Control of Augmented Reality Information Volume by Glabellar Fader

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ABSTRACT

In this paper, we propose a device for controlling the volume of augmented reality information by the glabellar movement. Our purpose is to avoid increasing the sum of the amount of information during the perception of "Real Space +Augmented Reality" by an intuitive and seamless control. For this, we focused on the movement of the glabella (between the eyebrows) when the user stare at objects as a trigger of information presentation. The system detects the movement of the eyebrows by the amount of the light reflected by a photo-reflector, and controlling information volume or the transparency of objects in augmented reality space.

Categories and Subject Descriptors

B.4.2 [**Input/Output Devices**]: Channels and controllers; H.3.3 [**Information Search and Retrieval**]: Information filtering; H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities;

General Terms

Human Factors

Keyword

glabellar, photo reflector, information volume

1. INTRODUCTION

The term AR refers both to the technique of superimposing virtual information on real-world visual information and to the resulting visual state. In the realm of mixed reality (MR) formed by this combination of real and virtual information, the volume of information presented is inherently greater than in the ordinary visual realm, and this has raised concerns that the dramatic increase in information volume may impede awareness of the real-world environment.

This has led us to the concept of an information volume fader, analogous to sound volume faders in music production mixers, for fading in and out the information volume in the AR presentation. In this concept, a "reality mixer" enables seamless fade-in and fade-out of AR information superposed on a real-world presentation. It may also enable smooth crossfade and linking of different virtual worlds. The operating interface is hands-free, enabling control while both hands are being used for other purposes. Both arbitrary and intentional control of presented information is desirable, for natural operation.

We have applied this concept to development of the "FAR Vision" ("Fader of Augmented Reality Vision") interface for controlling the volume of the AR information added to presentations. The fader operation is controlled by glabellar movement[1]. Experimental trials have been performed to verify the accuracy of glabellar movement detection and optimize detection points, as two prerequisites for intuitive, seamless control of the presentation.

2. RELATED WORK

One information-adding system which is currently distributed as an iPhone application program is the "Sekai Camera"[2].it enables on-screen perusal of added information, referred to as an "Air Tag", relating to the geographical location of the camera the user is holding. Users can also upload information to the system. Since its introduction, however, the Air Tags in some locations have quickly become so voluminous that they impede real-space observation. Restriction of consumer-generated media (CGM) is undesirable, and yet its voluminous on-screen addition can make it difficult to observe not only the real-space view but also the added information itself, and may ultimately cause an aversion to using the application.

A method of added-information display discrimination or information volume control is necessary, to avoid this problem. In one type of discrimination, only information of interest to the user is added. The Sekai Camera system performs this type of discrimination based on the direction in which the iPhone is pointed. This method is effective in concept, but has been found lacking in intuitive feel and on-demand response. As it requires holding and pointing, moreover, it is rather unsuitable for use during work and other activities involving use of the hands. Head-mounted displays (HMDs) can provide a continuous "hands-free" view of added information while worn, but in their present configuration require temporary removal to turn off the added-information display.

Augmented Human Conference, April 2–3, 2010, Megève, France.

The Sekai Camera system provides one type of added-information volume control named "Air Filter", in the form of a slider that filters out certain information based on dates, distances, and other parameters but includes no capability for dynamic information-depth control.

Various studies have been reported on the control of added-information "volume" in AR. In one such study, Tenmoku et al. discussed information volume control and performed on-screen highlighting in accordance with distance[3]. The methods described in this study, however, are not applicable to systems, such as Sekai Camera, in which the added information is concentrated within a specific domain, and means of turning the information addition off and on are not discussed.

3. SYSTEM

In the system proposed herein, the depth and permeability of the AR information is controlled in a stepwise manner by the fader, which is operated by changing the glabellar inclination. In the absence of any applied inclination, or "brow knitting", mapping is performed for added-information exclusion. When the user "peers", the accompanying change in glabellar inclination results in a "paranormal" effect, in which the AR comes into view. The glabellar movement, unlike that of the iris, can be either intentional or unconscious. The name of the system, "FAR Vision", was accordingly chosen to connote both "far vision" and "Fader of AR Vision", and thus convey its mixed-reality (MR) effect, a mixing of real-world and AR-world imagery.

A photo-reflector (Rohm RPR-220) is used to detect the glabellar movement and thus exact its control of the fader, and may be attached to spectacles, an HMD, or other such devices. The skin surface of the glabella is illuminated by infrared light (IR) and changes in the reflected IR intensity are monitored with an IR sensor, for non-contact detection of glabellar movement.

An analogous device has been reported for detection of temporal movement[4], but is inherently limited to conscious operation by the nature of temple movement. The glabella-based detection, in contrast, enables operation based on unconscious emotional response as well as conscious intention.

