Data-Gloves to Capture Motion

Introduction

Human interfacing is a field that has been recently drawing attention. Simplifying the controls of complex systems down to simple human gestures is becoming common practice. Some examples include the Nintendo Wii, which uses the motion of its controller by tracking its position and getting information from its accelerometer. Another is the use of gestures on Apple computers, allowing the automation of tasks based on the gesture used on the trackpad. One of the most desirable forms of control would be to use one's hands alone. This is achievable through data-gloves, which are wearable controllers that read the motion of the user's hands through sensors and in some applications offer feedback to emulate the physical sense of touch. This paper reviews some of the current state of data-gloves and their applications.

Commercial Applications

Motion Capture

A common application for data-gloves is motion capture. Motion capture is the technique used in animation in which human movements are monitored and applied to models in the computer. ShapeHand [1] has developed a data-glove with flexible external sensors that run over the glove in order to capture the movements of hand and finger motion. “ShapeHand's flexible sensors are not physically built into a glove so it can attach to most hand sizes.” The ShapeHand implementation of the data-glove also features an ambidextrous design so as to be worn on either hand. In [2] it is stated that the glove uses 40 sensors for data capture, and is able to interface with other full body motion-capture devices. The ShapeHand is manufactured by Measurand, a company that specializes in various motion capture devices. A wired version typically costs $10,890, while the wireless version costs $13,090, found by emailing the company.

Parkinson's Disease

A novel application for data-gloves has been suggested in [3]. Through the use of three-dimensional electromagnetic sensors, the gloves are able to “capture the motion of the human hand.” In doing so, tremors can be detected in patients with Parkinson's disease. The system uses 11 sensors taking 10 measurements per second, and interprets them through Fourier analysis in order to detect the frequency of the tremors. The system also is able to diagnose patients by analyzing the instantaneous speed of the hand motion.

Virtual Reality

Perhaps the most obvious application for the data-glove is the ability to interact with a virtual world. Currently most existing approaches to recognizing human gestures in a virtual environment use computer vision, but these are very costly and sensitive to the environment [4]. In [4], it was found that using a data-glove with 18 measurement points they were able to in some models receive up to a 100% recognition rate using different test subjects. The paper goes on to say that current VR data-gloves run off of a basic point and grab model rather than gesture based controls.

A current data glove used for virtual reality applications is the 5DT Data Glove [5]. It is a product of VRLOGIC. The current model uses 16 sensors, two per finger as
well as one to measure the abduction between the fingers. The 5DT Data Glove 16 wireless version uses wireless technology to transfer the information rather than being tethered. A data-glove from VRLOGIC costs around $995 for a five sensor model and $5,495 for a 14 sensor model.

**Technology of Data-Gloves**

The fundamental technology behind the data-gloves is mainly the sensors which relay the information on how the hand is responding. The implementation of this concept ranges greatly from data-glove to data-glove. Some sensors such as those in the ShapeHand device are called flex sensors. They work by relaying the information of how far the sensors, which are attached to the fingers, are being bent. From this data it is possible to calculate the angles of the fingers. The problem with this type of sensor is the wear and tear, reducing the lifetime of the sensors.

New research, as in [6] shows that a better implementation through the use of induction is possible. The sensor coils are placed on the phalange of the fingers rather than the joints. This ensures that the quality of measurement will not decrease with time. Another advantage of the induction sensors is that with only five sensors it is possible to measure 10 degrees of freedom.

**Implementing Data-Gloves**

The implementing of data-gloves requires both hardware and software. The hardware is comprised of the sensors which are worn on the hand. The sensors relay angles and distances to a system which processes these signals. Based upon the sensor data the system creates a response. The data-gloves can transmit the data through wires, sometimes call tethered gloves, but recently wireless models are becoming more common.

The 5DT Data Glove is implemented using a 12-bit A/D converter from the sensors to the system [7]. They are connected and powered via USB or bluetooth and wireless and a battery pack, and sample at 75Hz. The Flex sensors are implemented with fiber optics.


[3] 3-D motion system ("data-gloves"): application for Parkinson's disease
Yu Su; Allen, C.R.; Geng, D.; Burn, D.; Brechany, U.; Bell, G.D.; Rowland, R.;
Instrumentation and Measurement, IEEE Transactions on
Volume 52, Issue 3, June 2003 Page(s):662 - 674


[6] Development of a data glove with reducing sensors based on magnetic induction
Chin-Shyung Fahn; Herman Sun;
Industrial Electronics, IEEE Transactions on
Volume 52, Issue 2, April 2005 Page(s):585 - 594