

NEW OPTICAL ILLUSION BY ANIMATING JUDD ILLUSION USING SCALABLE VECTOR GRAPHICS

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Abstract: We present a method of creating a new illusion with motion accomplished by gradually changing the parameters of an existing still-image illusion. We applied this method to the well-known Judd Illusion and the angle of the tail of the arrow was gradually changed with SVG. We therefore found a new animated optical illusion in which volunteers perceived that the main segment was moving horizontally, although it actually remained stationary.

1 INTRODUCTION

We describe a new optical illusion which is produced by animating the Judd illusion. Optical illusions have long attracted the attention of scientists because they are considered phenomena deeply related to a person's cognition. However, it was too time consuming to accurately draw images manually in early days of such experiments. Although the time and labor required have been considerably reduced by the emergence of PCs and drawing software, considerable time and labor are still necessary, especially to create animated illusions.

Scalable vector graphics (SVG) (W3C, 2010b) has changed this: SVG makes us to draw considerably complex figures efficiently if the figures have regular shapes. Moreover, it is easy to animate some properties of figures using SVG's function. Therefore, SVG is an ideal tool for illusion experiments.

We added animation to Judd's well known illusion in which the angle of the tail of an arrow gradually changes by using SVG's function. As a result, we found a new animated method of optical illusion to create a new illusion with motion attained by gradually changing the parameters of an existing still-image illusion. We therefore found a new animated optical illusion in which volunteers perceived that the main segment was moving horizontally, although it actually remained stationary.

2 ABOUT SVG AND OTHER TOOLS MAKING FIGURES WITH ANIMATION

2.1 About SVG

According to W3C web site(W3C, 2010b), SVG has following characteristics:

SVG is a language for describing two-dimensional graphics in XML [XML10]. SVG allows for three types of graphic objects: vector graphic shapes (e.g., paths consisting of straight lines and curves), images and text. Graphical objects can be grouped, styled, transformed and composited into previously rendered objects. The feature set includes nested transformations, clipping paths, alpha masks, filter effects and template objects.

SVG drawings can be interactive and dynamic. Animations can be defined and triggered either declaratively (i.e., by embedding SVG animation elements in SVG content) or via scripting.

Sophisticated applications of SVG are possible by use of a supplemental scripting language which accesses SVG Document Object Model (DOM), which provides complete access to all elements, attributes and properties. A rich set of event handlers such as `onmouseover` and `onclick` can be assigned

to any SVG graphical object. Because of its compatibility and leveraging of other Web standards, features like scripting can be done on XHTML and SVG elements simultaneously within the same Web page.

Thus, there are several advantages of using SVG:

- it can be used to draw an accurate figure and to animate it smoothly.
- We can add to change the properties of the figures interactively.
- Anyone can reproduce our experiment because we used widely available equipment and software that the data are described in open format.

2.2 Other Tools Making Figures with Animation

One of tools making figures with animation is Processing language(Processing.org, 2010).

Processing is an open source programming language and environment for people who want to create images, animations, and interactions. ...

Processing gives the method to draw figures. When one wants to animate the figures, one must draw the figures on each frames. Moreover, the figures in Processing is not the object, so one try to add the interactivity to the figures, one needs more efforts than SVG. For these reasons, we do not use Processing.

3 ORIGINAL AND ANIMATED JUDD ILLUSION

The thick arrow with a black dot in Figure 1 is the original Judd illusion(Robinson, 1972, Fig. 2.21).

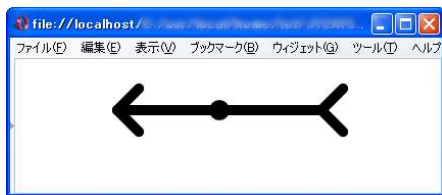


Figure 1: Judd illusion.

Although the dot is in the center of the main segment, it seems to shift left of center because of the arrowhead and the back tail of the arrow. Most optical illusions, including the Judd illusion, can be perceived in still pictures. However, moving illusions can be derived from a still geometrical optical illusion by

gradually changing parameters like the angle between the segments of the original still illusion.

For example, the length of the main segment in the famous Müller-Lyer optical illusion is perceived to expand and contract when the directions of the arrow's tail and arrowhead are alternately reversed (Goto and Tanaka, 2005, p. 271). However no other similar examples are known. Moreover, its movement is not continuous but discrete. Therefore, we investigated a new animated optical illusion created by changing parameters of an optical illusion.

To demonstrate animation in the Judd illusion in Figure 2, we prepared the code for SVG as follows:

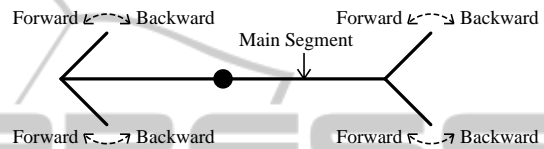


Figure 2: Judd illusion with animation.

