AUTOMATIC SHAKE TO ENHANCE FRASER-WILCOX ILLUSIONS

Kazuhisa Yanaka, Ryuto Mitsuhashi and Teluhiko Hilano
Kanagawa Institute of Technology, 1030 Shimo-ogino, Atsugi-shi, Kanagawa-ken, 243–0292, Japan

Keywords: Optical illusion, Fraser-wilcox illusion, Illusory motion, Peripheral drift illusion.

Abstract: The Fraser-Wilcox illusion, which is an optical illusion first found by Fraser and Wilcox in 1979 and later classified into the peripheral drift illusion that was presented in 1997, is the illusion that a disk drawn on a still image looks as if it is rotating. Recently, Kitaoka proposed an optimized Fraser-Wilcox illusion type V in which a stronger illusion can be perceived. This proposal has attracted a great deal of attention, but not everyone can see the illusion. It is well known that the effect of some existing illusions is reinforced by shaking the image by hand, and we therefore developed a system in which a still image displayed on the screen of an ordinary PC can be shaken automatically by using our software. Experimental results demonstrated that the strength of some types of Fraser-Wilcox illusions can be enhanced considerably by using the proposed system.

1 INTRODUCTION

Optical illusions are thought to be a kind of malfunction that occurs when the highly sophisticated human visual system processes retinal images. The study of optical illusions is therefore useful in terms of understanding human cognitive mechanisms.

Among the various illusions that have been reported up to now, there is a very interesting one, usually called the illusory motion or the self-animated image, in which parts of a still picture look as if they are moving just by glimpsing it. A typical example is the Fraser-Wilcox illusion (Fraser and Wilcox, 1979). In this illusion, disks that consist of repeated asymmetric patterns are drawn on paper or displayed on a screen and appear to rotate spontaneously, even though in actuality the image is perfectly stationary. The illusion is strong enough for those who are accustomed to it, but it is so faint that beginners of illusion can hardly see it.

It is empirically known that the strength of an optical illusion, not restricted to the Fraser-Wilcox one, can sometimes be reinforced when the figure is shaken: for example, by observers repeatedly moving their glasses up and down. However, reproducibility cannot be expected with such a method. We could find no reports on how to shake or with what kind of illusions this method is effective. Therefore, we developed a system that automatically shakes an illusion picture displayed on a PC screen and then studied this phenomenon experimentally.

2 FRASER-WILCOX ILLUSION

After the discovery of the Fraser-Wilcox illusion, a similar illusion was reported by Faubert and Herbert (1997). They called the illusion the peripheral drift illusion (PDI) because it is caused by peripheral vision and the illusion disappears when the pattern is gazed at directly. Since then, the Fraser-Wilcox illusion has been thought to be a typical example of PDI. Many researchers have studied it intensively in an attempt to reveal the mechanism behind such illusions. One possibility is that the gradient of the pattern that is scanned by the fixation movement of the eye cheats the neurons that detect movement. An interesting theory has recently been presented that explains illusionary motion by combining a time filter and a spatial filter (Fermüller, Ji, Kitaoka, 2010). Although this theory is feasible, further research would be necessary to develop any final conclusion.

In contrast, intensive experimental studies have been done to clarify the conditions in which a stronger illusion is perceived. A representative

Yanaka K., Mitsuhashi R. and Hilano T..
AUTOMATIC SHAKE TO ENHANCE FRASER-WILCOX ILLUSIONS .
DOI: 10.5220/0003321904050408
In *Proceedings of the International Conference on Computer Vision Theory and Applications* (VISAPP-2011), pages 405-408
ISBN: 978-989-8425-47-8

example of such studies is Kitaoka's work. He not only created a number of novel, beautiful, and strong "optimized" Fraser-Wilcox illusions, he also classified the illusions into six types based on the underlying rules. Among them, Type V (Kitaoka, A., 2009) is unique because the effect is very strong compared to other types. In addition, in Type V color is indispensable, whereas the other types are basically monochrome. Kitaoka's explanation of a similar illusion is that a longer-wavelength color, such as red, is perceived by our visual system faster than a shorter-wavelength color, such as blue (Kitaoka, A., 2010).

