Generating Eye Movement during Conversations Using Markov Process

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Figure 1. Proposed Markov Process

1. Introduction

Generating realistic eye movements is a significant topic in Computer Graphics(CG) contents production field. Appropriate modeling and synthesis for eye movements are greatly difficult because they have a lot of important features.

Gu et al[2007] proposed a method for automatically synthesizing realistic eye movements during conversations according to probability models. Despite eye movements during conversations include both saccades and fixational eye movements (FEMs), they synthesized only saccades which are relatively large eye movements.

We proposed a method for automatically synthesizing both saccades and FEMs[Iwao et al 2012]. While we classified eye movements accurately, we did not consider the time dependency of eye movements at all. For example, an eyeball often moves in the same direction to the previous direction, however, we could not express such eye movements in our previous work. In addition, we often synthesized unnatural eye movements like consecutive large movements. It is necessary to consider the time dependency of eye movements because a prospective eye movement has a strong relationship to the present one.

We propose a method for synthesizing realistic eye movements and blinks during face-to-face conversations using the first order Markov process model. Our contributions can be summarized as follows.

1-We appropriately analyze eye movements using the first order Markov process derived from actual measurements.
2-We easily synthesize realistic eye movements by simply inputting the initial eye movement state.

2. Measurement of Eye Movements and Blinks

We measured eye movements of 21 male and female subjects during actual conversations using EMR-9, an eye tracker manufactured by NAC Image Technology. This device can measure eye movements according to the corneal reflection. During the measurements, we set the distance between two subjects to 1.5 meters that they are able to have a conversation comfortably. Meanwhile, we also recorded videos of blinks by a camcorder to analyze them after measurements. To capture eye movements accurately, we requested the subjects not to move their head during measurements.

3. Analysis and Synthesis

We analyze eye movements and blinks using the first order Markov process to consider the time dependency of these movements. We separate the whole frames of acquired movies into every six frames. Six frames correspond to one node of a Markov process.

First, we define states in a Markov process. Eye movements during conversations include two different movements, saccades and FEMs. In our previous work, we can classify eye movements into saccades and FEMs by setting the threshold of angular rotation of the eye to two degrees. Therefore, states in a Markov process consist of three parts, such as saccades, FEMs and blinks.

Second, we determine the state of the nodes according to angular rotation of eyes from actual eye movements. We also acquire the initial state probabilities.

Third, we unite the consecutive same state nodes into a state cluster of nodes. For example, we unite three saccade nodes into a saccade cluster of three nodes. We also calculate state transition probabilities between the two same state clusters.

Next, we define eye movement elements to accurately represent eye movements. We classify saccade into four elements, such as angular rotation, angular direction and duration time. We also classify blinks into two elements, blink time and blink time interval. We do not classify FEMs into elements because they are very small movements and difficult to analyze. We use uniform random number to synthesize FEMs. We calculate each element transition probability between two same state clusters by using element values in clusters. We also acquire the initial element probabilities.

Finally, we synthesize eye movements and blinks by using both state transition probabilities and element transition probabilities with the Markov process trained from actual measurements. We present the synthesis result with the first order Markov process in Figure1.

4. Conclusions and Discussions

In this paper, we propose a method for synthesizing realistic eye movements and blinks during face-to-face conversations using the first order Markov process model.

Using our model which considers time-dependent transition, we are able to synthesize reliable human eye animations in arbitrary situations without any additional eye motion capturing. To figure out the relationships between eye movements and other human body actions, such as head motions and hand gestures, are our future works.

References

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