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Cardinal: An eye-gesture based communication system

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Cardinal:

An Eye-Gesture Based Communication System

BACKGROUND:

Existing eye-tracking communication systems predominantly rely on a dwell-based approach by which users convey choices by foveating on-screen targets. This approach is used widely in experimental and commercial software, including many programs developed for the MyTobii platform. It is also found in some analog systems, such as alphabet boards. However, dwell-based approaches present some problems with accuracy and eye fatigue (Mackenzie 2012). Anecdotal reports collected by our group further indicate that dwell based approaches may contribute to eye fatigue and inhibit the formation of eye-contact, a socially important component of the conversation dynamic.

However, gesture-based eye-tracking systems present their own challenges. Such systems often seek to use eye gestures that mimic or replicate the shapes of letters (EyeWriter 2013; Porta et al. 2008), and the complexity of these gestures results in a low level of accuracy and precision. Furthermore, the lengthy and exact nature of these gestures also contribute to eye fatigue (Møllenbach et al. 2010: 178)

We have developed Cardinal, a prototype that demonstrates a gesture based system of communication for users with limited speech and motor control. Language characters are represented by a series of Huffman-coded, cardinal direction eye gestures that reduce the exactness required of the user, and minimize the effort required to choose high-frequency characters. We have user-tested Cardinal on the MyTobii system both with screen-based prompts, and with the screen covered by a mirror, in an attempt to discourage on-screen dwelling, and to promote eye contact.

FACE-TO-FACE:

We have created a set of 32 eye gestures corresponding to the most common 95% of characters used in conversational typing. The coded characters were determined through analysis of five blog posts and accompanying comments on blog sites with distinct subject foci and readerships (Tom and Lorenzo, Huffington Post, Jezebel, Nature, and Fox News). An average of 19185 characters were analyzed for each website.

To reduce eye fatigue and the need for gestural accuracy and precision, we have chosen to restrict the required movements to straight lines in the cardinal directions (north, south, east and west). Each gesture is therefore a composite of multiple, straight-line, cardinal 'strokes'.

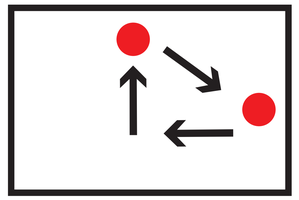
To further reduce eye fatigue as well as the time required to 'type' words and phrases, we have used a Huffman coding approach when creating our gesture set. This approach allows for the generation of a variable-length code, where the path length of each character code is dependent on the selection frequency of the source character. A major feature of Huffman coding is the prefix code, which allows for minimal code lengths while also minimizing the potential for errors. In our case, the strokes that compose one entire gesture will never be found at the beginning of another gesture.

Face-to-face conversation.

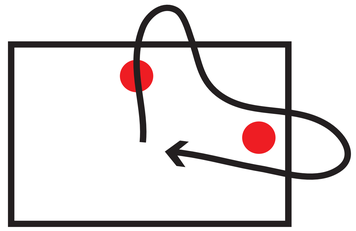
AAC Device obstructing face-to-face conversation.

GESTURE:

A combination of gestures based on Huffman coding allows for an efficient use of gestures to recreate conversational spelling.



Gaze requires the user to identify, locate and pause their eyes on a target.



Gestures requires the user to glance towards a target to trigger it.

Rather than identifying a button or target and then directing one's gaze at it, a user simply needs to glance towards a target, thereby reducing both eye strain and the cognitive strain of needing to visually process the target's content.

North / South	**= e**
North / North	**= t**
North / East	**= a**
West / East	**= o**
West / West	**= i**
West / South	**= n**
East / West	**= s**
East / East	**= r**
East / North	**= h**

Once trained on how a sequence of glances can be used for a task like spelling, the screen could be dispensed with entirely. The AAC user can return their gaze to their conversation partner's face, enhancing clarity and personal contact.

SWIPE:

It has been widely noted that the dwell- or blink-based inputs of conventional eyetracking systems may be seen as analogous to the click of a computer mouse (Dorr et al. 2007, FRS Custom Solutions 2013, Hansen et al. 2003, Mackenzie et al. 2010, Mackenzie et al. 2012).

However, the 'swipe' approach has become an increasingly popular strategy for executing on-screen actions (for example, on the OSX, iOS and Android platforms). We are seeking to take advantage of the parallel analogy between eye gesture and swiping, in order to develop a system that will be readily compatible with mobile devices. Future work on this project will involve the adaptation of our script for use on iOS or Android platforms.

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