Fixing Missing Eye-Contact in Video Conferencing Systems

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Abstract. *A novel but simple and experimentally motivated method related to the Mona Lisa effect for establishing eye contact in video conferences using big screens and cameras mounted above the screens is proposed.*

Keywords. human computer interface, videoconferencing, eye-contact

1. Introduction

Video-teleconferencing enables people to communicate face-to-face over remote distances. One of the major unresolved issues of teleconferencing concerning the user experience is the loss of eye contact between participants of a teleconferencing session [2]. While a person's eyes are usually directed at the center of the computer screen where the teleconferencing partner's face is displayed, the cameras are usually placed above the display. It has been shown, that if the vertical distortion angle between the line from camera to the eyes and line from the eyes to the screen is more than only 5 degrees the loss of eye contact is noticeable [5]. Using average sized desktop computer displays at a normal viewing distances, this angle is usually between 15 and 20 degrees [9], which results in inevitable loss of eye contact. An example is shown in Fig. 1. The same problems arise also if the face of a video conference correspondent is displayed in smaller window on a large screen if the angle between the correspondent's face in the window and the position of the camera is larger than 5 degrees. Users of small handheld devices, such as iPhone4 using FaceTime, do not experience these problems since the angle between the center of the display and the camera measured from the usual viewing distance of the user's face is smaller than 5 degrees.

Eye contact seems to be so important especially in individual to individual communications that poor eye contact may have hurt a wider adoption of videoconferencing technology since people associate poor eye contact with deception [1].

This problem has been known and addressed for many years. Initially, hardware-based solutions were proposed ranging from using half mirrors, beamsplitters and integrating the camera into the center of the computer screen. With increased computer power, software solutions of the problem involving the manipulation of the image itself were proposed [10]. To generate a virtual camera view from the middle of the computer screen anywhere from two to eight cameras have been proposed [3]. These systems are based on stereo matching and image morphing methods.

In this article, we try to formulate a solution related to the Mona Lisa effect [6] which occurs when a picture of a face appears to be looking at you even though the picture itself is tilted. Microsoft researchers first suggested that it might be possible to change the eye gaze by rotating the image if the face is not looking at the viewer but concluded only that more work needs to be done to figure out the exact relationship between rotating an image and eye gaze direction [10].

2. Enabling better eye contact in videoconferencing

Users now expect to use videoconferencing on their own desktop or portable computers. Based on our work involving


a)

b)

Figure 1: **Images of a user captured by the camera mounted above a 27 inch computer display at a normal working distance: a) when the user is looking into the middle of the display, b) when the user is looking straight into the camera. Case a) clearly demonstrates that if the user is looking at the image of his teleconferencing partner in the middle of the display there is no eye-contact between both partners.**

Figure 2: **The image of the videoconference participant in Fig. 1a was transformed so that the image plane was rotated around axis x for 15°. According to the experiment that we made, this improves the subjective eye contact experience in comparison to the original non-rotated image.**

dynamic anamorphosis [4] we propose a very simple way of providing a better eye-contact experience in videoconferencing. Viewing pictures from an oblique angle does not result in a distorted picture since human perception can automatically compensate for the distortion using the principle of shape constancy [7, 8]. When a picture is viewed from its center of projection it generates the same retinal image as the original scene, so the viewer perceives the scene correctly. When a picture is viewed from other directions, the retinal image changes, but we normally do not notice the change. This invariance or shape constancy is in human perception achieved through estimation of the local surface orientation [8].

If we rotate the image of our videoconferencing partner for a moderate angle around axis x with the top of the picture moving away from us we still perceive the partner as before since our human perception estimated the amount of the rotation to correct for the perspectival deformation (Fig. 4). The eye gaze of the video partner which in the original, not rotated image, is directed below our face (as in Fig. 1a) seems also to rotate. When the amount of the rotation of the image plane is appropriate, observers report a better eye contact (Fig. 2).

3. Experiment

To test our hypothesis we performed the following experiment. We took still pictures of four different people who were sitting in front of a 27 inch monitor and looking towards the center of the monitor with a camera mounted above the monitor, as was the case in Fig. 1a. We devised a web application which applies an anamorphic deformation of the selected picture around axis x which is for small angles similar to the rotation of the image around axis x. We asked a group of 54 mostly undergraduate and graduate students to visit the experiment's web page

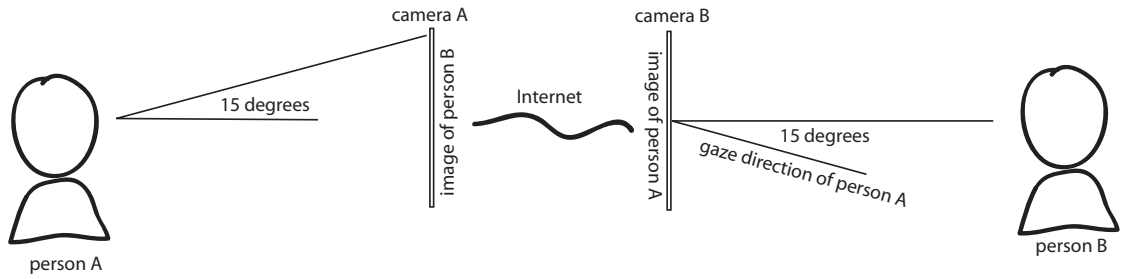

Figure 3: **Person A is looking at person B on screen in front of him (left). Because camera A is mounted above the computer screen, person B, when looking at image of person A, can not meet his eye gaze (right).**

