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Literature Survey on Fractals

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Abstract: - **A Fractal is a geometric figure where each part of it has the same characteristics .They are patterns that keep repeating and any pattern that keeps repeating over and over again form of fractal .There are natural fractals as well as computer generated fractals. The intention of this review paper is to explain the existing types of fractals both natural and artificial occurring, their characteristics and applications of fractals in our daily lives.**

Keywords- **Fractals, self-similarity patterns, dimensions, geometric figures, initiator, generator.**

I. INTRODUCTION

Fractals are unique geometric patterns. Some common patterns are circle, square, rectangle etc. In geometry, two figures are similar if their corresponding angles are congruent to each other. Fractals are formed by the repetition of their own original images. An example for fractals would be a triangle made up of triangles that are the same shape. Fractals possess an important property "fractal dimensions". In Euclidean geometry figures are considered to be as zero or many dimensions where as in fractal geometry figures may have dimensions falling between whole numbers made up of fractions. For example, a fractal curve would have a dimension between one and two depending on how much space it takes up as it twists and curves .Fractal geometry provides the complexities of shapes and allows the study of fractals better than Euclidean geometry. Fractals are formed by iterative formation; a simple figure is operated in order to make it more complex, then resulting figures are repeatedly operated to make it still complex. Mathematically, fractals are the result of repetitions of nonlinear-equations. Using the dependent variable, points is generated. When these points are plotted and graphed a complex image is formed. Few things would seem irregular, but in fractal geometry each has a simple organizing principle. The concept of finding underlying theories in random variations is called chaos theory. This theory is applied to study weather patterns, stock market and population dynamics.

II. ORIGIN OF FRACTRAL:

Uncustomary mathematician Benoit Mandelbrot termed fractal from the Latin word "fractus" in 1975, which means irregular or fragmented. These irregular and fragmented shapes together form our surroundings. Mandelbrot developed an idea of reconstructing natural scenes on computer screens. One of the first applications of fractals emerged long before the term had been created. Lewis Fry Richardson was an early twentieth century English mathematician who studied the length of the coast of England. He reasoned that the length of the coastline depends on the length of the measuring instrument. Property of self-similarity means that the parts are similar to the whole, with variations.
The first person to study fractals was Gaston Maurice Julia, who wrote a paper about the iteration of a rational function. He authorized Fractal Geometry of Nature that demonstrated the potential application of fractals to nature and mathematics.

III. CHARACTERSTICS

The characteristics of fractals were for the first time indicated by Alain Boutot: "It has a fine structure with details on all scales of observation; it is too irregular to be described in the language of Euclidean geometry, both locally and globally, it is a self-similar structure is the analogue of the whole, It has fractal dimension higher than the topological dimensions.

3.a Self-similarities:
Property of self-similarity means that the parts are similar to the whole, with variations. In the Serpinski triangle, the basic figure is triangle. This basic figure is repeated and the complex serpinski triangle is formed.

3.b Elements of a fractal:
A fractal is made up of two parts: initiator and generator. Initiator is equilateral triangle and a line that is divided into three equal segments is the generator.
The first iteration is realized by replacing every line of the initiator with the full generator. A snowflake can be approximated by iterating this operation again and again replacing every line of the new initiator with the full

generator. To generate a real Koch Snowflake is necessary an infinite process, but in practice, the process ends after a finite number of iterations

IV. NATURALLY AVAILABLE FRACTALS:

The natural fractals are time hardened and are a result of millions of years of evolution. It was almost pompous of the fractal mathematicians to drop their study of natural fractals and their application in search of understanding of their own constructed fractals.

A. Lichtenberg Figure:

This is a natural phenomenon of insulating materials such as acrylic, glass and sand when high amounts of electrical potential are forced through the material. This excess amount of energy causes the dielectrical breakdown of the material which changes it a molecule level. These molecular level changes can be visibly see by the change in color. It can be looked at as a frozen lightning.

Fig.1: Lichtenberg Figure

B. Trees:

Trees were the first place that fractals were observed and recorded by humans. It was also one of the first fractals that could be modelled and reproduced by humans.

