A method for enriching video-watching experience with applied effects based on eye movements

Masayuki Tamura[1], and Satoshi Nakamura[1]

[1] Meiji University, 4-21-1 Nakano-ku, Tokyo, Japan
mogamusa31@gmail.com

Abstract. We propose a method to enrich the experience of watching videos by applying effects to video clips which are shared on the Web on the basis of eye movements. We implemented a prototype system as a Web browser extension and created several effects that are applied depending on the point of a viewer's gaze. In addition, we conducted an experimental test, and clarified the usefulness of our effects, and investigated how adding the effects affected viewer experience.

Keywords: Eye movements, Effect, Video, Watching experience.

1   Introduction

There are various services and studies that have tried to make video content more enjoyable by adding special effects. For example, on the video-sharing Web site *Nico Nico Douga[1]*, comments are superimposed onto videos, which makes the content more enjoyable by enabling viewers to share their feelings with others. Yamaura et al. [1] presented a method that extends the experience of digital content by simply superimposing blurring effects that follow the gaze point of the user, and due to this method, almost all psychological impression items (immersion, stereoscopic effect and so on) to the video became higher.

For content such as animation and comics, effects such as emphasis lines and solid flashes are often used. These effects are used to add impact and to make it easier to grasp the situation being depicted. For example, emphasis lines can be superimposed towards the periphery of an object, thereby emphasizing the object's movement. A solid flash can surround a certain object and express changes in circumstances, among other things. In other words, it is possible to make content more enjoyable and easier to understand by applying effects onto content with moving images.

It is now possible to acquire a gaze-detection device even at home because eye tracking devices have become inexpensive. In addition, in the near future, laptop cameras are expected to come with a built-in gaze-detection function. DELL have already launched a laptop named Alienware 17 that is equipped with an eye-tracking device. Line of sight expresses the interest of a viewer well, so there are studies that propose methods for using Web sites to determine where the user was looking at [2]. In addition, there are studies that use blurring to guide the human gaze [6]. In the previous work,

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[1] http://www.nicovideo.jp

rather than using line of sight to analyze the user or operate the GUI, we used it to change the position of an effect being applied to on-screen content.

The objective of our work is to enrich the video-watching experience. In order to enrich the experience, we propose a method which overlays the effect on a video clip on the Web along the viewer's line of sight. We believe that the method makes the content more enjoyable by shifting the position of the effect each time the center is shifted. We also implement the prototype system as a browser extension, allowing effects to be applied to any video clips on the Web, with the goal of making content more enjoyable. Further, by conducting an evaluation experiment, we determined the usefulness of the proposed method and used viewers' gaze logs to analyze the effects the proposed method had on their behavior.

2   Related Work

There are various studies on enriching viewing experiences. *VRMixer* [3] enables a new viewing experience by letting viewers appear in the video they are watching. By displaying avatars that imitate others in accordance with their degree of excitement, they implemented a system that allows viewers to watch videos while feeling the presence of others through the avatars, thus enriching the viewing experience.

In contrast to these studies, our research is to enrich the viewing experience by applying effects onto videos on the basis of gaze information.

There are various studies on conducting gaze guidance using effects. For example, Kadaba et al. [4] proposed a method using somatic depth of field for enabling users to intuitively understand necessary items when there are multiple gaze point candidates. With this method, the researchers realized that intelligent acquisition of necessary information could be facilitated by blurring the information that is unnecessary for the viewer to the extent that the viewer notices the blur. Hata et al. [5], in contrast, focused on the fact that a person's line of sight is naturally guided from a blurred portion to a clear portion of an image. Hagiwara et al. [6] induced gaze by changing the image so that the salience of the area that the gaze was guided to be the highest in the image. They proposed and implemented a method of dynamically guiding the viewer's line of sight without the viewer noticing by partially blurring or clearing the resolution of the image. This technique uses the characteristics of the line of sight successfully. Differing from this, our research simply enriches the viewing experience by applying gaze.

The objective of our research is to enrich the experience of watching videos with only an individual's own gaze information.

3   Proposed Method

The proposed method enriches the video-viewing experience by adding effects to original content with moving pictures. There are various effects that could be applied depending on the line of sight, but in this paper, we prepared only the effects listed below. They were chosen because these effects are actually used in comics, animation, games, and similar media. The effects are as follows.

・**Emphasis line**: An effect to amplify a sense of momentum. This effect is often expressed with emphasis lines around an object in animation and comics. This is mainly used to amplify the sense of the object's momentum by directing the object with emphasis lines. By superimposing the emphasis line effect centered on the viewer's gaze point, a sense of momentum is amplified.