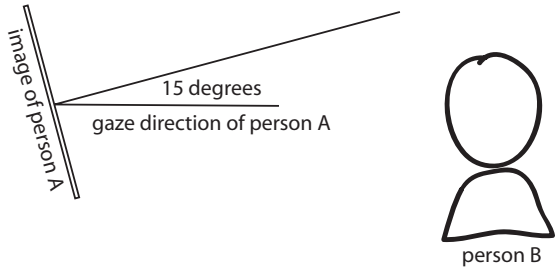

Figure 4: **By rotating the image of person A his perceived eye gaze direction also seems to rotate so that person B now has a better subjective experience of having eye contact.**

`http://papagena.fri.uni-lj.si/dyana/` to rotate the pictures in such a position where they experience the best eye contact with the person on the image. Two of the subjects responded that no amount of rotation could improve eye contact. The results of the other 52 subjects are summarized in Fig. 5.

The histogram of votes clearly demonstrates that an increase of eye contact satisfaction can be achieved by rotating the image of the videoconferencing partner so that the top of the image moves away from us. 80% of the votes selected this approach to improve eye contact. The peak of the histogram shows that the required amount of rotation is around 15°. When we sit in front of a 27 inch monitor 60 cm away our eye gaze directed to the center of the screen also changes the angle of direction for about 15° when we look at the camera mounted above the display. 42% of votes selected angles between 10° and 20° and 60% of votes selected angles between 5° and 25°.

4. Conclusions

The problem of missing eye-contact in video conferencing systems is due to the fact that when people want to engage in eye-contact with the speaking partner they cannot achieve it due to technical limitations of the teleconferencing systems. The normal way of establishing eye contact is to mutually look into the partner's eyes. Since the viewing axes of the cameras and displayed face images on videoconferencing systems are not aligned, this simple strategy does not work and at least subconsciously causes frustration. All methods that try to alleviate this problem, including our proposed method, do not force teleconferencing partners into eye-contact but just try enable it when and if the partners want it!

We believe the described experiment confirms that an approach related to the Mona Lisa effect works in practice and that a subjective experience of better eye contact can be achieved. More experiments are needed with cameras placed at different positions relative to the computer screen, especially if dynamic anamorphosis which can adjust the image of our videoconferencing partner to the changing position of our face in real-time is used [4].

The effect that we observed still needs to be explained also in the context of perceptual psychology since it concerns both, the perception of 2D images of 3D scenes from an oblique angle [8, 7] on the one hand and perception of gaze direction on the other [6].

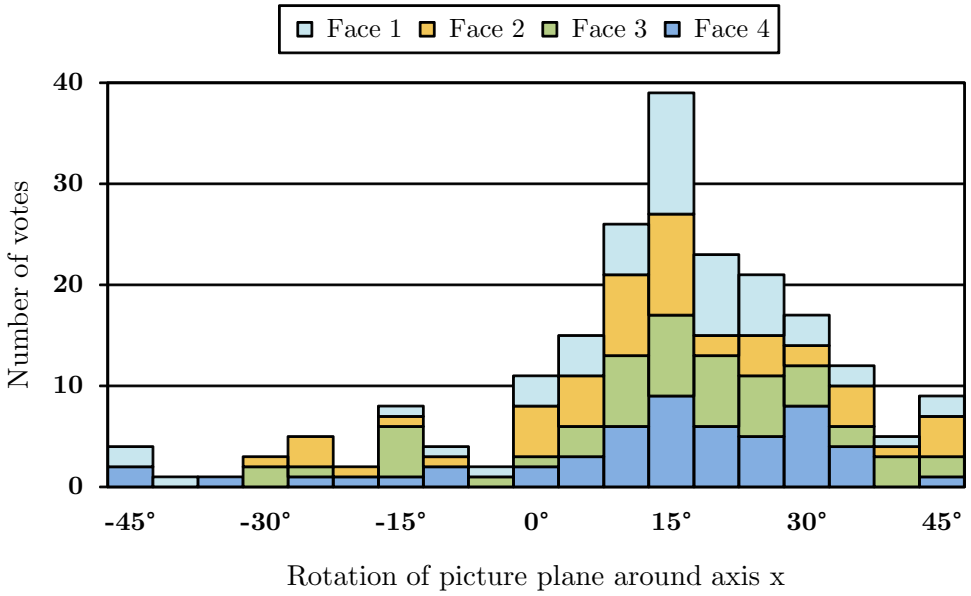

Figure 5: **Results of testing if the rotation of the image of an assumed videoconferencing partner around axis x can improve the subjective perception of eye contact. 52 subjects were included in the test. They had to select that amount of rotation where they experienced the best eye contact. Each subject selected the angle of rotation for four images. The peak of the histogram is at 15° which corresponds approximately to the angle when someone in front of a 27 inch monitor changes his gaze from the middle of the monitor to the top of the monitor where the camera is normally located.**

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