the 2018 Designing Interactive Systems Conference Pages 691-701*: 691–695.

8.   Celine Latulipe and Sybil Huskey. Dance . Draw : Exquisite Interaction. *22nd British HCI Group Annual Conference on HCI 2008: People and Computers XXII: Culture, Creativity, Interaction - Volume 2*: 47–51.

9.   Peter Wayne and Mark L Fuerst. 2013. *Harvard Medical School Guide to Tai Chi*. Shambhala Publications, Boulder Colarado.

10.   Fang-Jing Wu, Chen-Shao Huang, and Yu-Chee Tseng. 2010. My Tai-Chi book. *Proceedings of the 9th ACM/IEEE International Conference on Information Processing in Sensor Networks - IPSN '10* 3, 1: 428.