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A review of Application and Reference of Fractal Geometry in Art

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Abstract : Fractal art sits at the intersection of design and mathematical calculation, which makes it completely mind-bending. This type of algorithmic artwork results from fractal objects (never-ending patterns that are eternally complex and appear similar to the whole image) represented as various visual artforms, such as animation and still images. A sort of algorithmic or computer-generated art, fractal art was created in the 1980s. This art style is based on the computations of fractal objects that are rendered as pictures. fractal art is generated with the assistance of computer software; it is not art that is rendered by hand. In certain circumstances, non-fractal pictures are blended into the fractal design to produce a form of hybrid creation. Because they are based on mathematical calculations, fractals are an uncommon art form, but one that has been welcomed under the banner of digital art, and they are not the only occasion where artists have depended on mathematics for aesthetic expression. Part of the broader genre of new media art, fractal art is a trend that took shape in the mid-1980s. During that time, computer aesthetics also began to develop as an art form, as design became more digitized on the road to the 21st century.

Key Words : Fractals, Fractal Art

Introduction :

Like numbers, fractals are infinitely varied in terms of their uniqueness. In the creation of fractal art, mathematical equations or formulas are employed to govern how each computer pixel is produced and coloured. Artists may produce new works of art by altering their formulas. Typically, each piece is represented by a million or more pixels.

Many fractal-generating software packages are available to digital artists. It is common for artists to utilise their preferred software to establish parameters for their work, perform the calculation or formula, and evaluate the results of their work. To further improve their paintings, some artists would load their work into different software tools that allow for further modifications. The first commonly used software by artists is called Fractint.

Fractals may be seen in nature, too, where they appear as intricate designs. The Mandelbrot Set Fractal, which took nine hours to create, is generally considered the most renowned piece of fractal art. There are several fractal art galleries on the internet. Prints, screen savers, wallpaper, magnets, T-shirts, and much more have all been created using fractal art.

Fascinating fractal painters include Vicky Brago-Mitchell, William Latham, and Carlos Ginzburg. Fractal art has been included in exhibits and, of course, in permanent displays at major museums and art galleries across the globe. Mathematicians and art enthusiasts who are intrigued by the principles of fractals make fractal art as well. An artist's own calculations and adjustments are used to make fractal art, which is separate from computer-generated art that depends on software.

The History of Fractal Art

To figure out where this trend came from, we have to go back earlier than the 1980s. This decade was known for very retro styles and typography, but, due to the then-nascent emergence of computers and the Internet, also for technological inroads in design.

However, as a subset of algorithmic art, the roots of fractal design began with the American computer artist Roman Verostko. His claim to fame is the invention of his proprietary software for creating original art, back in the 1960s. Verostko's software manipulates the drawing arm of a pen plotter—a machine initially meant for engineering and architectural illustrations. Verostko's software changed this application to function as an extension of the artist's drawing hand and arm.

It's important to note that this was more along the lines of computer-generated art and design, as opposed to fractal art proper, since the computer program was written to tell the pen plotter what to do (instead of the artworks being created inside of computer memory). Still, this is a distinction without a difference because all art created by fractals is based on software created by man (ie, the artist), after all.

Between the 1960s and mid-1980s, something very profound happened that gave this design trend its identity and name. This was the coining of the word "fractals" by Benoit Mandelbrot, a French-American mathematician, in 1975.

In reality, though, the concept of fractals has been around since the 17th century, when the German mathematician Gottfried Leibniz mused about self-similarity (possessing the same, statistical similarity at different scales), a key principle in fractals. By the 19th century, another German mathematician, Karl Weierstrass, came up with the first definition of a fractal (a function with a graph) while presenting to the Royal Prussian Academy of Sciences.

Still, we can't ignore Mandelbrot's contributions to the actual development of fractal art, which is typically created with fractal-generating software. His work led to several, key evolutions that would popularize fractal design in the 1980s:

In 1979, Mandelbrot and IBM programmers came up with the first fractal printouts.

In 1980, computer graphics researcher and developer Loren Carpenter presents Vol Libre at SIGGRAPH (Special Interest Group on Computer Graphics and Interactive Techniques), a two-minute, computer-generated movie that included fractally rendered landscapes.

In 1983, Acorn User magazine featured a BBC BASIC listing for creating fractal shapes.

