The Just Noticeable Difference of Transition Durations

Jing Wang* Bobby Bodenheimer*
Vanderbilt University

1 Introduction

This work reports results on the noticeability of transitions between two segments of motion. Linear interpolation is often used as a method of generating such transitions because it is efficient and quick. [Wang and Bodenheimer 2004] reported methods to automatically compute such durations. In this work, we refine and extend their study of how noticeable the blend length is to viewers.

There is no generally accepted standard for generating or specifying a transition in the graphics community. Instead, two techniques predominate. Some researchers, e.g., [Rose et al. 1998] specify transitions using a start frame in motion 1, an end frame in motion 2, and a blend length d. We call this method a "start-end" specification. Other researchers, e.g., [Kovar and Gleicher 2003] specify a transition from frame i to frame j meaning that frames i and j are the midpoint in a transition of length d frames, i.e., the 50% blend points. We call this method a "center-aligned" specification. There are advantages and disadvantages to each of these two methods.

2 Method

We ran a set of experiments to determine the sensitivity of subjects to changes in blend length of motion transitions, i.e., to estimate the psychometric function of the just noticeable difference. The "just noticeable difference" is the amount that something must be changed for the difference to be noticeable.

Subjects were presented with two sets of animations. Each set contained a pair of motions. One set is the reference pair, consisting of two identical motions containing a length k transition. The length k varies for motions and transition schemes used in the study. The motions in the other set are different, consisting of a length k transition and a transition of another length. Participants were asked to watch two motion sets and to determine which motion pair consisted of different motions. This somewhat cumbersome design is necessary to make a two-alternative forced choice test with an objective answer, meaning that there are two choices and a correct answer as to which set of motions is different. The presentation of the transitions was randomized, both pairwise and among sets to eliminate order effects. An asymmetric staircase adaptive method that employs an up-down procedure was used to minimize the number of the trials. This staircase converges to a 71% correct discrimination [Wetherill and Levitt 1965].

3 Experiments and Results

For the center-aligned transitions we chose a baseline transition length of $k = 10$ frames, and generated transitions of length $k-8$ to $k+10$ (2 to 20) frames, at two frame intervals. Three different sets of motions were used. The stopping condition for the adaptive procedure occurs when any sample point is visited ten times. Twelve adults participated in the adaptive study. We conclude that people can differentiate between transition lengths that differ by -7 or 10 frames for center-aligned transitions. There was no statistically significant difference in the performance of the test across motions.

Similar studies were conducted for the start-end transitions between two different motions. The baseline transition length k was computed with the methods of [Wang and Bodenheimer 2004], and different transition lengths from $k-16$ to $k+16$ were generated at two frame intervals. Twelve adults participated in the adaptive study. Figure 2 shows the results of the adaptive study for the start-end transitions. We found that people can normally distinguish between transitions length that differ by 2 or -3 frames for start-end transitions. People are more sensitive to start-end transitions since some of the natural alignment of the motion is wrapped into the transition.

*email: {jing.wang,bobby.bodenheimer}@vanderbilt.edu

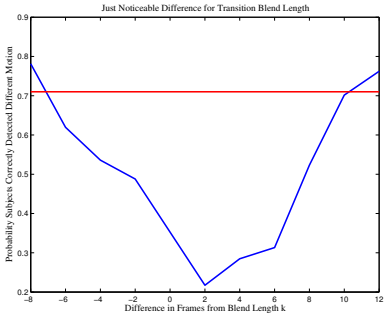

Figure 1: Results of the just noticeable difference adaptive study for center-aligned transitions. The x-axis shows the difference in blend length from 10 frame. The y-axis shows the probability of successfully detecting the motion pair containing the different motion.

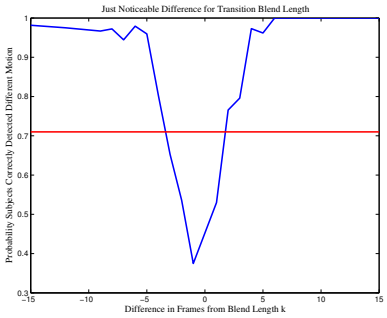

Figure 2: Results of the just noticeable difference adaptive study for start-end transitions. The x-axis shows the difference in blend length from the optimal value k and the y-axis shows the probability of successful detection, as above.

References

KOVAR, L., AND GLEICHER, M. 2003. Flexible automatic motion blending with registration curves. In *2003 Symposium on Computer Animation*, 214–224.

ROSE, C., COHEN, M., AND BODENHEIMER, B. 1998. Verbs and adverbs: Multidimensional motion interpolation. *IEEE Computer Graphics and Applications 18*, 5, 32–40.

WANG, J., AND BODENHEIMER, B. 2004. Computing the duration of motion transitions: an empirical approach. In *2004 Symposium on Computer Animation*, 335–344.

WETHERILL, C. B., AND LEVITT, H. 1965. Sequential estimation of points on a psychometric function. *Brit. Jour. of Math. and Stat. Psych. 18*, 1–10.