9th International Conference on DEVELOPMENT AND APPLICATION SYSTEMS, Suceava, Romania, May 22-24, 2008

A Short Introduction in the History of Fractals

Ildiko Szoke[1], Stefan Holban[2]

[1]*Computer Science and Engineering Department, "Politehnica" University of Timisoara, Faculty of Automation and Computers, Bd. V. Parvan 2, RO-300223 Timisoara, Romania,, E-Mail: ildiko.szoke@yahoo.com*

[2] *Computer Science and Engineering Department, "Politehnica" University of Timisoara, Faculty of Automation and Computers, Bd. V. Parvan 2, RO-300223 Timisoara, Romania,, Phone" +40 56 204333/204334 int. 125, Fax: +40 56 192 049, E-Mail: stefan@cs.utt.ro, WWW: https://www.cs.utt.ro/~stefan*

***Abstract*—The paper makes an introduction in the "uneasy" and coloured world of fractals.**

***Index Terms*—fractals**

MOTTO:

"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."

Albert Einstein

I. INTRODUCTION

A fractal is, first of all, a beautiful - coloured image. And because of this, fractals are very inciting to study and, maybe, to try to develop new images of Mandelbot and Julia's sets.

A. MANDELBROT'S SET

The Mandelbrot set is the most beautiful and remarkable discovery in the entire history of mathematics and it was discovered as recently as 1980s.

The invention of the Silicon Sheep in the 1970s created a revolution in computers and communication and the way it transforms our life. The fractals are seen as another revolution in mathematics.

It's not easy to describe the Mandelbrot set, it looks like a many, it looks like a cat, it looks like a cactus, it has a little bit of everything you saw in the real world, in particular living things.

The fractal, itself, is unique and new. Such things that can be magnified for ever do exist, but they are not touchable.

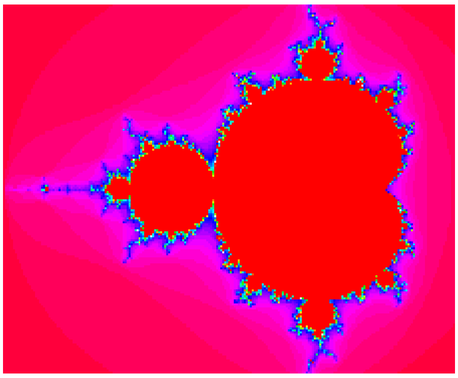

Figure 1.

If you have in front of you the Mandelbrot set and you "blow" it up, you will see more and more details of the original set almost identical and you can go one doing this, magnify it how many times you like until the set is bigger than entire universe, you will still see new patterns, new imagines emerging because the frontier of the Mandelbrot set is infinitely complex. And it's not just very big it's really infinitely.

What it's so remarkable about the Mandelbrot set is it or no it's infinitely complex, it's based on some incredible simple principles, and like everything in modern mathematics.

Anybody who can add and multiply can understand the principles on which it is based. In principle it could have been discovered any time in human history, not really in 1990s, but the problem is this the adding and multiplying operations are used millions, billions of times to create a complete set. And that's why it was not discovered until the era of modern computers.

At the basis of the discovery of the Mandelbrot set was decades before, in Paris in 1917 Gaston Julia, published papers connected with so called "Complex Numbers", now known as Julia sets, but Julia himself never saw a Julia set he could only guess of them. The Julia sets could not be seen because of the modern computers.

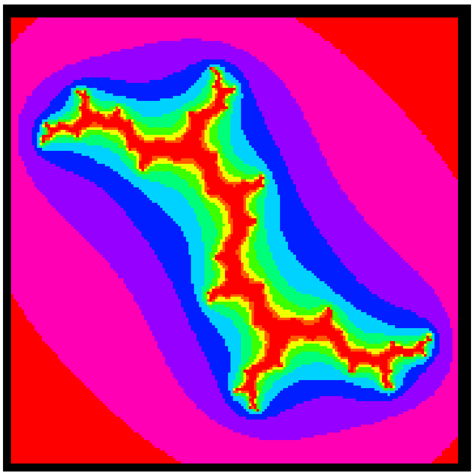

Figure 2.

Mandelbrot himself said: "The biggest problem was to program it and to see how it looks like. It was a lot of fun to play with the transformations but the greatest interest was on the simple ones

$$Z = z^2 + c$$

If you magnify a same piece of Mandelbrot set, that piece looks like Julia set itself. The Mandelbrot set is made of million and million of Julia sets.

