# Motion Illusion in Video Images of Human Movement

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http://www.dips-kwansei.gr.jp/Yagi's%20HP/top.htm

**Abstract.** We found a novel motion illusion; when a video clip presents a moving person, the background image appears to move incorrectly. We investigated this illusion with psychophysical experiments using a movie display that consisted of a human figure and a vertical grating pattern. The grating periodically reversed its light-dark phase so that it was ambiguous in terms of motion directions. However, when the human figure presented a walking gait in front of the grating, the grating appears to move in the opposite direction of her/his locomotion. This illusion suggests that human movements modulate perception of video images, and that creators of entertainment images need to pay attention to background images in videos used in animation and computer graphics.

## 1 Introduction

Viewing human movement has an important role in societal survival, and in enjoying entertainment such as sports, dance, cinemas, TV shows and video games. The latter field has been enlarged by computer graphics that easily create animation of moving people in virtual environments such as walkers on the moon, swimmers in the sky, runners in an imaginary street, and so on. However, we have found that seeing human movements accompanies visual motion illusions. When a person presents a walking or running gait, specifically, a background pattern appears to move in the opposite direction of his/her locomotion. We have called this illusion the 'backscroll illusion' because it is apparently created by backward display scrolling. Here we present some demonstrations, an overview of psychophysical experiments, and the implications of this illusion for entertainment computing.

## 2 Methods

To demonstrate motion illusions, researchers have used patterns of ambiguous movements. The backscroll illusion appears optimally in dynamic grating backgrounds, as illustrated in Fig.1. These gratings reverse dark-light phases periodically so that they have two motion components in opposite directions at an equal speed. An

individual grating is made by the linear summation of two gratings that move in opposite directions at equal speeds. Gratings are also suitable for visual stimuli in psychophysical experiments because their physical properties such as luminance contrast, spatial frequency, temporal frequency and velocity can be independently controlled. In addition, and known as motion cancellation methods, the strength of the illusion is physically represented by controlling the ratio of luminance contrasts between the two component gratings [8].

The human figures are presented in walking or running gaits, as if they stepped on a treadmill. There is no body-translation. Each body part moves along a pendulum-like trajectory with anti-phase to its counterpart (e.g. left vs. right elbows, wrists, knees, ankles, etc.). Thus, in physical terms the human figures also have no directional bias. In our experiments and demonstrations, the human figures were designed with Curious Poser 4/5 software, and superimposed on the gratings using a chroma key technique.

In our experiments, the size of the movie stimuli was about 8 cm width and height from 256 pixels on a 17 inch CRT monitor. Observers viewed the display from a distance of 90 cm, which resulted in a retinal size of 5 deg of visual angle. Other details about the experimental methods have been described in our papers [3] [4].

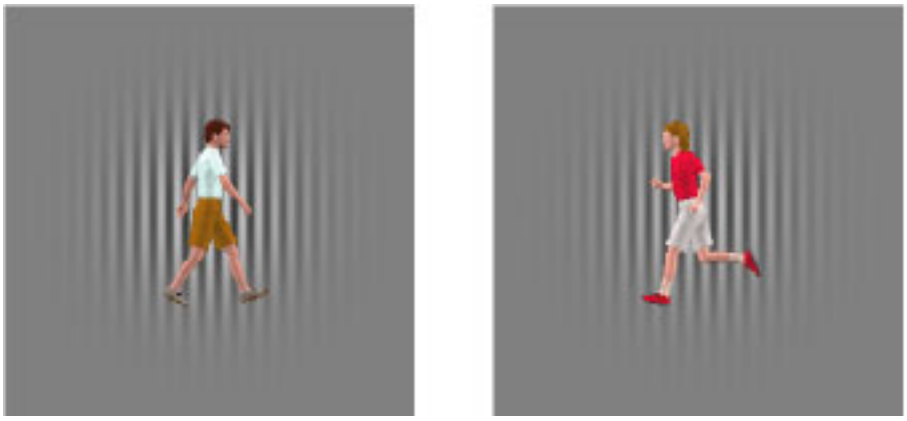

**Fig. 1.** Snapshots of video clips used in our experiments. The video images presented either a walker or a runner; they remained stationary as if stepping on a treadmill, and were seen against a counterphase grating background. The grating appeared to drift in the direction opposite to the gait despite there being no prominence of any physical components corresponding to such a perception. Demonstration movies are on the website at http://www.h6.dion.ne.jp/~fff/backscroll/.

## 3 Results

Psychophysical experiments showed that the backscroll illusion was optimally perceived under the following conditions: velocity match between the grating and the human gait, temporal frequency of grating at 10-20 Hz, and presentation time between 0.5 and 4 s [4]. Strength was as much as that of the well-known motion after effect (induced by prolonged observation of unidirectional motion [8]). Another experiment indicated that the effect corresponded to micro-stimulation of the motion-specific brain area of macaque monkeys [2] [9].

Further, we recently found involvements of a social factor. The backscroll illusion was enhanced when video clips were presented in peripheral visual fields and the walker appeared to go away from the fovea on the retina. In this case, a walker gradually disappeared due to decreasing acuity in peripheral vision unless observers tracked the walker with increasing attention.

We have reported another experiment using a point-light biological motion display in which only small light sources attached on the main joints of actors are visible [1]. Such fragmented human figures also affected observers' perceptual judgments, although they poorly produced illusory impression. The most important result was that the illusion disappeared when the point-lights were spatially scrambled without any change of moving trajectory of each joint. This emphasizes that there is no involvement of a physical motion bias in the backscroll illusion.

## 4 Discussion

Our psychophysical results have consistently suggested that the backscroll illusion involves high-level perception mechanisms. Physiological studies showed that recognition of human movements is mediated by the highest brain area of the visual system [6]. On the other hand, grating movements are analyzed in lower areas [7]. Thus, the backscroll illusion will find feedback streams in the neural network in the visual system.

We do not believe that it is only video images that produce the backscroll illusion. It should exist in natural scenes and influence our behavior. For example, seeing others' gaits upsets our vision enough to cause collisions in a crowded street. When driving at night, the sudden appearance of pedestrians attracts a driver's attention to produce illusory spatial perception, which can lead to a crash. We think that the backscroll illusion is likely to appear when background images are ambiguous.

We have reported elsewhere that background motion affects the perception of human gaits [5], which is a counter effect to the backscroll illusion. Our findings suggest that creators of images need to take care with background images in animation or computer graphics. If not, audiences will receive wrong information and experience feelings of unpleasantness. Rather, we hope that new entertainment vehicles will apply the visual illusions of human movements.

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