However, there are some people who cannot see an illusion of this type, perhaps because glimpsing is not easy for them. Therefore, we developed a system that can move an image displayed on a PC screen, thus enabling almost everyone to see the illusion.

3 THE SYSTEM TO SHAKE IMAGES

We used an ordinary Windows PC to shake illusion images, as shown in Fig. 1.

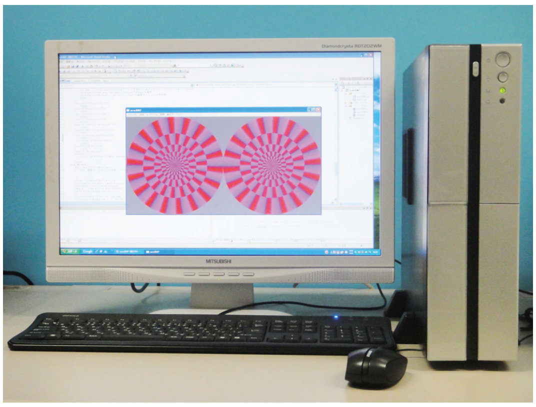

Figure 1: Our program running on a PC. (LCD: Mitsubishi RDT 202 WM 20.1 inch, 1680 × 1050).

Our program was written in C language and was developed with Microsoft Visual Studio 2008. The program reads the bmp file of a still image that causes an optical illusion and then displays the image on the screen. The image is updated tens of times per second and the position of the image on the screen is changed bit by bit by controlling an interval timer. This allows the shaken images to be displayed.

As shown in Fig. 2, the orientation of the shake can be designated as horizontal, vertical, diagonal (top left to bottom right and top right to bottom left), right rotation, and left rotation.

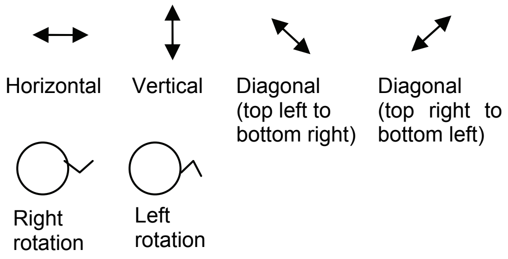

Figure 2: Orientation of the shake.

As shown in Fig. 3, there are two patterns of movement: sine wave and triangular wave. The cycle time of the wave can be varied from 10 to 2000 ms. The height of wave movement can be set from 0 to 100 pixels.

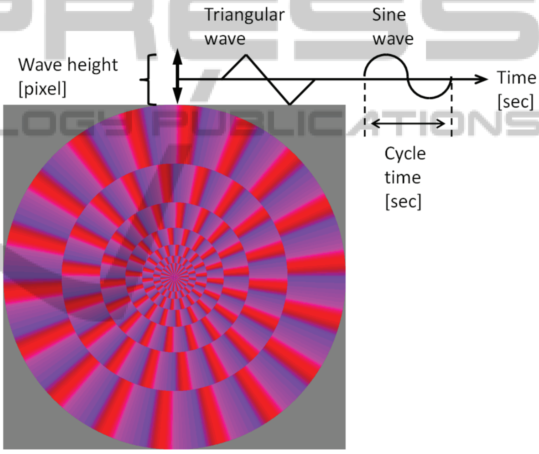

Figure 3: The case of vertical shake.

4 EXPERIMENTS

In the experiments, we primarily used a basic Fraser-Wilcox illusion (Fig. 4) and an optimized Fraser-Wilcox illusion Type V (Fig. 5). The synthesis of a pattern like the one in Fig. 4 is relatively straightforward because it consists of simple gradient patterns. On the other hand, a pattern like the one in Fig. 5 is rather complex because the variation of the color plays important roles.

Although the outline of the brightness variation of the figure that causes this type of illusion has been described online (Kitaoka, A., 2010), we could not find detailed information on the variation of the color anywhere. Therefore, the test patterns used in our experiment were created from scratch through trial and error by referring to published papers and Web pages.

