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The AcceleGlove: A Whole-Hand Input Device for Virtual Reality

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Abstract.

We present The AcceleGlove, a novel whole-hand input device to manipulate three different virtual objects: a virtual hand, icons on a virtual desktop and a virtual keyboard using the 26 postures of the American Sign Language (ASL) alphabet.

1 Introduction.

The AcceleGlove is a set of six dual-axis accelerometers, mounted on the fingers and the back of the palm, that report position with respect to the gravitational vector. Sensors are placed on the back of the middle phalanges, on the back of the distal phalange of the thumb, and on the back of the palm [**figure 1**]. To determine postures using this arrangement, we tested the 26 letters of the ASL alphabet until ambiguity was eliminated.

Figure 1
The AcceleGlove

Capacitive sensors distributed along two orthogonal axes (X and Y), inside the accelerometer, provide a measurement proportional to the displacement of a mass, suspended by springs, with respect to its rest position. Because the mass is displaced from the center, either due to acceleration or due to an inclination with respect to the gravitational vector, the sensor can be used to measure absolute angular position.

The Y-axis points towards the fingertip, and the X-axis measures hand roll or individual finger abduction when finger is in the vertical position.

Gloves like the CyberGlove and DataGlove have the disadvantage that readings change depending on how well it fits user's hand then, hand size is considered a source of noise. Since the AcceleGlove is not a complete glove, but a set of rings, hand size is not a source of error; hand thickness may affect interpretation of hand shape in some extreme cases, though. For example, when closing the fist, thin fingers are able to bend the joints up to 90° but thick fingers are not, so an 'a' in ASL could be miss classified as an 'o'.

2 Applications.

The CyberGlove, the DataGlove, the Dexterous Hand Master (DHM), and the PowerGlove, report only hand shape (finger flexion) [Sturman 1992]. The AcceleGlove provides hand posture, composed of hand shape and hand orientation as a 12-byte vector, at 9600 bits per second. Next, we present three virtual objects to show potential applications of the AcceleGlove.

2.1 Virtual Fingers

In general, only the thumb is able to move independently of the other fingers; the ability is gradually lost from the index to the pinkie. To track individual finger flexion, the AcceleGlove is connected to drive a virtual hand we have developed. The algorithm maps finger position into virtual finger bending. **Figure 2** shows a lateral view of a virtual hand with fingers partially bent.

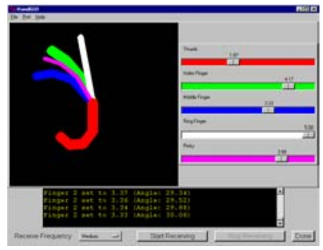

Figure 2 Virtual Hand

2.2 Grasp-and-Drop

To give a more intuitive interface between the user and a desktop PC, the AcceleGlove is used as a substitute for the mouse. The micro controller maps two hand shapes (closed fist or 'grasp' and open hand or 'drop') and Pitch and Roll of the hand into button 'clicks' and velocity control using the Microsoft-mouse format, so no especial hardware or driver is required to perform click-drag-drop operations.

2.3 Virtual ASL Keyboard.

Our third and more-complex application is a virtual keyboard controlled by ASL alphabet postures. It is used to practice or to learn the finger spelling technique. The user performs the hand posture wearing the AcceleGlove and, after our hierarchical, multi-class posture recognition algorithm solves for the letter, the key on the virtual keyboard is activated and the picture of the corresponding letter is shown.

The algorithm extracts a set of features that represents a posture (hand shape, palm orientation) unambiguously in "posture space." Hand shape is represented by overall finger flexion and overall finger roll. Palm orientation is given by pitch of the sixth sensor. With these three features, patterns are visualized as clusters in a 3-dimensional posture space. To our knowledge, this is a novel approach to ASL alphabet recognition. The GUI is shown in **figure 3** with letter 'L' displayed at the left.

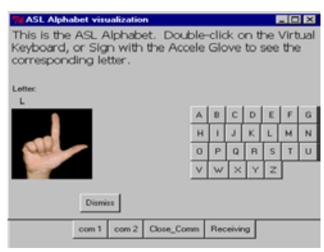

Figure 3 ASL Keyboard

References

STURMAN, D. J. 1992. *Whole-Hand Input.* PhD. Thesis, Media Lab, MIT, Cambridge, Mass.