

# Development of Printed Animated Graphic Images Based on Optical Illusions

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**Abstract.** The development of animated images that are printed on paper is covered in this article. Animated images are based on the illusion effect. Optical illusions include errors in visual perception caused by the inaccuracy or inadequacy of processes of unconscious vision correction. The illusions that create the effect of motion, the effect of resizing, the effect of motion are considered. The development is based on the division of key frames of the moving image. These illusions have been developed for the print and the algorithm for animation of the image has been developed.

**Keywords:** animated images, digital printing, optical illusions

## 1 Analysis of printed animated optical illusions

Animated optical illusions include images that use the properties of human vision and create the effect of a three-dimensional image and its motion. If you create an image using special algorithms that connect the individual image components in a specific way, it can create different special effects of motion.

Man reading books try to create images that reflect the movement of objects. Images travel from page to page and cause feelings of pleasure, anger, love and more.

For young children, they make books with a wealth of illustrations that should be simple, understandable and immediately evoke the feelings above. This allows you to better understand the book, learn about the world and develop feelings.

But all the illustrations are static, motionless and it is very difficult to create an illustration that triggers a movement response.

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Completely different matter cartoons, animations. But man, the child is constantly on the move. On the move, she learns about the world and develops. Therefore, we believe that it is appropriate to create illustrations in books that are more moving to convey the content and idea of the book. It is also very exciting and interesting. After all, we buy the book and it is “alive”.

When a person becomes an adult, he or she does not lose the taste of childhood and wants to see in the book the same beautiful, kind, charming illustrations, but which pass to another stage of perception. Man wants fairy tales. He wants something out of the ordinary. Optical illusions can become such unusual illustrations.

## **2 Optical illusions as a new kind of graphic images**

There are such types of illusions as physical, optical, sound, tactile, affective, verbal, organic, illusions of awareness, pre-eminence.

Physical illusions, these are illusions related to the objective laws of physics in the world, in particular a spoon, partially immersed in a glass of water, is perceived as broken [1].

Optical illusions - a mistake of vision; errors in visual perception, caused by the inaccuracy or inadequacy of processes of unconscious correction of visual image [2].

Sound illusions, such as Shepard's tone [3].

Tactile illusions, such as Aristotle's illusion [4].

Physiological illusions are related to the peculiarities of the human sense organs, for example, if several times simultaneously lifting two different objects by weight with both hands and then another pair of objects of the same mass, then the object that was in the hand, which was lighter before, will seem heavier than the object in the other hand [5].

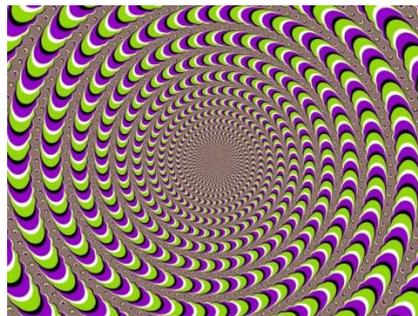
There are other illusions, affective illusions - arising under the influence of pronounced mood swings or due to the acute affect of fear, anxiety [6]. Verbal illusions - arise as a result of distorted perception of real conversations of others [7].

Organic illusions - the distorted visual perception of the shape, size, color, spatial location, state of rest or movement of a real existing object; distinguish between autometamorphopsia (sense of change in size, shape of parts of one's own body) and exometamorphopsia (violation of perception of surrounding objects); this kind of disorders of perception can be observed not only in mentally ill, but also in mentally healthy people with pathology of the organ of vision [8].

*An optical illusion* - is a mistake in visual perception, which is caused by inaccuracy or an inadvertent correction of the star image correction [9]. An optical illusion is also called brain fraud. The human eye sees the image of one object, but the brain understands the object in its way. What we see may not be true, and our brains may perceive the same things at different angles in quite another way.

Optical illusions have long been engaged in mathematics by M. Escher [10], O. Reutersward [11]. G. Spiro [12], while researching the works of Augustus Ferdinand Mobius, concluded that topology, vector theory, and multidimensional geometry found application in illusions. B.B. Lissing [13] developed a theory of topology. The

great contribution to the development of illusions was made by artists I. Oroc [14], D. Yun [15]. Ukrainian artists were also engaged in illusions. In particular S. Shcherbin [16], exploring the works of the artist Shuplyak, came to the conclusion that his "dual" (this is what the artist calls his paintings with double or even triple content) inspire reflection, reflect reality and carry certain information, and also intrigue, forcing a good look to solve the drawn . Known influence of illusions on people and psychiatrist A. Kitaoka [17].

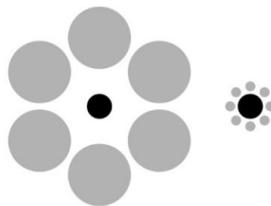


**Fig. 1.** The illusion of a moving picture

The reasons behind the illusions of perception are varied and unknown to the end. Some theories explain that visual illusions are created under the action of peripheral factors (irradiation, accommodation, eye movements, etc.), others - by the influence of some central factories. Fig. 1. Consider some types of optical illusions [10]:

## 2.1 Perception of mind

Such missions will lead to errors in the perception of real geometric quantities. Otherwise, errors can reach up to 25%. Estimates of real quantities are strongly dependent on the nature of the background image.