The most important application is that from very simple formula you can get very complicate results. It's the fundamental of the very base of science. Around us we have only mess, totally incomprehensibly and then eventually, more slowly, more easy to achieve, we find simple laws, simple formulas."

It's an interesting parallel with the equation which everyone is familiar with

$$E = mc^2$$

This is Albert Einstein's equation which says "Matter and energy are equivalent to each other".

This is a very simple equation with very far reaching consequences. The equation of the Mandelbrot set is very simple too

$$Z = z^2 + c$$

The letters in the Mandelbrot equation stand for numbers unlike those in Einstein's equation which stands for quantum physics.

The Mandelbrot numbers are coordinates, positions on the plan, defining the location of the spot.

Another difference from Einstein equation, and a very important one, is this double arrow

$$Z \leftrightarrow z^2 + c$$

The numbers are flying both directions. This process of going round and round like a loop is called *iteration*. The output of one operation becomes the input of the other. And so on and on and on.

When is given a number to the Mandelbrot equation, representing a point, and that number is iterated through the equation, one of two things occur: either the number gets bigger and bigger or it's shrinks to zero.

Depending on what happens the computer then knows where to draw a boundary line.

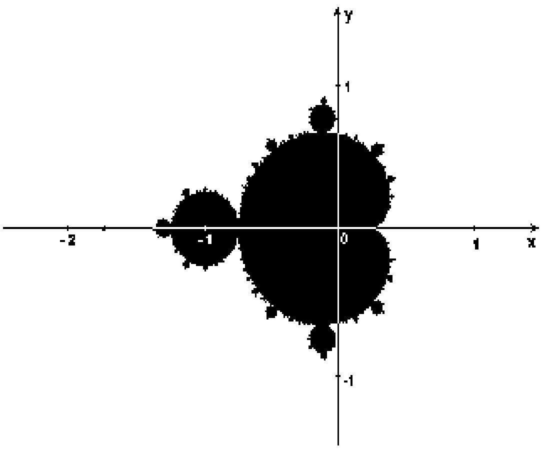

Figure 3.

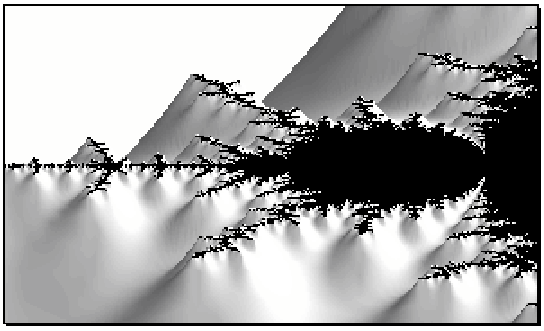

Figure 4.

If you look on the screen and you pick one of the pixel, you apply this rule lots and lots of times and either, the pixel moves of and disappears and go to infinity or it moves to a fix point in the middle of the screen. Any point that moves into zero when you apply it you colour black and any point that goes to infinity you colour differently according to fast it goes. The colours are arbitrar but are not completely meaningless.

If you take a beautiful coloured picture and you zoom in you will see another baby fractal just like the first one and it goes on for ever.

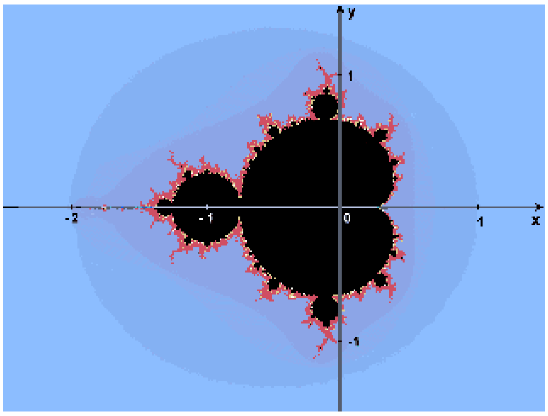

Figure 5.

I am sure that occurred to you that Mandelbrot set looks like a strange insect, it has an organic feel about it and it's hairy. If you take one of the hair and you split and split for ever this splitting is typical for mathematics entities are called fractals. The Mandelbrot set is the most famous fractal.

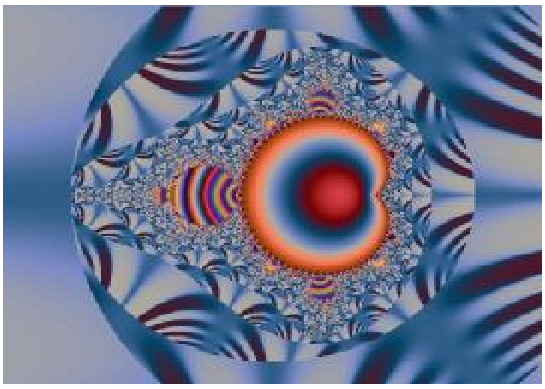

Figure 6.