Starting in 1984, computer games began to render fractal forms in games like Rescue on Fractalus!

Throughout the 1990s and into the 21st century, fractal art has intensified in popularity, thanks to the increasing use of software programs, as well as designers and artists who are willing to experiment with this visualization of mathematical beauty derived from precision algorithms.

Some self-similar, fractal-like patterns may be found that go back even longer in time. People all across the world have tried to convey the turmoil that surrounds them through art. Ancient Hindu temples, as well as the Selimiye Mosque in Turkey, which was built in 1574 and dates back to the time of the Selimiye dynasty, show the fractality inherent in art.

Intentional or intended, the use of fractality in art indicates a knowledge of the intricate systems that make up our universe. The technology we've discovered to correlate chaos now has a broader use thanks to the ability to apply the vernacular of fractal geometry to art.

In art, fractals have been existent for ages before the rigorous geometric vocabulary we use to talk about them was developed. Art has a propensity to reflect and dwell on the natural world, where these fractal patterns may be found.

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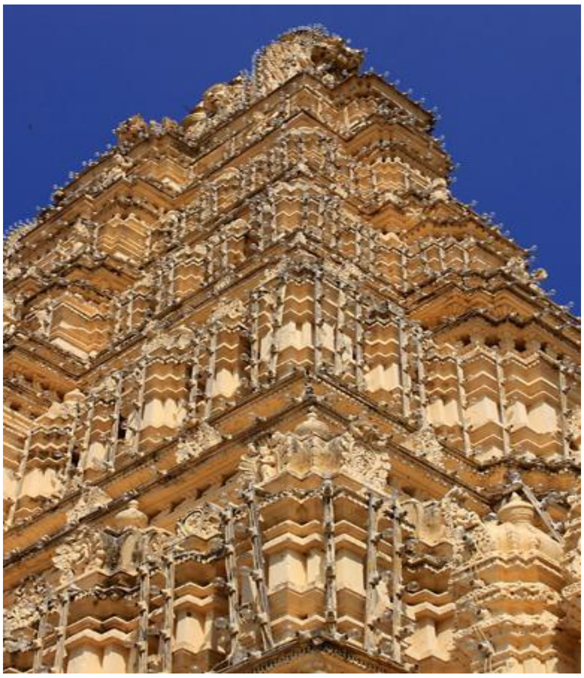

Reflections of a culture's worldview may be found in its fractality. Ancient Hindu temples are a good illustration of this. It was common practise for them to create large towers surrounded by smaller towers encircled by smaller towers surrounded by smaller structures, and so on. Figure 4 shows yet another example.

Figure 1 : Shweta Varahaswamy Temple [Karnataka] – Paul Prudence (https://www.dataisnature.com/?p=2138)

The tower's self-similar design alluded to the Hindu belief system. Reincarnation is likened to their belief in reincarnation; they believe that they ascend via the many levels of awareness to join the all-encompassing transcendence above. It is the fractal nature of their temples that represent the fractal aspect of their beliefs. Prior to the development of language and concepts, human beings used fractal geometry to communicate their ideas about how the world worked. I believe there is a fundamental understanding of complicated shapes and how they are interpreted and communicated.

Fractals and self-similarity in nature and art

Objects' physical structures have been defined for millennia using Euclidean geometry and the tope formula. Euclid, a Greek (Alexandrian) mathematician who penned one of the first known treatises on geometry (The Elements) about 325 BC, is credited with giving it its name. He laid the groundwork for modern-day geometry by defining basic geometric forms including circles, triangles, rectangles, and squares (Hawking 20051 7) When it comes to pure mathematics, these ideas have been used as a "model" (Clapham & Nicholson 2005:155). The term "non-Euclidean" was used to refer to any geometrical formations that did not conform to Euclidean geometry.

According to Leonard Shlain (1991:31-31), art and physics: parallel perspectives in space, time and light, there are parallel conceptions of the universe "In The Elements, Euclid made a few... assumptions that he didn't explicitly mention. This man made space seem to be linked by a network of straight lines that do not exist in nature, for example." This dissertation focuses on pictures and things that cannot be specified using Euclid's geometry.

For millennia, evidence of fractals and self-similarity have been seen in nature despite the inability of scientists to describe them. Nature's lightning, fern fronds, and Romanesco broccoli are all fractals, as seen in Figure 2. When he said, "Clothing is neither round nor smooth nor does lightning go in a straight path," Mandelbrot became a household name.