**Fig. 2.** The illusion of the size of Ebbinghaus

Ebbinghaus illusion or Titchener circle is an optical illusion of perception of relative sizes. The most famous version of this illusion is that when two circles, identical in size, are placed side by side, and around one of them are circles of large size, while the other is surrounded by small circles, the first circle seems smaller than the second. see Fig. 2. [18].

## 2.2 Illusions of motion perception

These are illusions, when the static and motionless pattern "comes to life" and begins to move, or starts to rotate into one and then to the other side. There are throbbing drawings, but really - all of these are static drawings see Fig. 3.



Fig. 3. The illusion of movement

## 2.3 The illusion of movement

Animations may not be just "live" pictures, but represent real puzzles for vision. Optical illusions always have ambiguous interpretations, and an illusory effect may be noticeable when tilting, rotating, or moving.

In artistic images, deliberate distortion of perspective causes special effects, best known for M. Escher's work [19]. The effect is enhanced by tilting, rotating, zooming in / out, in particular, the still image seems moving, when viewed with the same moving objects, you can see that they are different sizes, the same image can reproduce a rotating object clockwise, against her or make oscillatory movements.

## 3 Creating optical effects

Data transmission based on optical effects is also practiced in modern information technologies. Modern Snapchat development enables the reproduction of an image that is programmed to self-destruct in a few seconds [20]. Or, new to this software is that the image cannot be saved, making a screenshot or taking a camera. You can make sure the image is true through optical illusions, where images disappear or appear from different angles. This idea of protection was implemented by the developers of the utility "Yovo", which is available for "iPhone". Its essence is that the image is covered by translucent vertical stripes. They can be activated by the sender and in this case when they try to take a screenshot or take a picture the screen will be displayed, which makes the image unreadable. However, when viewing a submitted photo, the user will not feel discomfort. All because vertical bars are moving horizontally at high speed. Due to this, the gaps between them merge into one and the human brain per-

ceives the information sent without interference. Creating a screenshot makes a static striped copy. Due to the inability to reproduce the paper dynamics of the image.

Copying of printed grids with a low reproduction rate causes a defect such as a moiré. And on this phenomenon, it is possible to develop moving images.

Moiré is the result of the interference of two or more periodic structures having different spatial frequencies [12].

Moiré occurs when a set of straight or curved lines is superimposed on another set of lines. The name Moiré was derived from the French word "watered" [19]. You can see this effect by looking at the folds of the nylon curtain that fluctuate. If a grid with parallel black and white lines of the same width overlaps the same grid, edges will appear as the intersection angle changes.

## 4 Development of an animated image based on illusion

### 4.1 Creating a protective image

Therefore, the idea of creating an optical illusion for the protection of printing products is that the image will move as you apply and move the grid from above. Circle motion is taken as the input image (Fig. 4).

Creating an image will take several steps:

- Framing;
- Inversion;
- Animation.

The result will be images with thin lines up to 0.25 mm thick that cannot be copied.

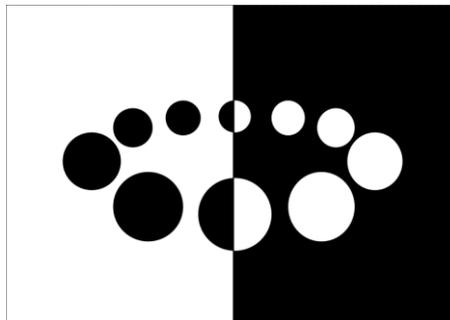


Fig. 4. Input image

### 4.2 Framing

The first step in creating an optical illusion is to crop the image. Each frame of the cat movement should be placed on a separate layer. Step by step cropping procedure:

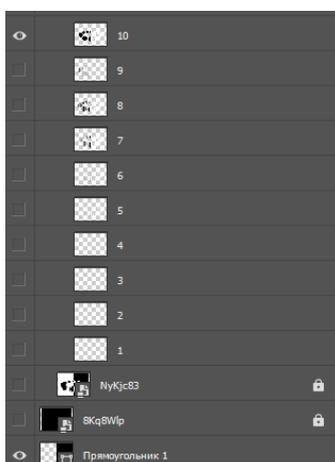
- Add an image to a new layer of a document by dragging it from a folder to an window.
- Use the Rectangular Selection tool to highlight the first frame.

- Right-click on the highlighted area and select Copy to New Layer from the popup menu.
- Repeat step 3 with other frames. The result will be 9-12 layers of frames
- The crop is complete. For convenience, place all the layers with frames in one folder.

