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A method for gaze correction between video conference participants that synthesizes eye areas image within the perceptual range of eye contact

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Yasutomo KAWANISHI*, Daisuke DEGUCHI*, Ichiro IDE*, Hiroshi MURASE*, Takayuki

KUROZUMI *** , and Kunio KASHINO***

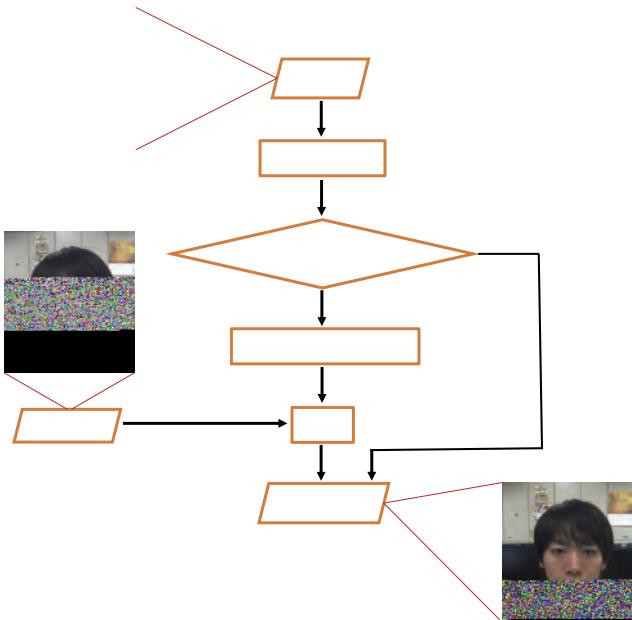
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Abstract Recently, the spread of Web cameras has facilitated video-conferencing. Since a Web camera is usually located outside the display while the user looks at his/her partner in it, there is a problem that they cannot establish eye contact with each other. Many researchers have proposed methods to solve this problem, but most of them required specific sensors. We proposed a method which uses only one camera and transforms the user's eye areas in an image to his/her eye image with a straight gaze to the camera only when the user's gaze falls in a range that the partner would perceive eye contact, which is called perceptual range of eye contact.

