Based Human-Computer Interaction Technique

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1. INTRODUCTION

The new and fastest technique to interact with computer is the interaction through eye. Current user-computer dialogues tend to be one sided, with the bandwidth from the computer to the user for greater than that from user to computer. A fast and effortless mode of communication from a user to a computer would help this imbalance. So therefore the possibility of introducing the movements of a user's eyes as an additional input medium is introduced. While the technology for measuring eye movements and reporting them in real time has been improving, what is needed is appropriate interaction techniques that incorporate eye movements into the user-computer dialogue in a convenient and natural way

2. PERSPECTIVES ON EYE MOVEMENT-BASED INTERACTION

As with other areas of user interface design, considerable leverage can be obtained by drawing analogies that use people's already-existing skills for operating in the natural environment and searching for ways to apply them to communicating with a computer. Direct manipulation interfaces have enjoyed great success, particularly with novice users, largely because they draw on analogies to existing human skills such as pointing, grabbing, moving objects in physical space, rather than trained behaviors; and virtual realities offer the promise of usefully exploiting peoples existing physical navigation and manipulation abilities. These notions are more difficult to extend to eye movement-based interaction, since few objects in the real world respond to people's eye movements.

3. CHARACTERISTICS OF EYE MOVEMENTS

In order to proceed with the design of effective eye movement-based human-computer interaction, we must first examine the characteristics of natural eye movements, with emphasis on those likely to be viewed by a user in front of a conventional that is non-eye tracking computer console.

The Eye

The retina of the eye is not uniform. Rather, one small portion near its center contains many densely-packed receptors and thus permits sharp vision, while the rest of the retina permits only much blurrier vision. That central portion that is the fovea covers a field of view approximately one degree in diameter which is the width of one word in a book held at normal reading distance or slightly less than the width of your thumb held at the end of your extended arm. Anything outside that area is seen only with ‘‘peripheral vision,’’ with 15 to 50 percent of the acuity of the fovea. It follows that, to see an object clearly, it is necessary to move the eye so that the object appears on the fovea.

4. METHODS FOR MEASURING EYE MOVEMENTS

Human eye movements can be grouped into several categories.

• First, the principal method for moving the fovea to view a different portion of the visual scene is a sudden and rapid motion called a *saccade.* Saccades take approximately 30-120 milliseconds and traverse a range between 1 and 40 degrees of visual angle (15-20 degrees being most typical). Saccades are ballistic, that is, once begun, their trajectory and destination cannot be altered. Vision is suppressed (but not entirely prevented) during a saccade. There is a 100-300 ms. delay between the onset of a stimulus that might attract a saccade (e.g., an object appearing in peripheral vision) and the saccade itself.

• During a fixation, the eye does not remain still. Several types of small, jittery motions occur, generally less than one degree in size. There is a sequence of a slow drift followed by a sudden, tiny saccade-like jump to correct the effect of the drift (a microsaccade). Superimposed on these is a high-frequency tremor, like the noise seen in an imperfect servomechanism attempting to hold a fixed position.

• Another type of eye movement occurs only in response to a moving object in the visual field. This is a pursuit motion, much slower than a saccade and in synchrony with the moving object being viewed.

• Yet another type of movement, called *nystagmus,* can occur in response to motions of the head. This is a pattern of smooth motion to follow an object (as the head motion causes it to move across the visual field), followed by a rapid motion in the opposite direction to select another object (as the original object moves too far away to keep in view).

5. METHODS FOR MEASURING EYE MOVEMENTS

What to Measure

For human-computer dialogues, we wish to measure *visual line of gaze,* rather than simply the position of the eye in space or the relative motion of the eye within the head. Visual line of gaze is a line radiating forward in space from the eye; the user is looking at something along that line. To illustrate the difference, suppose an eye-tracking instrument detected a small lateral motion of the pupil. It could mean either that the user’s head moved in space (and his or her eye is still looking at nearly the same point) or that the eye rotated with respect to the head (causing a large change in where the eye is looking). We need to measure where the eye is pointing in space; not all eye tracking techniques do this.

Electronic Methods

The simplest eye tracking technique is electronic recording, using electrodes placed on the skin around the eye to measure changes in the orientation of the potential difference that exists between the cornea and the retina.

However, this method is more useful for measuring relative eye movements i.e., AC electrode measurements than absolute position which requires DC measurements. It can cover a wide range of eye movements, but gives poor accuracy particularly in absolute position. It is principally useful for diagnosing neurological problems revealed by eye movement patterns. Further details on this and the other eye tracking methods discussed here can be found in.

Mechanical Methods

Perhaps the least user-friendly approach uses a non-slipping contact lens ground to fit precisely over the corneal bulge. A slight suction is applied between the lens and the eye to hold it in place. The contact lens then has either a small mechanical lever, magnetic coil, or mirror attached for tracking. This method is extremely accurate, particularly for investigation of tiny eye movements. It is very awkward and uncomfortable, covers only a limited range, and interferes with blinking.

Optical/Video Methods – Single Point

More practical methods use remote imaging of some visible feature located on the eye, such as the boundary between the sclera white portion of the front of the eye and iris i.e. colored portion–this boundary is only partially visible at any one time, the outline of the pupil works best for subjects with light-colored eyes or else the pupil can be illuminated so it appears lighter than the iris regardless of eye color, or the reflection off the front of the cornea of a collimated light beam shone at the eye. Any of these can then be used with photographic or video recording for retrospective analysis or with real-time video processing.

Optical/Video Methods – Two Point

However, by simultaneously tracking two features of the eye that move differentially with respect to one another as the line of gaze changes, it is possible to distinguish head movements the two features move together from eye movements the two move with respect to one another. The head no longer need be rigidly fixed, although it must stay within camera range which is quite small, due to the extreme telephoto lens required. Both the corneal reflection from the light shining on the eye *and* outline of the pupil illuminated by the same light are tracked.

Conclusion

We have reviewed the progress of using eye tracking in human–computer interaction both retrospectively, for usability engineering and in real time, as a control medium within a Human–computer dialogue. We primarily discussed these two areas separately, but we also showed that they share the same principal challenges with eye tracking technology and interpretation of the resulting data. These two areas intersect in software applications where fixations are both recorded for analysis and the display is changed contingent on the locus of a user's fixation.