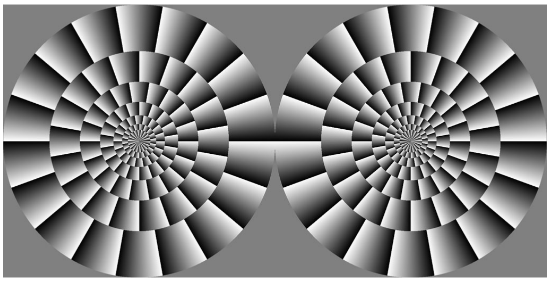

Figure 4: Basic Fraser-Wilcox illusion.

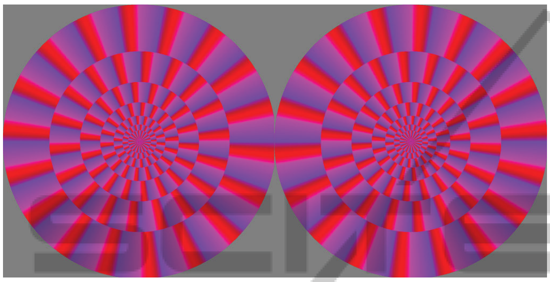

Figure 5: Optimized Fraser-Wilcox illusion type V.

One of the circular patterns included in Fig. 5 consists of two or more rings that share a center. If a ring is taken out, as shown in Fig. 6, it has periodicity along the angle θ. When one cycle is taken out, each brightness value of the RGB components is a function of θ because the distance from the center does not affect the value.

A very interesting question is what kind of functions should be used in order to obtain the illusion. We concluded that the green component should be at least a constant, and its desirable value is zero. As for the red and blue components, various functions of θ are possible. For example, sine waves of the same frequency but different phases, one for the red component and the other for the blue, are acceptable, although the illusion is not very strong. On the other hand, our experiment showed that a relatively strong illusion can be obtained when the functions shown in Fig. 7 are used. Please note that the vertical axis of Fig. 7 has been normalized by the full brightness and the horizontal axis has been normalized by the single cycle.

Experimental results showed that the Type V caused a stronger illusion to be felt. The results also suggest that an appropriate viewing angle is necessary for perceiving a strong illusion. In other words, the viewing angle greatly influences the effect of the enhancement. For example the rotation could be seen when the distance between the eyes and the display was about 30 cm. However, no rotation could be seen when the distance was about 2 m.

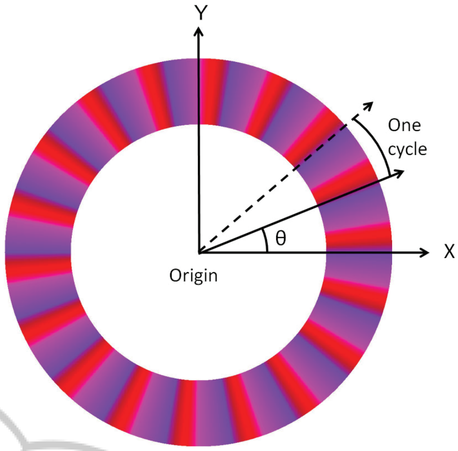

Figure 6: A ring extracted from Fig. 5.

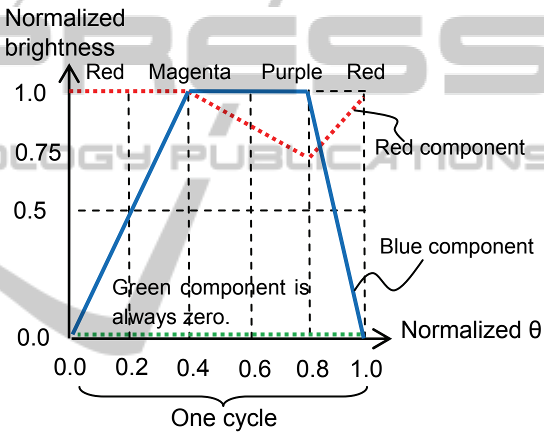

Figure 7: An example of variation of RGB values, each of which has the function of θ.

