Perception of Gaze Direction in 2D and 3D Facial Projections

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Figure 1: The two projected facial displays utilized in the experiment: a flat surface and a 3D mannequin

1 Introduction

In human-human communication, eye gaze is a fundamental cue in e.g. turn-taking and interaction control [Kendon 1967]. Accurate control of gaze direction is therefore crucial in many applications of animated avatars striving to simulate human interactional behaviors. One inherent complication when conveying gaze direction through a 2D display, however, is what has been referred to as the Mona Lisa effect; if the avatar is gazing towards the camera, the eyes seem to “follow” the beholder whatever vantage point he or she may assume [Boyarskaya and Hecht 2010]. This becomes especially problematic in applications where multiple persons are interacting with the avatar, and the system needs to use gaze to address a specific person. Introducing 3D structure in the facial display, e.g. projecting the avatar face on a face mask, makes the percept of the avatar’s gaze change with the viewing angle, as is indeed the case with real faces. To this end, [Delaunay et al. 2010] evaluated two back-projected displays - a spherical “dome” and a face shaped mask. However, there may be many factors influencing gaze direction perceived from a 3D facial display, so an accurate calibration procedure for gaze direction is called for.

In this paper, we propose an experiment for evaluation of different facial animation display setups in terms of perception of gaze direction. In addition to providing a measure of the precision of a particular display in terms of conveying gaze direction, the experiment also provides the data required in order to estimate the underlying psychometric function describing the relationship between eye control parameters in the virtual face model and the gaze direction perceived by human observers.

2 Setup

We use front projection on a solid mannequin head, and compare it against projection on a flat surface, see figure 1. The avatar used is the same as in [Salvi et al. 2009]. The experiment is designed to simulate a multi-user scenario. Five subjects are seated equal distance but at varying angles from the display. At each trial, the avatar utters a cue phrase and gazes in a particular direction. During each block of 20 trials, the dependent variable α - the horizontal rotation of the eye-balls of the avatar - is varied over the full available range

($\pm 40^\circ$). The task of the subjects is to note which subject the avatar most likely is addressing at each turn.

The data of the experiment can be analyzed in several ways to gain different insights. The agreement in the estimates of the subjects gives a first measure of the precision of the display in terms of perceived gaze direction. Secondly, by relating α to the subject responses, it is possible to estimate the relationship between eye-ball angle and perceived gaze direction for a given avatar display. In general, it should be possible to use the same procedure to calibrate the psychometric function of perceived gaze direction for any given physical facial display device - be it a projected computer generated image, a holographic display or even a mechanical robotic head.

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