・**Flashlight**: An effect for amplifying fear. To amplify the element of fear in horror games, there are times when the player is directed to illuminate the dark with a flashlight. This is intended to amplify the viewer's sense of tension by limiting the field of vision to only that area lit by the flashlight, darkening other areas. By superimposing effects that darken everything other than what the viewer is looking at, fear is amplified.

・**Spotlight**: An effect that emphasizes an object or amplifies a feeling of searching for something. The spotlight is used when you want someone to look at a specific scene in an animation or on a stage. The spotlight is a dimly lit effect that emphasizes only the range you want to see. To emphasize and amplify the feeling of searching for something, we superimposed the effect of the spotlight onto a moving element of the video.

・**Fog**: An effect to amplify anxiety. People become uneasy if visibility is impaired in reality. Therefore, anxiety is amplified by making fog appear thin in some places and
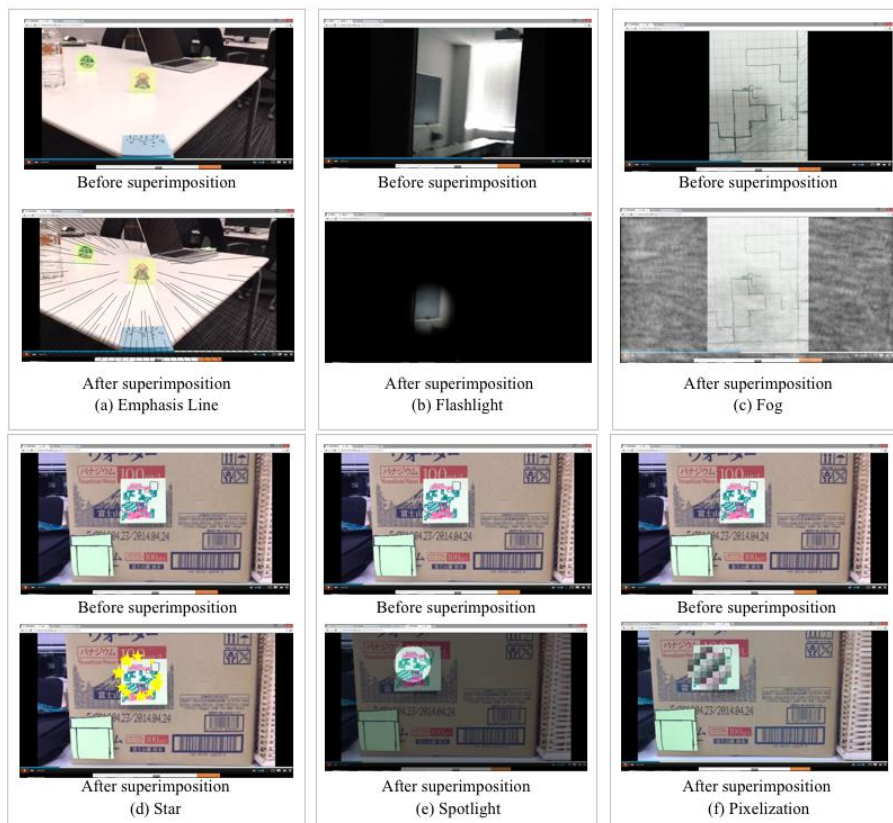

Fig. 1. Examples of adding effects to video clips.

darker in others.

・**Pixelization**: An effect to amplify impression of violence or sex. Pixelization is applied to censor violent and sensual depictions in television dramas, animation, comics, and other media. Therefore, by using this effect and displaying a pixelated visual at the end of the viewer's line of sight, we amplify the sense of violence or sensuality of the scene because viewers cannot see what is pixelated even if they want to.

We implemented the prototype system as a browser extension for *Google Chrome* using JavaScript. For this study, the averaged gaze coordinates of both eyes were used. It is not possible to directly obtain the information from *Tobii EyeX* with JavaScript, so a mechanism was implemented with C# to send the gaze information obtained by *Tobii EyeX* to the *Chrome* extension via WebSocket. The Chrome extension superimposed the effects onto the videos with the center set to the coordinates of the gaze. The proposed system supports *Nico Nico Douga* and *YouTube*. Figure 1 shows examples in which each of the effects proposed is added to the video. When the user accesses a corresponding Web page after installing the proposed system, the effect assigned to that Web page is superimposed on the screen[2].

4 Experiment

We performed an experiment to evaluate how the video-viewing experience was enriched by applying effects following the line of sight. In the experiment, we examined the impressions of viewers when the effects were and were not superimposed on the videos to clarify the extent to which the viewing experience was enriched. In this experiment, we explained to the experiment participants the content of the experiment and how to proceed in advance, calibrated the gaze-measuring instrument, and then started the experiment.