Key words Video conferencing, eye-contact, gaze classification



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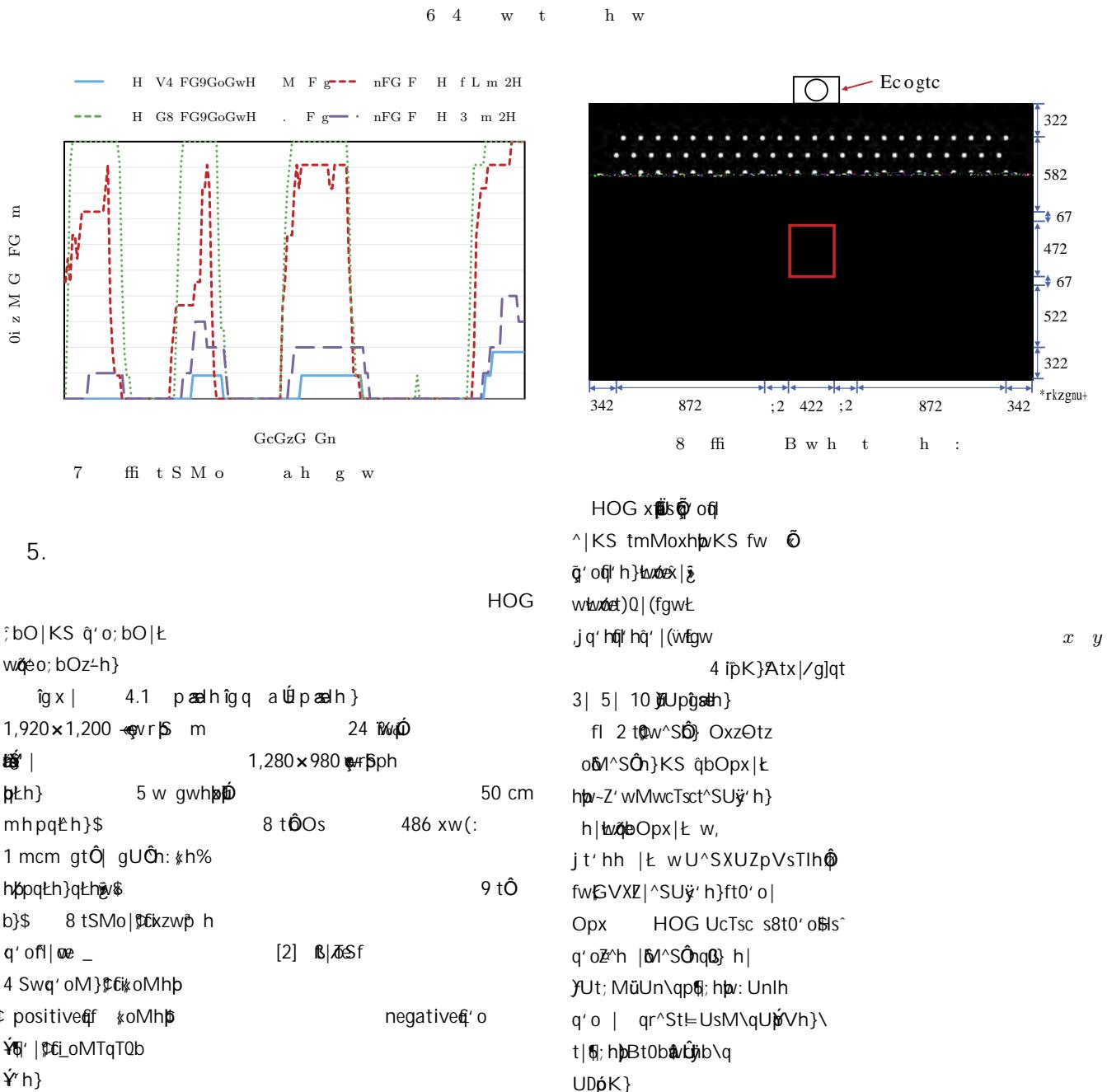
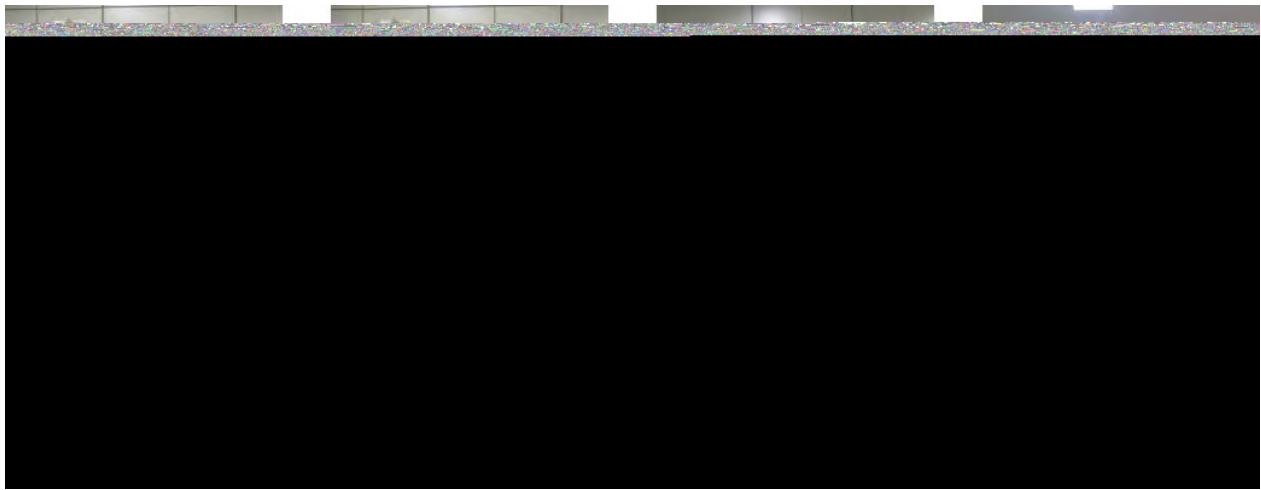
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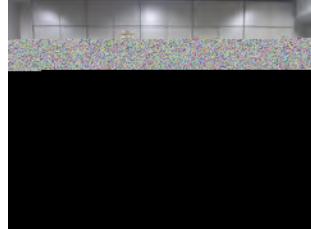
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	w ,	0.362	0.938	0.522
5	HOGffi ffi	0.606	0.899	0.724
	K S	0.432	0.986	0.600
	w ,	0.364	0.936	0.525
3	HOGffi ffi	0.606	0.896	0.723
	K S	0.421	0.986	0.590
	w ,	0.369	0.961	0.534

