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Gestural Control of Pervasive Systems using a Wireless Sensor Body Area Network

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Abstract

This paper describes the prototype implementation of a pervasive, wearable gestural input and control system based on a full body-motion-capture system using low-power wireless sensors. Body motion is used to implement a whole body gesture-driven interface to afford control over ambient computing devices.

1 W-BAN BODY GESTURE CAPTURE

Our system is comprised of sensor “nodes” that can be attached to key locations on a user’s body, monitoring the movement of major body parts, detailed technically in [2]. An internal processing system provides us with an updatable skeleton model of the use, which is a method also used by other researchers, e.g. [3]. The posture of the skeleton is calculated in real-time through forward kinematics. Kinematics simplifies computations by decomposing any geometric calculations into rotation and translation transforms. Orientation is obtained by combining (or fusing) these information sources into a rotation matrix – an algebraic format that can be directly applied to find the posture of the user. The result is a simple skeletal model defined as a coarse representation of the user. In general terms, gesture recognition consists of several stages, like feature extraction, pre-processing, analyzing and decision-making. Our experimental method consists of using linear angles between any two links in the skeletal model as a dataset that is fed into the gesture recognition algorithms described below. Analyzing sequences of linear angles and performing the gesture recognition itself was implemented with the help of AMELIA general pattern recognition library [6], which we used as a basis to implement our own customized Hidden Markov Model. Our system allows users to record their own gestures for predefined actions that control the behaviour of ambient computing devices. As such, different actors may use diverse gestures, which can combine multiple body parts moving in different ways, for the same action. Typically, to record one gesture an actor repeats it for 3-4 times, as in [1] [5]. Once a few "recordings" of a gesture have been made, the system is then trained on the captured motion data set in order to be able to recognize the gestures. After training, the user can perform gestures in different sequences as well as performing actions that are not gestures. Our system recognizes gestures with the probability of 80-90% (determined experimentally). Examples of our gesture recognition systems are available to view online in video form[1].

At this point in time, our system has two limitations: Firstly, saving of the recorded gestures training data is not yet implemented (due to development-time constraints) but we consider it as a simple goal. Secondly, our current recognition model does not allow a gesture to stop in the actor's relaxed position. For example, if a user stands still and tries to record a gesture, finishing it at the relaxed posture, the recognition system will not determine when the gesture ends. However, this limitation will be removed in the near future.

2 CONCLUSIONS & FURTHER WORK

Our system is comparable to existing commercial offerings (e.g. XSens, EoBodyHF). These systems use sets of wired sensor packs, connected to a wireless hub, which transmit aggregated data wirelessly using Bluetooth or 802.15.4 respectively. Our system's advantage is that all sensors are wirelessly connected to a coordinator/transmitter node, which allows for improved wearability and flexibility in the configuration of the system, for full or partial body motion capture. We are particularly interested in its potential in mixed reality situations for gaming. We also wish to investigate issues in human-human interaction through embodied agents, controlled

[1] http://www.mucom.mobi/Projects/BodyArea

through the motion capture system. We are looking into the control of VR agents, as well as robotic agents for which the metaphor of “transferring one’s soul” will be used to investigate response and interaction with other humans. Finally, we are interested in pursuing applications in tangible interfaces and semi-virtual artifacts, as well as gesture-based whole-body interaction with large situated displays. We hope to be able to create new types of human-computer interfaces for manipulating program windows, arranging or opening files using ad-hoc large projected or semi-transparent situated displays.

3 REFERENCES

[1] Philip Smit, Peter Barrie, Andreas Komninos. Mirrored Motion: Pervasive Body Motion Capture using Wireless Sensors. Whole Body Interaction Workshop, ACM CHI2009, Boston MA.

[2] Crossan, A., Williamson, J., Brewster, S., Murray-Smith, R., 2008. Wrist rotation for interaction in mobile contexts. In Proceedings of the 10th international conference on Human computer interaction with mobile devices and services. Amsterdam, The Netherlands: ACM, pp. 435-438.

[3] S. Rajko, G. Qian, T. Ingalls and J. James, Real-time Gesture Recognition with Minimal Training Requirements and Online Learning, IEEE Conference on Computer Vision and Pattern Recognition, 2007.

[4] Bodenheimer, B., Rose, C., Pella, J., Rosenthal, S. 1997. The process of motion capture: Dealing with the data. Computer Animation and Simulation. pp. 3-18

[5] AMELIA: A generic library for pattern recognition and generation: http://ame4.hc.asu.edu/amelia/ (link valid 5/09)