Embedded Motion -Generating the Perception of Motion in Peripheral Vision-

Yu Okano, Shogo Fukushima, Masahiro Furukawa, Hiroyuki Kajimoto - The University of Electro-Communications

Problem

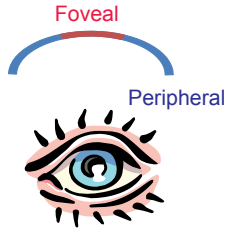
Cartoons often drawradial or parallel lines corresponding to motion. Movies often use motion effects. They both aim to emphasize the perception of motion. Recently, some other methods were proposed to emphasize motion. However, all these drawing algorithms result in a loss of original information. In other words, there is a trade-off between the expression of motion and image distortion.

Without motion effect

With motion effect

Difference about foveal(central) and peripheral visual perception

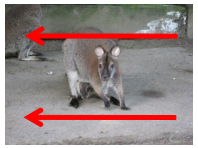
It is well known that we cannot recognize small signs in peripheral vision. On the other hand, peripheral vision is superior to foveal(central) vision in temporal resolution. The peripheral region has a higher temporal response (CFF; Critical Flicker Frequency) of about 50 Hz in light adaptation, while the foveal(central) region has lower temporal responce. Therefore, if the display shows visual motion with particular flicker frequency, users perceive motion only in their peripheral vision.



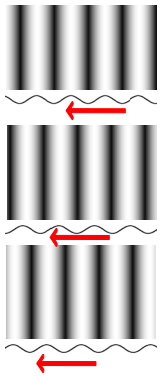
Challenges

Previous methods that emphasize motion of moving objects hide or distort large part of the original image. To avoid this trade-off, it is necessary to express motion while preserving the original image. We utilize the functional differences of foveal(central) and peripheral vision to solve this conflict.

Method



Step1.
Decide or calculate motion direction in the picture.

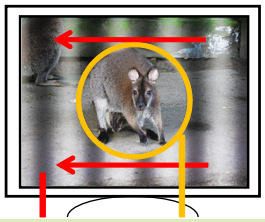


Step 2.
Prepare three luminance wave patterns, each of which has a different phase lag (0, 120, or 240 deg)

1/150sec
2/150sec
3/150sec

Step 3.
We repeatedly flip these patterns at 150 frames per second, generating a 50 Hz traveling wave.

Perceived Image



Peripheral vision	Foveal vision
- perceive motion	- luminance fused

As the traveling wave frequency is higher than temporal resolution of foveal(central) vision, it is not perceived as motion in the central visual field. On the contrary, it is perceived as motion in the peripheral visual field. Importantly, this technique does not require the measurement or tracking of eye motion.

Previous work

Knowledge about relation between critical flicker frequency and retinal positions

- Hylkema, B. S. 1942. Examination of the visual field by determining the fusion frequency, Acta Ophthalmology, 20, 181-193
- Fukuda, T. 1979. Relation between flicker fusion threshold and retinal positions, Percept Mot Skills. 49(1):3-17

Works for adding speed sensation on pictures

- Chi, M., Lee, T., Qu, Y., Wong, T. 2008. Self-Animating Images: Illusory Motion Using Repeated Asymmetric Patterns. ACM Trans. Graph. 27, 3, 1-8.
- Okabe, M., Anjyo, K., Igarashi, T., Seidel, H. P. 2009. Animating Pictures of Fluid using Video Examples. Eurographics, Vol. 28 No. 2.

Application for gaze direction

- Bailey, R., McNamara, A., Sudarsanam, N., and Grimm, C. 2009. Subtle gaze direction. ACM Trans. Graph. 28, 4, 1-14.

Perceived image and other examples

Added linear motion effect

Added radial motion effect

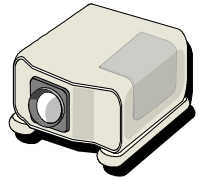
When user watch center of display

When user watch other part of display

Future Work

- Larger color display

  We will apply this method to larger display area using high-speed projector. It is expected that people perceive different visual motion while they watch same visual content together.



- Multi-directional luminance wave pattern in one scene

  Currently, the motion direction is one in one scene. In the next step, we will create visual stimuli that have different direction in one scene. Then we can adopt it to images containing many objects moving to arbitrary directions.