3 w Sffi w ffi " ffi

		p	6 p	F
10	HOGffi ffi	0.662	0.964	0.785
	K S	0.400	1.000	0.571
	w ,	0.310	0.958	0.468
5	HOGffi ffi	0.662	0.958	0.783
	K S	0.400	1.000	0.571
	w ,	0.313	0.959	0.473
3	HOGffi ffi	0.651	0.952	0.773
	K S	0.388	1.000	0.560
	w ,	0.316	0.976	0.478

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- [1] L. Muhlbach, B. Kellner, A. Prussog, and G. Romahn, “The importance of eye contact in videotelephone service,” Proc. 11th Int. Symposium on Human Factors in Telecommunications, no. O-4, pp. 1–8, Sept. 1985.
- [2] S. Uono and J.K. Hietanen, “Eye contact perception in the West and East: A cross-cultural study,” Plos one, vol. 10, no. 2, e0118094, Feb. 2015.
- [3] S.M. Anstis, J.W. Mayhew, and T. Morley, “The perception of where a face or television ‘portrait’ is looking,” American J. of Psychology, vol. 82, no. 4, pp. 474–489, Dec. 1969.
- [4] R. Kollarits, C. Woodworth, and J. Ribera, “An eye-contact cameras/display system for videophone applications using a conventional direct-view LCD,” Digest of 1995 SID Int. Symposium, pp. 765–768, May 1995.
- [5] R. Yang and Z. Zhang, “Eye gaze correction with stereovision for video-teleconferencing,” IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 26, no. 6, pp. 956–960, July 2004.
- [6] C. Kuster, T. Popa, J.C. Bazin, C. Gotsman, and M. Gross, “Gaze correction for home video conferencing,” Proc. ACM SIGGRAPH Asia, ACM Trans. Graphics, vol. 31, no. 6, pp. 174:1–174:6, Nov. 2012.
- [7] D. Giger, J.C. Bazin, C. Kuster, T. Popa, and M. Gross, “Gaze correction with a single webcam,” Proc. 2014 IEEE Int. Conf. on Multimedia and Expo, pp. 68–72, July 2014.
- [8] B. Yip, “Face and eye rectification in video conference using affine transform,” Proc. 2005 IEEE Int. Conf. on Image Processing, vol. 3, pp. 513–516, Sept. 2005.
- [9] F. Solina and R. Ravnik, “Fixing missing eye-contact in video conferencing systems,” Proc. 33rd Int. Conf. on Information Technology Interfaces, pp. 233–236, June 2011.
- [10] J. Saragih, S. Lucey, and J. Cohn, “Deformable model fitting by regularized landmark mean-shift”, Int. J. of Computer Vision, vol. 91, no. 3, pp. 200–215, Jan. 2011.
- [11] N. Dalal and W. Triggs, “Histograms of oriented gradients for human detection,” Proc. 2005 IEEE Computer Society Conf. on Computer Vision and Pattern Recognition, vol.1, pp. 886–893, June 2005.
- [12] Y. Sugano, Y. Matsushita, Y. Sato, and H. Koike, “Appearance-based gaze estimation with online calibration from mouse operations,” IEEE Trans. on Human-Machine Systems, vol. 45, no. 6, pp. 750–760, Feb. 2015.