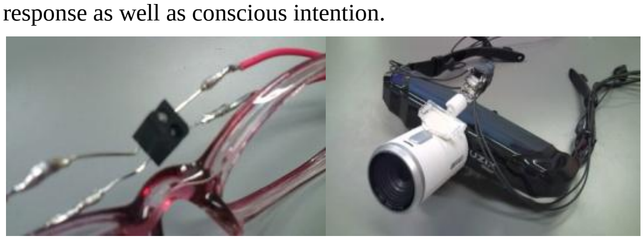

Fig. 1. Glabellar fader on spectacles and on HMD.

4. EXPERIMENT

For the proposed system it is essential to establish the detection accuracy and detection target position, to heighten the level of intuitive, seamless operation of the glabellar fader. We therefore investigated the "width", as defined below, between fader output values at multiple detection points on the glabella of seven participants.

For each subject, the measurements were performed at ten points in 2 mm intervals in one direction along a horizontal baseline extending between the inner tips of the eyebrows, beginning with the center of the baseline as 0 mm. With the device held stationary by hand, three measurement sets were performed at each measurement point for each subject, with each set consisting of measurement with the eyebrows relaxed, then fully knit, and then again relaxed. The maximum and minimum output values in each set were selected, and from among these, the largest and smallest values were taken as the "largest maximum output" and "smallest minimum output", respectively. The difference between these two output values was defined as the "output width" for that subject.

5. RESULTS AND DISCUSSION

Table 1. Experimental results:

Subject	A	B	C	D	E	F	G
(a)	14	16	14	16	14	16	18
(b)	49	89	32	32	71	26	80
(c)	18	30	13	26	23	10	29
(d)	2.72	2.97	2.46	1.23	3.09	2.60	2.76

(a) point of maximum output width, in mm from 0-mm centerline; (b) output width at point (a); (c) output width at centerline; (d) ratio between (b) and (c)

As shown in Table. 1, for the seven participants in this experiment, the output width was generally largest in the region between 14 and 18 mm from the centerline. Some differences were found among the subjects in relation to distance from the centerline and maximum output width, but for most of the subjects the output width was uniformly small throughout the region from near the centerline up to the point just before the 14- to 18-mm region where it tended to exhibit the maximum values, as shown for Subject A in Fig. 2.

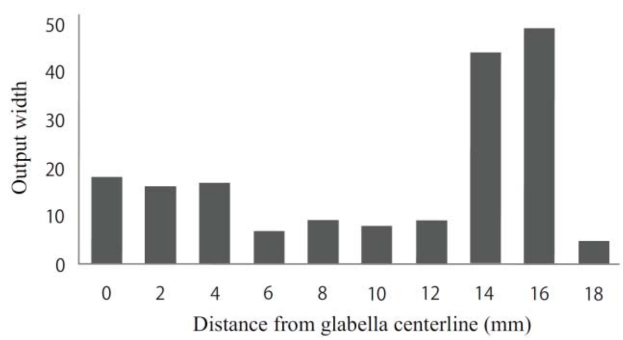

Fig. 2. Glabellar output widths found for Subject A.

These results may be attributed to a characteristic feature of glabellar skin movement. When the brow is knit, the central region tends to protrude and a crease forms near the inner tip of each eyebrow. The skin movement is far more pronounced in the regions near the eyebrow tips than in the central region, presumably resulting in a greater change in reflection intensity and thus in a greater output width in those regions.

Variation was also found in the number of distinguishable output steps that could be detected in the output width, but as shown in Fig. 1, the number was at least 26 and ranged up to 89, and was generally at least twice as large as the number of detectable steps in the central region. In terms of information volume percentage, one step corresponds with 1.15 to 4% of total information volume. This is considered quite sufficient for control of information volume as envisioned for the proposed system, even though the requirements will naturally vary with the image and display conditions. It should therefore be possible to obtain comparatively seamless information volume control, using detection points just to the side of the eyebrow tip, 14 to 18 mm from the glabellar centerline.

6. CURRENT AND FUTURE OUTLOOK

Current plans call for experimental evaluations directed toward improving operating ease and mapping of the subjective degree of eyebrow knitting of individuals to display content and enabling more intuitive operation. Development efforts are also envisioned for other interfaces and systems centering on information volume control.

7. REFERENCES

[1] Hiromi Nakamura, Homei Miyashita. A Glabellar Interface for Presentation of Augmented Reality, Proceedings of Entertainment Computing 2009 (in Japanese), pp.187-188 2009.

[2] Sekai Camera: http://support.sekaicamera.com/en

[3] Ryuhei Tenmoku, Masayuki Kanbara, N. Yokoya. Intuitive annotation of user-viewed objects for wearable AR systems, Proceedings of IEEE, International Symposium on Wearable Computers'05, pp. 200-201, 2005.

[4] Kazuhiro Taniguchi, Atsushi Nishikawa, Seiichiro Kawanishi, Fumio Miyazaki "KOMEKAMI switch:A novel wearable input device using movement of temple, "Journal of Robotics and Mechatronics, Vol.20, No.2 , pp. 260 -272 , 2008.