Pisco Med Publishing

Demonstrating Dynamic Pictures Using a Flat Mirror

Yuanhao Xiao

Hubei Shiyan Foreign Language School, Shiyan 442000, China.

Abstract: The interesting instrument making is not only a better way to show the principles of physics, but more importantly it can be used to stimulate interest in physics through the display of the equipment. It is also possible to apply the principles of physics in teaching to create simple experimental equipment which not only attracts the attention of the students but also explains the principles of the experiment in a subtle way. In this thesis, a dynamic picture demonstration instrument was created. Using the principle of visual staying, the effect was demonstrated along with an explanation of the theoretical phenomena associated with film playback and other related phenomena. Finally the concept of instrument making was introduced into the teaching of physics, making full use of this instrument making.

Keywords: Visual Staying; Dynamic Picture; Plane Mirror Imaging

1. Introduction

Physical experiments are an important means of understanding the world, an important way of studying scientific problems and an important method of understanding abstract concepts. Interesting instrumental making can not only better demonstrate the principles, but moreover can be used to generate interest in physics through instrumental displays. In teaching, the instruments can also be applied to create simple experimental equipment which not only attracts the attention of the students but also explains the principles of the experiment in a subtle way.

Physics is a subject that comes from life and serves life, with its greatest charm being its ability to combine simple principles to create magical and interesting effects. Inspired by the concept of science and technology museums and the exhibit system, it is believed that innovative low-cost experiments can open up effective ways of solving problems. In this subject, the focus and innovation is on improving the visibility of existing experiments, simplifying the materials used to make them, and designing interesting experiments outside of school to innovate and design this low-cost fun experiment in physics.

The principle of the instrument is the same as that of the Western mirror, a technique that uses the principle of visual staying. Following the rapid rotation of the turntable, the eye and brain put the pictures together into a moving image. Using a common device in life, it demonstrates the principle of magical animation.

2. Principle of dynamic drawing instruments

2.1 Visual staying phenomenon

There is a property of the eye to retain visual impressions. This is because when the retina is stimulated by light, a strong chemical change occurs; after the light stimulus has stopped, the chemical breakdown cannot be reduced immediately, so the visual image can only gradually disappear. This ability to retain visual impressions for a short period of time is called visual staying. The actual measurements show that the eye retains the visual image for about 0.1 seconds when the light is neither

too strong nor too weak. Thus, when a light source flashes more than ten times per second, it looks as if it is not flashing, but glowing with a uniform light. An electric fan spinning at high speed appears as if its blades are linked together; raindrops falling appear to be linked in a line, etc. These are all visual staying phenomena (Fig. 1 Principle of visual staying). The earliest application of visual staying phenomenon was the "revolving scenic lantern" in the Song Dynasty recorded in Chinese history, which was called "horse-riding lantern" at that time.

Fig. 1 Visual staying principle

In 1824, Peter Roget published Persistence of Vision with Regard to Moving Objects, which was the beginning of the study of the principle of visual staying. The book proposes the idea that "the image stimulus can remain on the retina for a number of times after its initial appearance. Thus, when various separate stimuli are revealed in fairly rapid succession, the stimulus signals in the retina overlap and the image becomes continuous." This book sparked nearly 50 years of research that followed. Then in 1828 the Frenchman Paul Roget applied the principle of visual staying to the invention of the staying disc. It was a disc with a string running through it on two sides. One side of the disc was painted with a bird and the other was painted with an empty cage. When the disc is rotated, the bird appears in the cage. There are also many applications of the principle of visual staying, such as the 'phantom lens' and the 'zoetrope', a series of sketched drawings on a roll of paper, which are then seen through thin slits to see the moving image. In addition, "practical mirrors" and "thaumatrope" and "flip book also make use of the rotating discs and the visual staying principle to achieve a dramatic effect that is pleasing to the eye. While the principle of visual staying provided the scientific basis for the invention of animation, the spread of photography was also an external factor in the development of animation.

To better explain this principle, the following experiment on visual staying can be carried out: two small lamps are placed 1-2 metres apart in a dark room. The two lights are allowed to alternate between being lit and extinguished at a slow rate. The observer sees the two lamps light up and go out separately. The two small lights are allowed to alternate between 25-40 millisecond intervals. The observer sees one small lamp jumping around between the two positions instead of two small lamps lighting up and going off separately. In the second case, one light remains in one's vision for a brief period of time when it is lit, and before it is extinguished the other light is lit again, and the observer visually mixes the two lights into one and feels that only one light is jumping around, which is the visual staying phenomenon.

2.2 Visual principles of animation

When watching a film, television or cartoon, the characters and scenes in the picture are continuous, smooth and natural. However, when looking closely at a piece of film or cartoon, the picture seen is not continuous at all. The visual effect of movement is only possible if the film is projected onto the screen at a certain rate, a phenomenon caused by visual staying. Animation and film take advantage of this visual staying property of the human eye.

