



Tai Chi Chuan: A Computer Based Trainer for Health and Well Being

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Abstract

This project sets out to study the relationship between the underlying benefits of Tai Chi and Tai Chi teaching by combining computer and motion sensor systems to study teacher and practitioner movements. The research objective is to program the Tai Chi teaching process within a real time computer sensor system, whereby students can learn the main movements that will most likely lead to sustainable health and well being. Multimedia based training and Mathematical algorithms are combined to extract motion features, to study the quality of performance and to provide real time movement feedback using audio and video signals that replace the teacher's suggestions.

Keywords

Tai Chi, Health and Well Being, Elderly and Infirm, Computer Training, Computer interaction, Motion Capture

1. The Benefit Of Tai Chi

Tai Chi is an exercise form comprising a set of movements, which are performed slowly and directed with great attention by the mind of the practitioner. The potential physical and mental health benefits of Tai Chi have been well known in the Far East for thousands of years. The uptake and interest in Tai Chi is rapidly growing in the West as medical research has published a number of specific health benefits particularly relevant to the elderly and infirm.

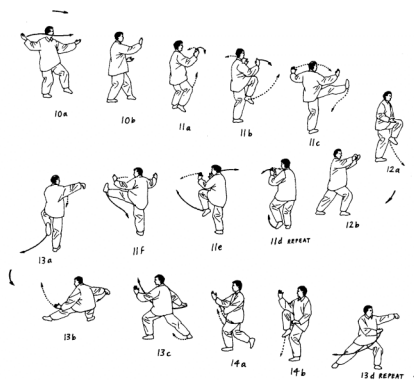


Fig. 1 Example Tai Chi Movements, 24 Yang Style

However, the more widespread uptake is limited as competent teachers are required to ensure that the student is doing the exercise correctly so as to obtain the full benefits of the form. Simply copying the Tai Chi movements on a superficial level is not enough to achieve sustainable health benefits.[1] Tai Chi has been used for hundreds of years to promote health as part of Traditional Chinese Medicine, which studies the flow of "qi", or life force in the body. If "qi" becomes blocked in the body, this can lead to problems with the immune system or can lead

directly to damage to the vital organs [2]. Techniques such as acupuncture directly target blockages while exercises such as Tai Chi aim to massage the body and to encourage the free flow of "qi".



Fig. 2 Measuring motion signals of practitioners

Tai Chi is also a martial art and includes exercises to adhere and reflect forces applied by an adversary. It is therefore quite an active and powerful muscle and balance promoting art, despite its seemingly slow delicate appearance. Above all, Tai Chi combines movement, breathing and visualization. Tai Chi benefits people of all ages, but is particularly useful to people 40 years old and upwards [3]. This is because the exercise acts both on the body and the mind. As people age, they often turn away from exercising due to stressful lifestyles, allowing stress to dominate their lives [4]. Tai Chi tackles balance and muscle tone in the lower body and waist which provides an excellent muscle and posture stimulant for desk bound workers [5]. Studies have shown a 48% reduction in the incidence of falls by the elderly who study Tai Chi [6]. A large amount of research has been directed at the benefits of Tai Chi in reducing falls and in assisting the immune system in combating chronic illness.

2. The Role of the Computer

The research being conducted in connection with this paper attempts to identify the main sources of benefit in doing Tai Chi and also to study what are the "correct" physical movements and mental approach required. This is done by applying computer sensor and processing technology to Tai Chi Teachers and Students and studying their specific differences and the improvements that follow through correct tuition. As Tai Chi comprises a set of for example 24 distinct sub-movements, in order to make a quantifiable assessment of each action within any sub-movement, the movement (one of 24) must first be recognized and then the particular action within that movement can be compared to the ideal one. This is done by using mathematical techniques such as Hidden Markov Method and Principle Component Analysis.

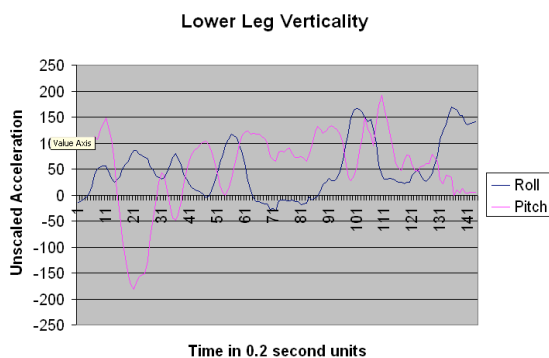


Fig. 3. Accelerometer signals of movements as in Fig 1.

Tai Chi needs to be performed in a relaxed uninhibited fashion. Therefore the project would like to move away from a large number of complex sensors and wires, such as has been used to date, and to use less obstructive and easier ones. To achieve this simplicity, only wireless acceleration sensors will be used to monitor the verticality of relevant limbs such as the thigh and shin, the back and palms. A recording of the lower leg is shown above in Fig. 3, using the sensor in Fig. 4.

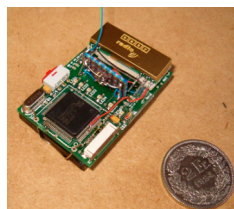


Fig. 4 Wireless Acceleration Sensor and CPU

3. Multi media training

Since a practitioner needs good feedback to learn quickly, the training system must not only identify how well a person is doing but also provide immediate feedback. By using a visual pre-training environment, the student first sees what the exercise comprises. Then as it is performed audio feedback of an abstract musical nature is played; for example in the form of a synchronized Midi file. The music will provide a real time memory aid for the tasks the student must perform. More importantly, the tempo of the music will act as a linear metronome, guiding the student to follow a particular rate of movement, breathing and visualization. This feedback is aimed to enhance and speed up the rate at which all aspects of an exercise are learnt and to reduce the need for time warping the motion data received before applying the detection and assessment algorithms.

The audio feedback will also provide an indication as to whether an action is being performed correctly.



Fig. 5. A simple pattern of notes for musical feedback

4. Demonstration

An interactive prototype system was displayed at the Digital Arts Week in July 2006 in Zurich, where event visitors were

asked to try out the system. Visitors were fitted with a single leg sensor arrangement attached with simple elastic band. The visitor was tasked with repeating a movement, by following first a visual instruction and then by doing the same movement accompanied by music feedback. The waveforms obtained were compared graphically against prerecorded movements of a Tai Chi teacher.

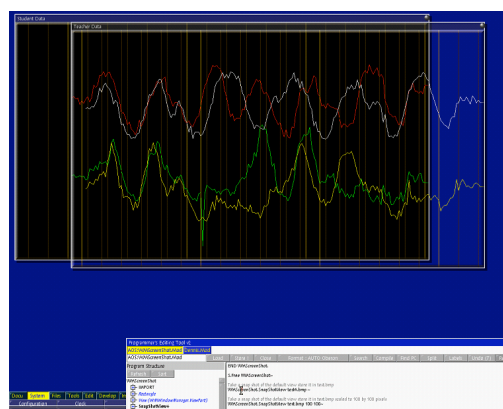


Fig. 6. Accelerometer Waveform Teacher vs. Visitor

5. Conclusion

A new approach is being taken to apply computer motion sensor methods to training and to promoting Health and Well Being. By using low cost wireless sensors and a new approach to visual and audio feedback, Tai Chi movements are likely to be learnt much faster, with more accuracy and with only a computer as the teacher. By accurately measuring the way a student performs a movement, it is expected that the underlying forces that drive the benefit of Tai Chi can be applied in the correct manner leading to sustainable health improvements.

6. REFERENCES

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