Automatic Synthesis of Eye and Head Animation According to Duration and Point of Gaze

Hiroki Kagiyama†1 Masahide Kawai†1 Daiki Kuwahara†1 Takuya Kato†1 Shigeo Morishima†2
Waseda University†1 Waseda Research Institute for Science and Engineering†2

1. Introduction

In movie and video game productions, synthesizing subtle eye and corresponding head movements of CG character is essential to make a content dramatic and impressive. However, to complete them costs a lot of time and labors because they often have to be made by manual operations of skilled artists.

[Itti et al. 2006] and [Yeo et al. 2012] proposed an automatic eyes and head's motion control method by measuring a real person watching a displayed gaze point. However, in both approaches, a rotational angle and speed of eyes and head are treated together uniformly depending on the gaze point location. Specifically, displaying duration time of gaze target strongly influences the motion of eyes and head because the shorter the blink interval of a gaze target is, the more quickly a human response becomes to chase the target by the combination of eye rotation and head movement.

In this paper, we propose a method to automatically control eyes and head by taking account of both gaze target location and its blink time duration. As a result, eye and head movement are modeled combined with measured data by a function whose arguments are gaze point angle and duration time.

So a variety of gaze action along with head motion including Vestibule-ocular Reflex can be generated automatically by changing the parameters of a gaze angle and duration.

2. Measurement of Eye and Head Movements

In our experiment, eye and head movements of 9 participants facing a screen are measured by an optical Mocap system (VICON) and a head mount type eye-tracker (EMR-9), when a yellow circle is displayed on the screen with a variety of angles and duration.

We measured the movement of the eyes and head during subjects are gazing and chasing the yellow circle with the angle variation in every 10 degree from -90 degree to 90 degree and the display time duration in every 0.5 seconds from 0.5s to 2s. So the total 72 experiments are defined as 1 set and total 10 sets are operated.

3. Analysis and Synthesis

Eye movement is divided into three sections (**Fig.1**). First section (red section), "Stationary part", is defined as the time between the moment that yellow circle appears and that eyes begin to move. Second section (blue section), "Saccade part", is defined as the time between the moment that eyes begin to move and that the eyes acquire the yellow circle. Third section (green section), "Vestibule-ocular Reflex part (VR part)", is defined as the time between the moment that eyes acquire a yellow circle and that the eye movement stabilizes. By simulating these three steps depending on the display angle and the duration of gazing target, a very natural gazing animation along with the head movement can be generated.

1) Generating criterial function The angle and time are normalized in the Saccade part and the VR part from 0 to 1. We fit the following equation (1) in the Saccade part and equation (2) in the VR part to the normalized functions,

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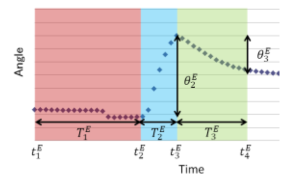

Figure 1. Actual eye movements

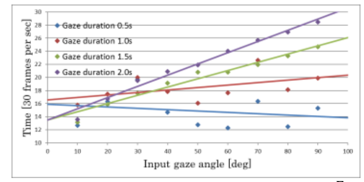

Figure 2. Example parameter T_2^E

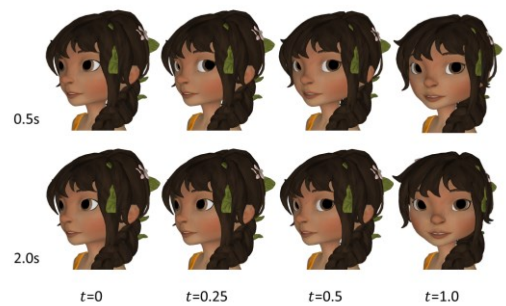

Figure 3. Synthesized eye and head animations normalized in time. Top: gaze duration is 0.5s. Bottom: gaze duration is 2.0s.

$$\theta = e^{at}\left(\sin\frac{\pi}{2}t\right)^b, (1) \qquad \theta = 1 - e^{at}\left(\sin\frac{\pi}{2}t\right)^b, (2)$$

where t denotes the measurement time, θ denotes the eye angle, and a, b denote fitting parameters, respectively. A, B are average of a, b in all individuals and all gaze duration. The criterial functions in the Saccade part and the VR part are generated by the Eq. (1) in which A, B is substituted for a, b, respectively.

2) Analyzing parameters of angle and time Each parameter of time T_i^E $(i = 1,2,3)$ and angle θ_i^E $(i = 2,3)$ is extracted from each of the three sections and then averaged in the individual. These averaged parameters are approximated by a linear interpolation at each gaze duration (**Fig.2**). In **Fig.2**, the longer the gaze duration is, the steeper gradient of the function becomes.

3) Changing scale of the criterial function Three time scales T_i^E and two angle scales θ_i^E are decided from input gaze angle and gaze duration. For example, time scale T_1^E is obtained from **Fig.2**. The time scale of the criterial function is magnified T_i^E times. Similarly, the angle scale of the criterial function is magnified θ_i^E times. By combining those criterial function whose scale is changed, the entire graph is generated.

Head movements are divided into two section, "Stationary part" and "Saccade part". The analyzing method of head movements can be similarly treated with that of eye movements.

4. Result and Future Work

The resulting animations of the eyes and head are shown in **Fig.3** and the supplemental movie. Even in case of the same gaze angle, our method can create a variety of natural and compelling gaze animations according to a gaze target's display duration. As future work, to express character animations that can respond to multiple objects, we plan to introduce a novel method of creating saliency map. I would like to thank "Mixamo, Inc." for the model.

References

ITTI, L., et al. 2006. Photorealistic Attention Based Gaze Animation. *ICME 2006*, pp. 521-524.

YEO, S. H., et al. 2012. Eyecatch: Simulating Visuomotor Coordination for Object Interception. *SIGGRAPH*, vol.31 issue 4, no.42