It has been experimentally proven that if the picture refresh rate of an animation or film is around 24 frames per second, the human eye sees a continuous picture effect. A rate of 24 frames per second is therefore the standard for film projection. It is the most efficient way to make a continuous and smooth motion picture. When a film projector plays 24 pictures per second, i.e. at a projection speed of 1/24 of a second, before the previous still picture disappears in front of the eyes, the next similar picture appears in front of the eyes, so it feels like the film is coherent. The same principle applies to television broadcasting, but the speed of television is 1/30 of a second.

2.3 Principle of plane mirror imaging

The principle of plane mirror imaging follows the principle of reflection of light. The light from the sun or a lamp hits a person and is reflected back into the mirror (this is diffuse reflection). The plane mirror in turn reflects the light back into the person's eyes, so we see our own virtual image in the plane mirror. Looking in a mirror is the same principle.

The image in a plane mirror is formed by the intersection of the extension lines of the reflected rays of light, so the image in a plane mirror is an imaginary image. The imaginary image is equal in size to the object and equal in distance. The image and the object are equal in size. So the image and the object are symmetrical to the mirror.

The image and the object are always equal in size according to the characteristics of plane mirror imaging. No matter how the distance between the object and the plane mirror changes, the size of the image in the plane mirror always remains the same, and the size of the object is always the same. However, because people have a sense of "big near and small far" when looking at objects. When a person walks towards a plane mirror, the image does feel 'bigger' to the eye. This is because the size of an object as observed by the human eye is not only related to the real size of the object, but also to the 'perspective'. The angle between these two lines is the "angle of view". If the angle of view is large, the object is perceived as large, and if the angle of view is small, the object is perceived as small. When a person approaches a plane mirror, the distance between the image and the person is smaller, and the person's perspective of the object increases, so the image seen feels larger, but in reality the image and the person are always the same size. This is the reason why the human eye sees objects as 'large near and small far'. This is the same as when a person sees a person walking in the distance in front of them, at first it is a small dark shadow, but slowly it gets bigger and bigger, and when it comes to them it is even bigger. In fact, the small shadow is the same size as the person walking in front of it, but because of the visual relationship, the image and object of a plane mirror are symmetrical about the mirror. Therefore, as the person gets closer to the mirror, the image must also get closer to the mirror, and the person's perception is that it is "bigger near and smaller far", which is a visual effect.

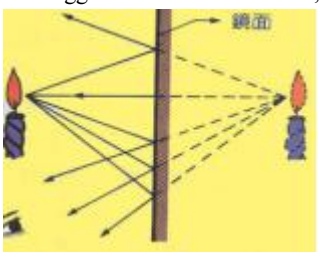

Fig. 2 Plane mirror imaging

2.4 Apparent movement phenomenon

Two stationary stimuli, separated by a certain distance, are presented at appropriate intervals. The observer develops the sensation that the stimuli are moving from one point to another, a phenomenon known as apparent movement phenomenon. It is due to the fact that the successive presentation of the stimuli acts on the sensation and also causes the organism to produce a physiological stimulus similar to the real movement. After the first stimulus has ceased, the neural excitation it induces continues for a brief period of time, and if a second stimulus appears during this brief period, the neural excitation it induces is linked to the temporary sustained excitation induced by the first stimulus, so that the sensation of the first stimulus moves to the place of the second stimulus.

Max Wertheimer, a German psychologist, was the first to study the phenomenon of like-motion in 1912. The filming and projection of films and television make use of the principle of apparent movement phenomenon. The application of the apparent movement phenomenon in film and animation is not too complicated, as it consists in making still images appear and disappear in a certain order. When people receive such images, they automatically "string" them together in the brain, creating a sense of movement.

Conclusion

Making the apparatus can be a good way to show the principles in the academic image vividly and give people a more intuitive feeling. So the purpose of this apparatus making is not only to make a fun experiment, but more importantly, to analyse and explain the phenomenon through. It can lead to a better understanding of the principle of visual staying and the principle of plane mirror imaging. In physics teaching, the reason why students do not understand the principle is that the model corresponding to the principle behind it does not appear in their brains. Therefore, in order to give students a better understanding of the principles, it is essential to create simple experimental apparatus. The demonstration of the apparatus not only simplifies the knowledge, but more importantly, stimulates and engages the students' interest.

References

[1] Lv WJ., Dynamic graphics in interactive media [J]. Journal of Zhengzhou Railway Vocational Technology College, 2021, 33(3):3.

[2]Wang, ZQ., Mu, ZX., Qian, LQ., et al. A shaky image mute presentation device for visual staying:,CN103258480B[P]. 2015.

[3] Li, H., What is "visual staying"[J]. Journal of Healthy Teenagers,2017,000 (011): 5.