Practical Eye Movement Model using Texture Synthesis

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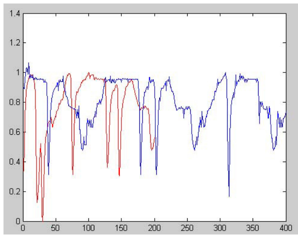

Figure 1: eye blink synthesis – the red curve is the texture sample and blue is the (longer) synthesized eye blink texture.

1 Introduction

As humans we are especially sensitive to the appearance of the face, and on the face, the eyes are particularly important. In fact, in attempts to animate photo-realistic CG humans, the eyes are very often what destroys the illusion [Williams 2003]. The state of art in eye movement synthesis is the *Eyes Alive* model [Lee et al. 2002] that develops a custom statistical model specifically for eye movement. While its results are the best to date, the model is complex and one wonders if it could be improved by using additional or different statistics. In fact the problem of generating novel animation that captures the "character" of given training data is the same problem as texture synthesis. In this sketch we describe a practical eye movement model using non-parametric texture synthesis techniques ([Efros and Leung 1999]), simulating the eye gaze motion and eye blink motion simultaneously. This approach uses the data directly and without an intervening human-crafted statistical model, yet it produces results that appear as good or better than the more complex statistical model.

2 Approach

In a training stage, both eye blink and eye gaze motion data are obtained from real persons. The eye blink motions were captured with a hardware motion capture rig, using markers on the left and right eyelids. Because the eye blink motions in X, Y, and Z are strongly correlated, the eye blink motion in three dimensions can be simulated by a one dimensional "blink" signal based on the dominant Y (vertical) direction. Examining the captured data, we found that the motion of the left eyelid is nearly synchronized with that of the right eyelid. As such, we only need the motion capture trace for one eye to create the eye blink texture signal. By scaling the y-coordinates of the eye blink motion into range [0,1] (Figure 1), we get a 1D eye blink texture signal -- here 0 denotes the closed eyelid, 1 denotes the eyelid fully open, and any value between 0 and 1 represents a partially open eye.

Corresponding eye gaze direction signals were obtained by manually estimating the eye direction in several training videos frame by frame using an "eyeball widget" in a custom GUI (Figure 2). While the manually estimated direction data is not completely accurate, it qualitatively captures the character and cadence of real human gaze movement; the timing is also frame-accurate.

Then, in the modeling stage, the non-parametric sampling technique [Efros and Leung 1999] is used to synthesize novel eye blinks and eye gaze motions. The idea is to grow one sample at a time from an initial seed, by identifying all regions of the sample texture that are similar (threshold ε) to the neighborhood of the sample, and then selecting the corresponding sample from one of these regions chosen at random. For more details on the non-parametric sampling technique, see [Efros and Leung 1999]. Figures 1,2 illustrate synthesized eye blink and gaze signals.

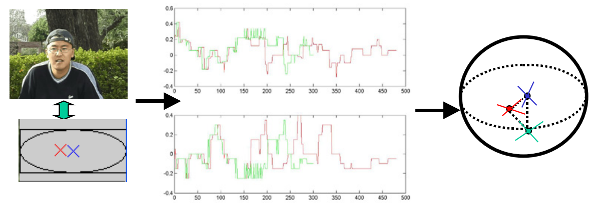

Figure 2: (left) eye direction training signals are manually digitized; (middle) eye gaze x- and y- movement synthesis; (right) 3D eye orientation calculated from the x and y signals.

3 Results and Evaluations

We asked eight people (customers at a coffee shop) to view two videos comparing our algorithm with the eyes alive model augmented with a random Poisson blink process, and indicate in which video the eye movement 'appeared more natural'. Seven preferred our model (one had no preference). These results are largely due to the more accurate eye blinks in our model (real eyelids are not simply open or shut, Fig. 1), but people also commented that the eye gaze in our model appeared "less jumpy".

4 Conclusion

In summary, this sketch presents a practical eye movement model that generates quite realistic eye motions based on real human motion data. It demonstrates that well-developed texture synthesis techniques can be applied to the modeling of incidental facial motions such as eye gaze and eye blinks.

References

EFROS, A., AND LEUNG, T.K. 1999, Texture Synthesis by Non-parametric Sampling, *ICCV'99*, 1033—1038.

LEE, S.P., BADLER, J.B., AND BADLER,N. 2002, Eyes alive, *ACM Transaction on Graphics, 21*, 3, 637—644.

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Figure 3: Face models used to evaluate eye motion.

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