### 4.3 Inversion

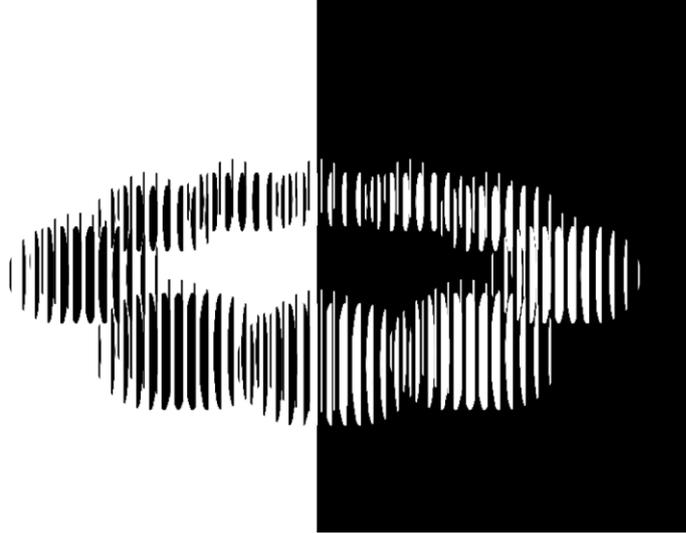
Each frame of the image becomes clearly visible when placed on it grid. Therefore, the protective image should be formed of thin fragments placed between the grid lines (Fig.5). Step by step image inversion procedure:

Remove all frames from view. Make the first image visible. Center it.



**Fig. 5.** Step one is to place the first frame.

Repeat the first step with the rest of the images, alternately including the visibility of each frame.



**Fig. 6.** Step two is to place the frames in the center

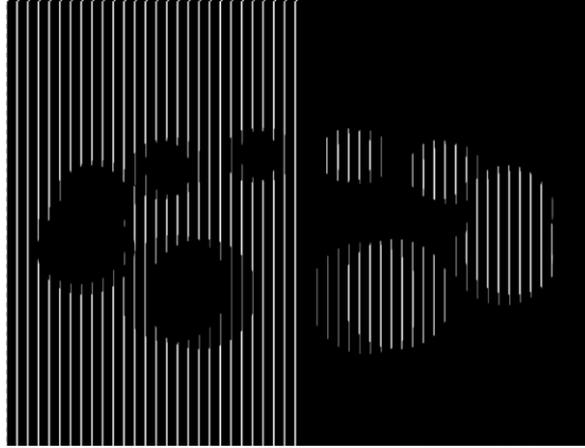
#### **4.4 Animation**

Each time the grid moves, a separate image frame should fall into the area of view between the grid lines. Therefore, it is necessary to place the frames so that each frame drops another frame.

First you need to calculate the number of frames. The input image consisted of 12 frames of motion of a circle, so it is possible to select frames that will form a smooth motion of the optical illusion. The line spacing is  $1/9$  of the grid line. This means that 9 frames are placed next to each other with offset to create the animation (Fig.6).

#### **4.5 Step by step animation procedure for an image:**

Remove visibility from all but the first frame. The first image frame remains in place. Enable grid visibility (Fig. 7).



**Fig. 7.** Step One - Placing the first frame

- Enable second frame visibility. Move the grid to the left one step with the ← key. Both frames were out of sight.
- Move the second frame into view by pressing the ← key.
- Enable third frame visibility. Move the grid one step. Press the ← key to place the third frame in the area of view.

Shifting the grid one step, similarly to place another 6 frames. Disable grid visibility.

Therefore, as a result of performing all the steps of image and grid creation, a protective optical illusion is obtained, consisting of thin lines, about 0.24 mm thick. It is not possible to copy such thin lines, which means that the image is copy-protected by printing fine graphics. Another layer of security is also implemented - mesh authentication. The copied image will not be clear. When moving the grid, the original image will move smoothly. Methods for constructing print print growth are taken in [21]. The development of image filtering at the pre-treatment stage of the method is taken in [22]. Further processing of animated images was developed in [23]. Building methods for intelligent decision support systems based on adaptive ontology were used in [24]. Ontological structures were developed in [25]. The construction of libraries and systems was elaborated in [26]. The development of the data protection method is presented in [27]. And hiding and protecting animated illusions is taken in [28]. Creation of corresponding color profiles is taken in [29]. Building systems based on the above properties is shown in [30]. The use of high resolution and its reduction for animated images is taken in [31]. Data protection is shown in [32]. [33] shows the automatic filtering by Ateb-Gabor.

## Conclusions

The phenomenon of optical illusions as a perspective direction for creating moving images is investigated. The causes of illusions and their reproduction are analyzed. The literature on optical illusions and moiré is analyzed. The model of constructing phenomena is investigated. During acquaintance with the theoretical aspects of optical illusions and moiré, it became possible to formulate requirements for the developed "moving" images.

The effects of the moiré printing defect are analyzed and based on its motion images. Printed animated graphic images based on the moiré phenomenon and optical illusions have been developed. Animated images are made using modern software.

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