A Camera-based Eyebrow Tracker for Computer Control via a Binary Switch

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Extended Abstract

We created the *Eyebrow-Clicker*, a camera-based human computer interface system for hands-free computer control. The *Eyebrow-Clicker* detects and tracks the user's eyes and eyebrows. When the user raises his eyebrows, the *Eyebrow-Clicker* issues a mouse click and thereby sends a selection command to the computer.

The *Eyebrow-Clicker*'s selection functionality can be found in other modern switch technologies. An advantage of our switch is the lack of special or intrusive devices, such as electrodes or a suck-blow straw. The only equipment needed is a video camera, which can be discreetly placed away from the user. Other advantages of the *Eyebrow-Clicker* are its self-initializing and self-correcting properties. The system functions in real-time on a Microsoft Windows NT workstation and uses a Sony EVI-D30 color video CCD camera with a Matrox capture card.

The *Eyebrow-Clicker* continues a long line of projects designed to better aid humans and their computers to communicate more effectively and intelligently. Here we can only mention a few camera-based projects, for example, [1, 2, 3]. Black and Yacoob describe a system that uses facial tracking and cues from motions of features, including eyebrows, to determine the user's emotional state [2]. In our group, a mouse replacement system for people with severe disabilities was developed that tracks body features [1]. Another system was designed to detect prolonged blinks as a means of making selections [3].

The *Eyebrow-Clicker* begins with searching for the user's eyes. If the user does not move except for blinking his or her eyes, image differencing can be used to detect the location of the eyes. Once the eyes are isolated, the eyebrows are found located directly above the eyes. Next, for each subsequent frame, the eyes and eyebrows are relocated. If they cannot be found, the tracker is restarted. Otherwise, the distance between the eyes and eyebrows is measured. If it has grown, then the user has raised his eyebrows, as shown in Figure 1,

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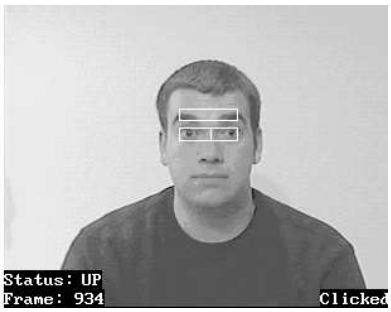

Figure 1: A user of the *Eyebrow-Clicker* in the middle of a click.

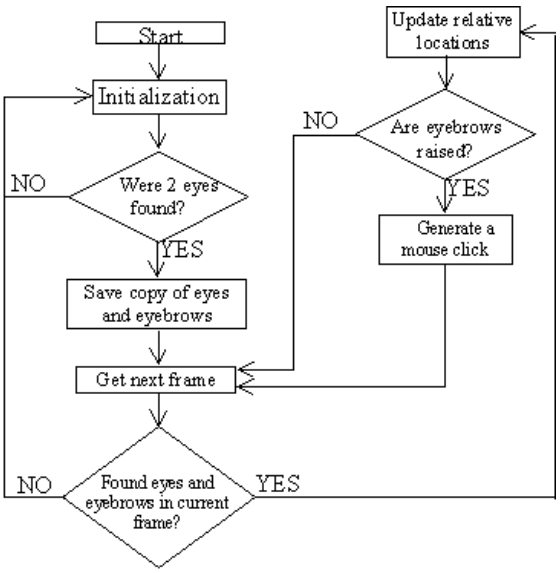

Figure 2: Flowchart of the Eyebrow-Clicker algorithm.

and a simulated mouse click is sent to the computer. Figure 2 shows a flowchart of the algorithm. Five subjects tested the system. The system successfully determined 93% of the time when a user attempted to issue a mouse-click using his or her eyebrows.

References

[1] M. Betke, J. Gips, and P. Fleming. The Camera Mouse: Visual tracking of body features to provide computer access for people with severe disabilities. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 10(1):1–10, March 2002.

[2] M. J. Black and Y. Yacoob. Tracking and recognizing rigid and non-rigid facial motions using local parametric models of image motions. In *Proceedings of the Fifth International Conference on Computer Vision*, pages 374–381, Cambridge, Massachusetts, June 1995.

[3] K. Grauman, M. Betke, J. Gips, and G. R. Bradski. Communication via eye blinks - detection and duration analysis in real time. In *Proceedings of the IEEE Computer Vision and Pattern Recognition Conference*, Kauai, Hawaii, December 2001. IEEE Computer Society.