When the wave height is not large to some degree, the illusion is not caused. When the frequency of the vibration is high, the illusion grows. However, when the pulse height is small, the illusion is not generated. The ideal wave height varies with individuals, but overall it is about 50 pixels. When the pulse height grows, it becomes difficult to determine whether the illusion is caused or not.

A supplementary experiment was conducted for comparison. In this experiment, a hard copy of the illusion was printed with an ordinary inkjet printer (Canon MP960) and then hung from a clipboard with a weight and a spring, as shown in Fig. 8. It was then shaken by hand.

We confirmed that the optical illusion could be felt even with this simple system. This means that the enhancement effect of illusion described in this paper is not limited to a PC screen. However, the strength of the illusion with the hand shake system was weaker than the one with the automatic shake system. The reason for this is currently being investigated. Presumed causes are a too low frequency of the shake or the change of color.

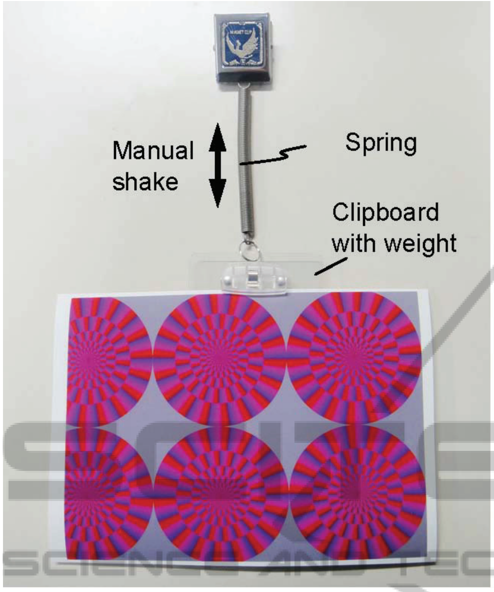

Figure 8: Manual shake system with hard copy.

5 CONCLUSIONS

We developed a new technique for enhancing illusory motion and were able to create a very strong illusion by shaking a picture of the illusion that was displayed on a PC screen by a programmed control. A particularly strong illusion was observed in Kitaoka's optimized Fraser-Wilcox illusion Type V. In contrast, in the famous rotating snakes illusion (Kitaoka, A., 2003), the enforcing effect of the shake was barely perceived. Among the six “optimized” Fraser-Wilcox illusions classified by Kitaoka, only the type V showed considerable enhancement. This result seems to suggest the possibility that the Type V is fundamentally different from the others.

Because the Fraser-Wilcox optical illusion is slight, experimentation has been rather difficult up to now unless special devices are used. However, the strength of the optical illusion can be boosted by introducing the “automatic shake” technique proposed in this paper, thus enabling easier experiments. Therefore, we expect this technique to significantly contribute to the advancement of illusory motion research.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Masahiro Suzuki of the Kanagawa Institute of Technology for his valuable comments.

REFERENCES

Fraser, A. and Wilcox, K. J. (1979). Perception of illusory movement, In *Nature 281,* pp. 565–566.

Faubert, J. and Herbert, A. M. (1997). The peripheral drift illusion: A motion illusion in the visual periphery, *Perception*, Volume 28, pp.108–121.

Fermüller, C., Ji, H., and Kitaoka, A. (2010). Illusory motion due to causal time filtering. *Vision Research*, Volume 50, Issue 3, pp. 315–329.

Kitaoka, A. and Ashida, H. (2003). Phenomenal characteristics of the peripheral drift illusion, *VISION*, 15, pp. 261–262.

Kitaoka, A. (2003). Rotating snakes. http://www.psy.ritsumei.ac.jp/~akitaoka/rotsnakee.html.

Kitaoka, A. (2009). Optimized Fraser-Wilcox Illusion Type V, http://www.psy.ritsumei.ac.jp/~akitaoka/
OFWtypeV.html (in Japanese).

Kitaoka, A. (2010). A brief classification of colour illusions, *Colour: Design & Creativity,* Volume 5, No. 3, pp. 1–9.

Murakami, I., Kitaoka, A., and Ashida, H. (2006). A positive correlation between fixation instability and the strength of illusory motion in a static display, *Vision Research,* Volume 46, Issue 15, July 2006, pp. 2421–2431.