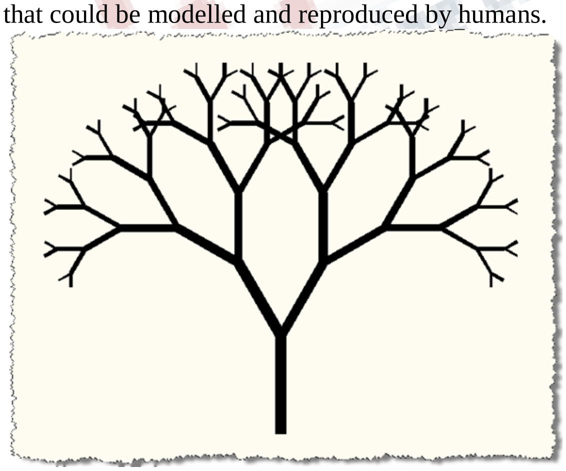

Fig.2: Fractral of Tree

C. Waterways/Shoreline:

A shoreline next to a body of water is a very interesting example of a fractal. The single greatest reason for this is that there is an infinite amount of perimeter in a finite amount of

Fig.3: Fractal formed by River Coastline

space. The most well known case of this is in England. To make a long story short "a long time ago there was a king who wanted to survey his land so he sent a team of men to measure the coastline of England. They came back and reported their findings. A little while later another king dispatched a team of men to measure the very same coastline. To their amazement the distance grew. The figure was bigger by quite a large margin. Due to the dilemma the king sent out another team of men to verify the coastline, each time the distance varied.

D. Animals:

The use of fractals in animals is the product of millions of years of evolution. The fractals patterns and mechanisms utilized by certain animals are only present because of the direct success of the fractals in their ancestors. If fractals did not provide some type of advantage then the trait would have died long ago in the evolutionary chain and it would not be able to be observed in animals in the present day.

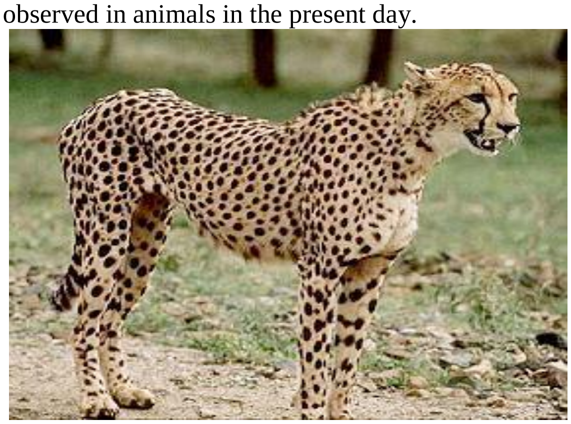

Fig.4: Fractals on Living Diversity

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V. APPLICATIONS OF FRACTRALS:

Fractals can also be used to create computer graphics. The basic fractal of any natural object is predicted and its rules of construction are determined. When these fractal objects are designed on computer screen, the resembling images are formed. The application of Fractal geometry is in many areas of science such as astrophysics, biological sciences and is evolved as one of the most important application in computer graphics. The below given are evolved applications of fractals:

A. Fractals in astrophysics:

Is anyone aware of how the stars were formed and how stars found their home in the Universe? The fractal nature of interstellar gas is predicted as the solution to this problem by the Astrophysicists. Fractal distributions are hierarchical. The way of describing the shapes of clouds in sky and space and their repetitive patterns is very difficult without the help of fractal geometry.

B. Fractals in the Biological Sciences:

Euclidean representations of natural figures are modelled by biologists. They represented heartbeats as sine waves, conifer trees as cones and cell membranes as curves. Using fractal geometry, scientists have come to recognize that many natural constructs are better characterized. Biological systems and processes are typically characterized by many levels of substructure with the same general pattern repeated in an hierarchical manner. The tree like structure is found in chromosomes. they consists of many 'mini-chromosomes', and these are the another examples of fractals.

C. Fractals in computer graphics:

Graphics files are compressed to less than their original size by Fractal algorithms. Computer graphic artists use many fractal forms to create textured landscapes and other intricate model.

D. Geometric construction of fractals:

Many fractal objects may be generated with geometric constructions. The class of fractals created using this method is known as linear fractals class. A part of linear fractals can be represented by the initiator (initial polygon), generator and the production rule. In addition to the production rules geometric information is also necessary, which is stored in data structures. The main advantage of this class of fractals is that geometric production rules can be designed interactively and in a, relatively, easy way. Non-linear complex mappings generation The most important part of the fractals is represented by fractals in which relation between input and output is non-linear, using complex variables and parameters

Self-similar geometrical figure are illustrated by many fractals including Koch fractals, cantor fractal and many more. Below are given the interesting fractals that are generated by self-similar geometrical figures.

