Head Mounted Accelerometers in the Control of a Video Cursor

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Background

Spinal disabled persons often have limited movement capability in lower and upper extremities but some cerebral innervated muscles are still intact to move the head. It is therefore obvious to use head movements for man - machine control. In this paper a head mounted triaxial accelerometer, is used as an input device to control a video cursor in interactive software applications. Two transducer mechanisms of piezo-resistive accelerometers are available to calculate cursor position from the accelerometric signal: double integration and inclination in the gravity field. The first mechanism is considered in this study.

Realization

To use accelerometers for full cursor control three basic functions have to be realized, (1) - get the zero position of the cursor before movement, (2) - move the cursor from one position to an arbitrary position on the screen and (3) - perform a prompt to do an action in the software. Zero position (1) was obtained by a twitch-like turning of the head in the horizontal axis. Peak acceleration is used to discriminate between functions 1 and 2. For cursor movement (2) the accelerometric signal is continuously integrated two times to calculate velocity and distance. Both distance and velocity are used to calculate the cursor trajectory. Prompt (3) was obtained in the same way as (1) but with turning the head in vertical axis.

Miniature triaxial accelerometers were used in this study (Type EGAX-5, Entran Inc., France). Cursor positioning software was implemented in „C“ on a laptop (Toshiba T 3100 SX) with an integrated 12-bit A/D-card (TADA, IBP Inc., BRD).

Results and Conclusions

The results had been obtained on non disabled. As in contrast to the hand the head has considerable mass and head movement further acts as an input to the vestibulo-ocular system, the display gain (ratio of head movement to cursor movement) should be less than 0,5. If the values become smaller than 0,1 cursor position control becomes less accurate due to some tremors and the integration drift. Peak acceleration for discrimination between smooth cursor movement (2) and functions (1) and (3) was found optimal in the range between 0,5 and 2 g.

This study also shows that a twoaxial accelerometer (x and y-axis of the triaxial sensor) will be sufficient to realize the three basic functions, as fore and back movements (z-axis of the sensor) of the head are unphysiological. A disadvantage is the cable supporting the sensor. By the use of micro-machined sensor technology realization of a telemetric wireless sensor will be possible in near future. In combination with a speech recognition system the keyboard and the mouse of a traditional computer system may be totally replaced by contactless head functions.