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Mathematical Thinking in Photography

Wang Shuai

School of art and design, Yancheng Normal University, 224000, China

ABSTRACT. *When we talk about mathematics and photography art, we will think that they are different from each other. However, mathematics and photography art are inextricably linked. We often see the shadow of mathematics in some photographic works, and many theorems and laws in mathematics can also create the beauty of various photographic arts, in which mathematics plays an irreplaceable role.*

KEYWORDS: *Mathematical thinking; Photography; Connection; Aesthetics*

1. Art and mathematics are two kinds of cultural products created by human beings with different styles and natures.

It is generally believed that art and mathematics are two kinds of cultural products with different styles and natures created by human beings. One is at the peak of highly rationalization, the other is at the center of the emotional world; the other is a model of Science (NATURAL SCIENCE) and the other is a masterpiece of aesthetics. However, behind all kinds of seemingly unrelated and even completely different phenomena, there is a very rich universal significance of art and mathematics. Maurits Cornelis Escher (1898-1972), a Dutch “graphic artist” in the 20th century, is an example of the perfect combination of art and mathematics in this field. We know that mosaic is a kind of plane geometry. Regular plane division is called mosaic. Mosaic is an arrangement of closed figures without overlap and space. Generally speaking, the basic unit of a mosaic is a polygon or similar conventional shape, such as triangle, square, hexagon, circle, etc. these patterns often appear on the brick and wall decoration paintings laying the ground. However, many other irregular polygons can also form mosaic after tiling. Escher used these irregular basic patterns in his mosaics, using reflection, smooth reflection, transformation and rotation in geometry to obtain more varied patterns. Through careful design, these basic patterns are distorted into animal, flower, bird and other shapes. These can be obtained by three, four or even six times of symmetry. Its artistic effect is both amazing and beautiful. Not only that, Escher also produced inspiration through the research of symmetrical illustrations in a mathematical article, and created a series of decorative paintings of four art works “circle limit”. Mathematics is also everywhere in architecture. Taking the golden section as an example, almost all the most famous buildings in the world have the golden section rate, including the pyramids of ancient Egypt, Parthenon Temple of ancient Greece, Taj Mahal of India, forbidden city of China, Notre Dame of Paris of France, etc. Like Notre Dame in Paris, its front height and width ratio is 8:5, so is the length width ratio of each window. The application of symmetry in these buildings is even more common. There are many axisymmetric buildings in ancient China. The Forbidden City is a well behaved axisymmetric building. Then there are “pagodas”, such as big wild goose pagoda and small wild goose pagoda, as well as “Pavilions”, ZUIWENG Pavilion and Lanting, and “towers”, such as yellow crane tower and Yueyang Tower.

So for photography major, SLR camera is a common photography tool. As we all know, it must have lens assembly, and all lenses are marked with a group of aperture values, such as 2.8, 4.0, 5.6, 8.0, 11, 16, 22, etc. through careful analysis, adjacent values are (root number 2) times of the relationship, each separated pair of numbers are multiple relationships, and the larger the number is, the greater the aperture The smaller the number, the smaller the aperture, and the larger the aperture. The former number is exactly twice the exposure of the latter one. How are these numbers determined? How is the relationship? In fact, the aperture size is the size of the lens into the light area. If the light input area is analyzed quantitatively, the light input area of the front stop diaphragm should be twice that of the rear stop diaphragm. Since all lenses are standard circles, we set the light input area of the front gear as A1, the aperture value of the front gear as A1, the light input area of the rear gear as A2, and the aperture value of the rear gear as A2, so as to find out the relationship between A1 and A2.

2. A Good Photograph Depends Not Only on the Delicate Control of Exposure and Composition, But Also on the Brightness of the Color.

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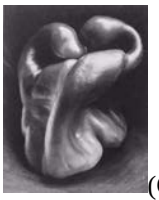
With the development of digital camera, both the SLR camera and the display itself have high requirements for its color space. At present, the bit depth of civil computers is 8, which is expressed by the power of 8 of 2. It contains 256 colors (or 256 gray levels). In RGB color space, the distribution of each color is 0-255, a total of 256 kinds. The combination of each color value of RGB three primary colors and the other two color values can represent a color. This color is the only permutation and combination principle in RGB color space according to mathematics. The total number of colors is: 256 × 256 × 256 = 16777216. How can we find the color we need in such a variety of color space Just like the three-dimensional space (x, y, z) in mathematics, establish the spatial coordinate system in the color space, and make the three primary colors red (R), green (g), blue (b) as the X, y, Z axis. If the longitude, latitude and elevation of the space point are determined, the point is unique in the space. This has long been used in Photoshop. This huge value can basically meet the needs of image color combination. If the bit depth can reach 16 or higher in the future, and the color is almost astronomical, the image performance will be more real.

In digital photography, histogram is the test sheet of the image. The over exposure, under exposure and bright distribution of the image can be qualitatively or even quantitatively displayed, whether in the process of shooting or later adjustment, histogram is very important. We all follow the principle of “middle gray” of Adams when shooting exposure. Through the statistical analysis of a large number of photos, the gray distribution has a certain rule. The histogram in probability statistics is used to express the image and accurate. Most images can conform to a certain probability distribution, such as the middle tone photos conform to the normal distribution, and some photos conform to some special probability distribution, such as high The binomial distribution of b-value is consistent with the tonal photos, while the low-key and night view photos are very similar to the F-distribution of the Kummer function, etc. If we know these mathematical characteristics and the relationship with photography, we can adjust the exposure in time according to the histogram (many cameras now have real-time histogram or even color separation histogram function) in the shooting process. In the later adjustment, we can more quickly and accurately determine the position of highlights and shadows. Through the middle slider, we can adjust the gray distribution and get satisfaction Contrast image.

Graziano, a student in mathematics and photography at the Rochester Institute of technology, overlays graphics and equations on carefully composed photos. “I want to create something that will let everyone know that math is really great,” she said Graziano doesn't look for specific functions every time he goes out to shoot, but lets them appear. Once she took her favorite image, Graziano quickly measured the data and got the corresponding function, and then adjusted the function slightly until the curve of the function and the image were completely aligned.

3. Mathematical Thinking in Edward Weston Photography.

Edward Weston is one of the greatest photography masters in the 20th century, and also one of the most familiar still life photography masters. In fact, he also uses mathematical thinking incisively and vividly in the photography art. Green pepper, conch and toilet are his most famous works. The characteristic of Weston's photography is that he can use his unique vision to find ordinary things, and use light and composition to render a certain angle and part of their beauty. In his shot, green pepper doesn't seem to be the same as green pepper, nor is the toilet.

 (Green pepper by Edward Weston)

In green pepper, for example, Weston used Fibonacci helix, also known as the “golden helix”, which refers to the square with Fibonacci as the side length, and then made a 90 degree fan-shaped, connected arc inside the square. In short, this spiral can make the picture more beautiful in a golden ratio. Fibonacci helix is just one of the golden proportion. Other things like golden line and golden triangle can make your photos show the beauty of golden proportion. In addition, there are three parts composition, symmetrical composition and frame composition. It's not easy to find the exact golden ratio in the shooting. Some cameras will bring Fibonacci spiral in the shooting, just like the grid lines and grid lines, which can be called out. There are also some professional photo taking apps on mobile phones that have this function.

The mysteries of the universe, time and reincarnation may not be imagined by the photographer himself. Maybe one day, the mystery of many photographic works can be explained by rigorous mathematical

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calculation.

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