WEARABLE KINEMATIC AND PHYSIOLOGICAL BIOFEEDBACK SYSTEM FOR MOVEMENT BASED RELAXATION

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1. Background

Movement and mind control based arts such as Yoga and Tai Chi have been in existence for many centuries. In recent years much experimental evidence and research with a sound scientific basis has emerged to confirm that these arts / therapies have significant effects on the cardiovascular, respiratory and musculoskeletal systems. The main benefits of these ancient therapies include:

1. Promotion of mental and physiological relaxation
2. Enhanced body posture & musculoskeletal function
3. Improved cardiorespiratory function
4. Improved psychological well being & perceived quality of life.

Nowadays yoga has also been used as a therapeutic modality in the treatment of many ailments including chronic pain, cardiac disease, psychiatric disease and epilepsy. This widespread use in medicine and rehabilitation is due to wide evidence base that exists for the physiological and psychological effects of yoga (Tran et al 2001).

2. Proposed System

We are developing an effective feedback system for a human interface to promote mental and physical relaxation. We are designing a garment based physiological and kinematic measurement system in order to investigate therapies such as yoga and Tai Chi.
This system will provide real time measurement of posture, rate of movement, and physiological indicators such as respiratory rate and heart rate. In our biofeedback system an individual can be guided through a series of Yoga or Tai Chi exercises through an interactive computer game and have their performance based on measurement of physical and physiological variables related to the exercises. This system could be used by patients suffering from many conditions including hypertension, anxiety disorder and chronic pain.

3. Methods and Tools

To measure the human body motion we have designed and are now testing a Universal Serial Bus (USB) based unobtrusive kinematic transducer capable of scalable deployment with minimum instrumentation.

The sensor consists of a USB interfaced SMD mounted magnetic field/accelerometer package. The logical topology of the USB standard allows the host to communicate with all devices as if they were connected to the root hub but always maintains an awareness of the physical topology. This gives the ability to have 127 sensors interfaced with any device utilizing a USB host, which is ideal to return kinematic data for a hierarchical description of the body/bodies. Furthermore the backward compatibility of the forthcoming Wireless USB standard will provide wireless motion capture.

4. Test and Results

In a provisional test of our sensor (costs approx €50) it was compared with the line of sight dependant "Coda mpx30" system (costs approx €70,000). In its initial test versus the Coda system, the angle was measured for a simple leg movement of the ankle from the knee joint from vertical to the ground to horizontal. Our sensor was shown to keep on average within +/- 2.9 degrees of the Coda system. This result is expected to be surpassed with further sensor development.

5. Conclusions

The guiding principle in our work is to marry ancient therapies and arts i.e. yoga and Tai Chi with modern multimedia and sensor technology to provide a new virtual environment for enhancement of body and mind.

Development of the sensor on SMD technology makes it miniturizable, inexpensive and ideal for use with motion capture and shows that the utilisation of USB scalability is ideal for wireless kinematic data capture. The next stage of our work will involve development of a movement and physiological signal pattern recognition system in order to integrate the output of our clothing embedded sensors into a computer game.

We feel that this project highlights the value of collaboration between medical and computing expertise in developing novel approaches to exercise science and hope that this work will eventually lead to development of wearable feedback training systems for other exercise therapies such as core stability training.

6. References

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