Program 1: Code of Animated Judd Illusion

```

1  <?xml version="1.0" encoding="UTF-8" ?>
   <svg xmlns="http://www.w3.org/2000/svg"
       xmlns:xlink="http://www.w3.org/1999/xlink"
       height="100%" width="100%">
5   <defs>
       <g transform="rotate(45)" id="Line">
           <line x1="0" y1="0" x2="30"
               line-cap="round" stroke-width="10"
               stroke="black" >
10          <animateTransform
                attributeName="transform"
                type="rotate"
                values="30;150;150;30;30"
                keyTimes="0;0.4;0.5;0.9;1"
                repeatCount="indefinite"
                dur="25s" fill="freeze" />
           </line>
       </g>
       <g id="edge" >
20          <use xlink:href="#Line" />
           <g transform="scale(1,-1)" >
               <use xlink:href="#Line" />
           </g>
       </g>
25 </defs>
       <g transform="translate(100,50)" >
           <line x1="0" y1="0" x2="200" y2="0"
               line-cap="round" stroke-width="10"
               stroke="black" />
30          <circle cx="100" cy="0" r="10"
                  fill="black"/>
           <use xlink:href="#edge"/>
           <g transform="translate(200,0)" >
               <use xlink:href="#edge"/>
35          </g>
       </g>
   </svg>

```

Details of the code is as follows:

- Line 1 denotes the XML declaration.
- Lines 2–4 denotes the root tag and declares name spaces to use this document.
- Lines 5–25 defines one segment of feathers with animation (lines 6–17) and make an arrow (lines 19–24), which makes easy to change the speed of animation of the tail and the length of tail.
 - Lines 10–16 defines the rotated animation of the tail.
 - Line 13 defines the head/tail rotation angle first to 30° and then to 150° , which is kept for one cycle and then changed back to 30° and kept for one cycle, and so on.
 - Duration time or rotation time is defined in line 16 and line 14 defines the ratio of the time denoted the angles.
 - Line 15 denotes the animation will be continued forever.
- The rest of the code denotes the final figure.
 - Lines 27–29 denotes the main segment.
 - Lines 30–31 denotes the circle at the center.
 - Line 32 specifies the left tail to refer ones previously defined.
 - Lines 33–35 specifies the right tail to shift the ones previously defined.

Because the code of SVG can be embedded in HTML code or directly written in HTML5 (W3C, 2010a), we make a web page to change parameters of an optical illusion interactively.

4 EXPERIMENTS

As previously stated, we used SVG to create and animate the Judd illusion by continuously changing the angle of the tail and arrowhead. The number of browsers can currently play animated SVG files is very limited.

We chose the Opera browser for this study because some famous browsers does not support to show SVG's figures or no to show animation of SVG.

We animated the Judd illusion so that the tail and arrowhead repeatedly rotated forward and backward with a cycle 25 sec, as see in Figure 3.

There are three figures in the right side indicates to show or not to show the figures on the right side respectively. Figure 4 shows the figure when the bottom of the check boxes is clicked.



Figure 3: The figure using the experiment.



Figure 4: The figure when the bottom of the check boxes is clicked.

Thus, one can easily check that one figure's animation gives effects to change the degree of optical illusion of the other figures. The animation of this figures starts when one clicks on the areas of the browser.

Despite the fact that both the main segment and the dot were completely stationary, all five volunteers who watched the animation responded that they perceived the main segment to be moving horizontally.

With three figures displayed simultaneously, the main segments seem to move even when the central dots were present, as shown in Figure 3.

When we increased the rotation speed (cycles of 5 sec), the effect of the illusion weakened. However, such movement was barely perceived when the central dot was omitted, as shown in Figure 5.

Figure 6 shows a case in which the main segments are omitted, but the dots are displayed.

Interestingly, the "invisible" main segments seemed to move. However, the orientation of the motion differed from what was expected from "Morigana's paradox of displacement" (Ninio, 2001, Fig. 13.1).

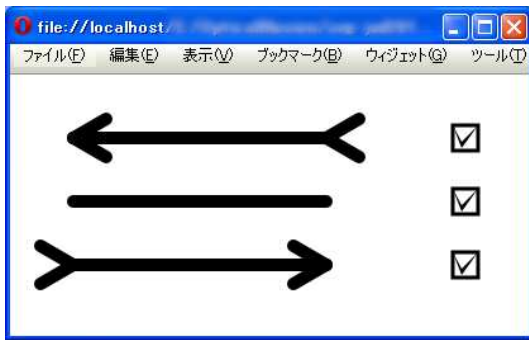


Figure 5: Three figures without dots in center.



Figure 6: Three figures without main segments.

5 APPLICATION TO OTHER ILLUSIONS

Figure 7 shows the Fick Illusion (Robinson, 1972, Fig. 3.76), in which the two segments appear to have different length, although they are actually the same.

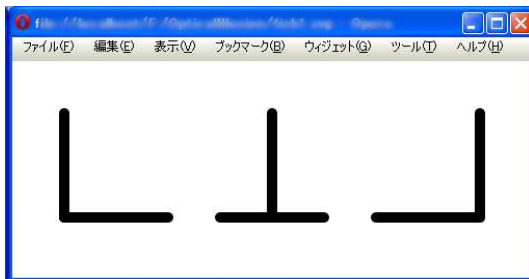


Figure 7: Fick Illusion.

A vertical segment was continuously moved from left to right by using SVG's animation function. We concluded that the subjects could not perceive any changes in the length of the line when the segment was moving. We think that this is because the subjects did not focus on more than two segments at the same time.

6 CONCLUSIONS

When we animated a still image of the Judd illusion with SVG, we found an unexpected new animated optical illusion. This method seems to have extremely wide coverage because it is possible to animate most optical illusions by changing their parameters.

This study is useful not only for providing a new way of enjoying illusions, but also to help clarify the mechanism responsible for illusions from a different perspective.

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