Although lightning does not travel in a straight path, each smaller branch resembles the bigger bole (as seen in Figure 2 (b)). This is seen in Figure 2(b), where the form of clouds is impossible to correctly characterise using Euclidean geometry. Another example of a self-similar structure is a fem leafs structure (Figure 2(c)), which consists of numerous tiny leaves that have the same form and structure. If you're looking for anything that looks like a conical broccoli, you'll find it in Romanesco (Figure 2(d)) (Frame, Mandelbrot & Neger 2014).

Figure 2 : Nature Fractals : (a) Lightning, (b) Clouds, (c) Leaves and (d) broccoli (frame et. al. 2014)

Nature seems to be full of complex self-similar patterns. This has been a source of inspiration for many artists throughout history. Leonardo da Vinci, an Italian Renaissance polymath, used a blotting technique to produce paintings that resembled self-similar clouds. One such event is the Deluge (Figure 3). (Frame et.al 2014). In his writings on water and sound waves, Leonardo da Vinci repeats the idea of self-similarity Sound travels in circles in the air like a stone thrown into water, becoming the centre and starting point for many more circles. Those who are put in the light air spread out in rings, filling the surrounding area with an endless likeness of themselves, and appear in every portion of the surrounding space.

Figure 3 : Da vinchi, The Deluge (Kuhn 2009)

Alternatively, the term "unlimited self- similarity on all scales" might be substituted for the phrase "infinite self-similarity". Da Vinci and his contemporaries were aware of self-similar and fractal formations in nature.

Katsushika Hokusai (1760-1849), a Japanese printmaker, drew inspiration from Mount Fuji for his woodblock prints in the 1830s and 1840s. Fractal features of nature are shown in his poster, "The Great Wave" (see Figure 4) with "a subtlety seldom equaled, even now" (Frame et.al 2014, Kuhn 2009:67). Like this picture, a lot of his works include waves with jagged edges that become smaller as they approach the outside border.

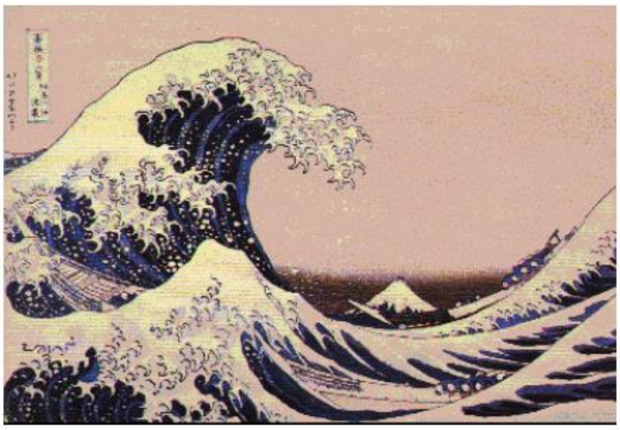

Figure 4: Hokusaki, The great wave (frame et. al 2014)

When it came to "non-Euclidean forms" in the late 19th and early 20th centuries, artists and scientists alike had a greater interest in creating them, as well as understanding them. M.C. Escher, a Dutch graphic artist, serves as an excellent illustration of this (1898-1972). While he is most known for his optical illusion drawings, many of his works are characterised by greatest accuracy, symmetry, and self-similarity, in particular. Mathematicians like H.S.M. Coxeter have studied his paintings mathematically (1979). Esctier's Picture 'Circle Limit III—The Non-Eudidean Symmetry of Coxeter's Article suggests an awareness of self-similarity in the artist's work, as shown by the title of Coxeter's article:

Conclusion :

The fractal geometry argument is as fractious as its subject matter. Even while there is some debate about the precise definition of a "fractal," its wide range of applications in nature, materials, and art make it evident that even a strictly defined fractal set may be freely used to far less structured forms. Even the most complicated and chaotic forms of the cosmos may be associated with the appropriate dialect since the world exists in the language of mathematics.

• Fractals and self-similarity are important compositional tools. There are several ways to classify music according to fractals, including genre, composer, or a combination of the two. As fractal geometry has advanced in the sciences, more and more artists have turned to it for musical inspiration.

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