6.A. SIERPINSKI TRIANGLE:

The non-technical approach of forming sierpinski triangle :

- Design the 3D shape and glue the design to a cardstock.
- Choose the contrast colours for making siepinski triangle so , that we can identify the difference at each fractal .
-

Use shades of same colour to make siepinski triangle it makes us to easy identify

- Frame many more triangular shapes and join them to form a pyramid. Cut an extra line around the shape to use for gluing.
- Thus, Sierpinski Triangles include Euclidean geometry figures.

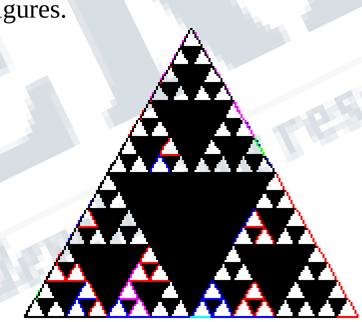

Fig.5: Sierpinski Triangle

Step One

Draw an equilateral

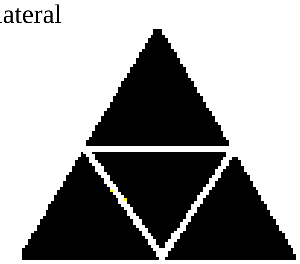

Fig.6:Resut of step one

Truncate the triangle in the centre.

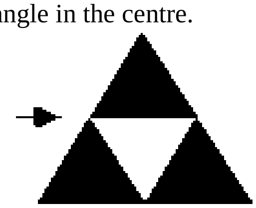

Fig.7:Result of step two

Step Two

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Figure another equilateral triangle with sides of 4 triangle lengths each. Connect the midpoints of the sides and cut out the triangle in the centre as before.

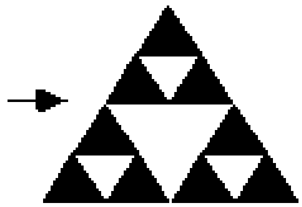

Fig.8:Result of step three

Note: The three small triangles that also need to be cut out in each of the three triangles on each corner - three more holes.

Step Three

Figure an equilateral triangle with sides of 8 triangle lengths each. making sure to follow the cutting pattern.

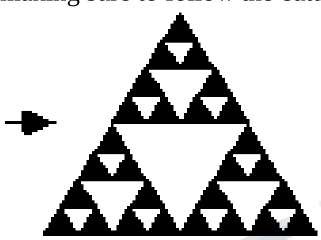

Fig.9: Result of step three

Step Four

A larger paper, or cut smaller triangles. Follow the given pattern and the fourth stage of the Sierpinski Triangle is to be completed. Use interesting colour patterns. Then the figure looks as below.

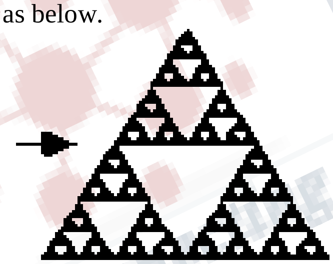

Fig.10:Result of step four

Thus sierpinski triangle is formed.

B. The Koch Snowflake:

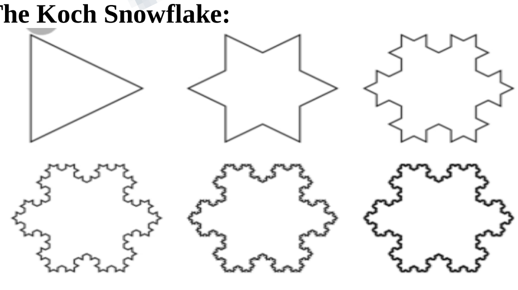

Fig.11: The Koch Snowflake model

Step One:

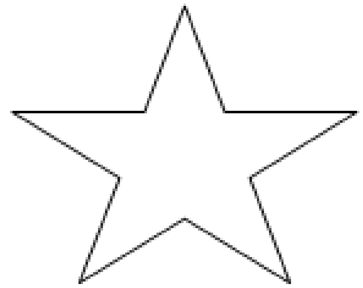

Fig.12:Step one to be formed

Step Two.

1. Draw a Star.
2. Divide one side of the triangle into 3 equal section and trim the middle part.
3. Replace it with 2 lines the same length as the part you trim .
4. Follow this to all three sides of the triangle.

VII. CONCLUSION

Fractals are looping patterns dated way back to 1970's.These fractals define a concept of fractals dimensions into a pattern. After going through the fractals in detail, we conclude that they are the most beautiful and abstract method used to make the concept interesting and more appealing to the audience they are certainly making learning fun.

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