In this experiment, we chose five effects (emphasis line, spotlight, flashlight, fog, and pixelization) that we felt were particularly compatible with gaze. For the video used in the experiment, we selected two videos that match each effect to ensure no bias due to the video, and prepared ten videos in total. The criteria for selecting the animation in each effect is as follows: a race animation from the racing driver viewpoint for the emphasis line, a reasoning video for the spotlight, a live video of a horror game for the flashlight, a video that induces insecurity in viewers similar to high altitude for the fog, and a video showing a person wearing a swimsuit for the pixelization. We divided the experiment participants (eight male university students in their twenties) into two groups, A and B. One of the two videos selected in advance for each effect was set to α, and the other was set to β. Then, the participants of group A watched α with the effect applied and β with no effect applied. Likewise, the participants of group B watched α without the effect and β with the effect. This was done so as to circumvent the order effect.

We acquired line-of-sight logs while the experiment participants were watching the videos. The time to conduct the experiment per person was about 1 hour. In a questionnaire conducted after the experiment, we investigated how the viewers' impressions of

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[2] https://www.youtube.com/watch?v=J152z3NN00Q

Table 1. Results of the questionnaire in each effect and impression.

		Surprise	Terror	Impressive-ness	Interest	Frustration	Sadness	Disgust	Enjoyment
Emphasis line	Using	-0.13	-0.88	0.50	1.00	0.00	-1.50	0.00	1.00
	None	-0.13	-1.13	0.00	0.88	-0.75	-1.63	-1.38	0.13
Flashlight	Using	1.38	1.38	0.63	1.63	0.63	-1.50	0.38	0.38
	None	0.63	0.50	-0.13	0.88	0.88	-1.50	0.50	0.00
Spotlight	Using	-0.25	-1.50	0.50	1.50	-0.38	-1.75	-1.25	0.88
	None	-0.75	-1.63	0.50	1.00	0.00	-1.75	-0.38	0.63
Fog	Using	0.13	0.38	0.50	0.25	-0.38	-1.63	-0.88	-0.25
	None	1.25	0.63	0.75	1.13	-1.63	-1.75	-1.13	0.00
Pixelization	Using	0.13	-1.88	1.13	1.50	0.75	-0.38	0.25	0.25
	None	0.00	-1.88	1.00	1.00	-1.13	-1.38	-1.50	0.25

the videos changed with the application of the effects. Using Plutchik's wheel of emotions as a reference, we selected "surprise," "terror," "impressiveness," "interest," "frustration," "sadness," "disgust," and "enjoyment" as questionnaire items. Each participant was asked to respond to each item using the five-point Likert scale. Also, in all the experiments, we asked for opinions and comments on the videos.

Table 1 lists the average evaluation values given by the experiment participants for each pair of videos (for a total of ten videos) for each effect. As shown in Table 1, for the emphasis line effect, impressiveness, enjoyment, frustration, and disgust were amplified. For the flashlight effect, surprise, fear, impressiveness, and interest were amplified. For the spotlight effect, interest increased, and surprise decreased. For the fog effect, however, frustration was amplified while surprise and interest decreased. Interest, frustration, sadness, and disgust were all amplified with the pixelization effect.

5 Discussion

The questionnaire results indicate that negative evaluations such as frustration and disgust increased for the emphasis line effect, but because the values were not high, it is safe to assume that the evaluators were not particularly frustrated and did not feel a strong sense of disgust. Moreover, enjoyment and impressiveness increased, which suggests that by applying the effect, the impact and presence of the video were amplified, viewers felt more of a sense of momentum, and their enjoyment increased.

For the flashlight effect, evaluations of surprise, fear, impressiveness, and interest increased. This effect was expected to enrich the viewing experience with a component of fear by amplifying the viewer's interest in the invisible part. Because part of the screen was made dark, the viewer's surprise and interest increased. For the spotlight effect, interest and surprise increased, and irritation decreased. We presume that irritation decreased because this effect was able to emphasize central vision without obstructing peripheral vision. Contrary to our expectations for the fog effect, evaluations for surprise and interest decreased. One possible reason for this is that the ease of viewing may have been reduced; however, the evaluations of frustration were low. For the

pixelization effect, negative evaluations such as frustration, sadness, and disgust all increased. However, evaluations of interest also increased, which suggests that there was a sense of morbid curiosity, and viewers were interested in the part of the video that they could not see in their central view.

6 Conclusion

In this paper, we proposed a method to enrich the experience of viewing videos by displaying effects on the basis of the viewer's gaze, evaluated the development and usefulness of the system, and determined the effect on user behavior of applying the proposed effects. We found that the viewer's impression of the video changed in the way we expected for many of the effects. However, we did find that the fog effect had the opposite effect of what we intended.

In this study, there was an effect that did not produce the expected effect like the fog effect because we chose the effects subjectively. Therefore, in the future work, we will analyze a detailed feature of effects with good and poor results in this study and upgrade the effects.

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