What fractal means? Any geometrical structure that has detail on all scales of magnification, no matter how big you make it you still will see some details that you did not see before. The name was actually invented by Mandelbrot himself, he thought that he had to have a name for the area he was working in, and so he chose fractal because it converse this feeling of fragmenting, broken, fractional and irregular.

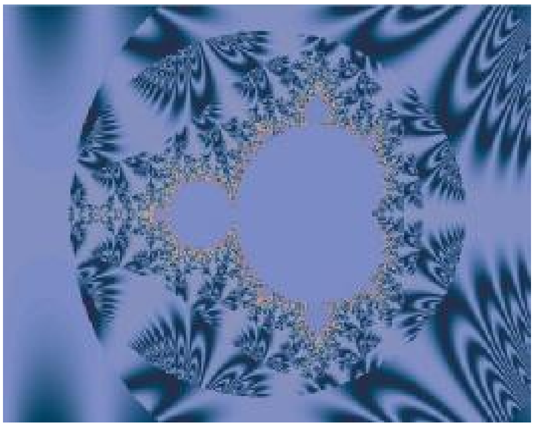

Figure 7.

Dr. Michael Barnsley said: The wonderful discovery is that on extension of classical geometry, Euclidian geometry, which is called fractal geometry.

Fractals are shapes which we are extraordinary used to in our organized life. For example, if you take a map of Britain of a small school globe, you see a very simplified shape. You can not put a lot of details on a small map. If you look on a larger map you can add more detail. Closer you come you see more details and the boundary line disappears.

Once you developed an fractal geometrical eye, you can not help but to see them every where. Every single thing you see is one way or another described by reference other to is self or to something else in the picture you see. It's like you are staring to a vast dictionary, but the dictionary's words are pictures and the references are the definitions of the words made of other pictures. So you look at one picture and you see some relationships between the picture and other parts of the picture. Those relationships are no more no less real-sessions and you start to see fractal everywhere.

The discovery of fractal geometry changes completely the kind of patterns we can look for in nature and this is a fundamental change and it got to have a big effect.

Fractal geometry is already being applied through the physical science as a way of describing data in a new way. And the dream is that a geometrical -fractal can describe a cloud as simply as an architect can describe a house. He can use the use simple and repeated formulas to describe these unimaginable complex and beautiful shapes and then to communicate them from me to another scientist. There is a slit similarity about how Mandelbrot set and nature operates.

Just looking to the Milky Way is like looking at a fractal, it's got a dotty character and yet if you take a magnifying glass which is a telescope and you look at it ever closer you find that there are hundreds and hundreds more little dots when you thought that there were almost none. So this is an example of a structure that seems to go on and on with more and more details.

The Mandelbrot set is infinite in detail and you can explore it for ever and ever and zoom into it. But the real world does seem to have a limit. If you go down to the micro world you got molecules, atoms, neutrons and other atomic particles. But does the real universe go one for ever? Is there a limit unlike Mandelbrot set?

In the case of the universe there seems to be a limit in scale it is called the *blank links* and it's million times smaller than an inch and so this means that there is a limit on how complex the universe can be. But it means also that the universe can be describe by a very simple formula at least on the scale of the blank links.

Some mathematicians think that there is something under the blank links, which is million and million smaller than we think we know. So perhaps the real universe does end there or it can go for ever like the Mandelbrot set. Nobody knows this yet.

B. THE USANGE OF FRACTALS

The fractal pictures are very pretty but what is their value? Fractal geometry has an enormous value. The discovery of Mandelbrot set and the fractals in general is very important. It's important on the intellectual level more than on the technological level. There are some applications but are not yet put into every home or things like this. But this is the way, the ideas come first and then you transform them into practical things.

No longer do you have to draw line to your date to make science of it, you can actually draw some fractal curve through it or measure some fractal dimension of the date and do science.

II. CONCLUSION

The first application is in terms of a better description of the physical observable world. There is a new branch of mathematics available to all scientist and this application can stretch on through the century on as the primary tool for descriptive physical science.

The primary application was a tool for the science and the start of the new generation of devices and equipments. It will be new devices based on the principles of fractal geometry that will emerge over the new centuries.

Fractal geometry has surprising application in medicine, for example for the blood circulation system body. This is the most important fractal of all in the human body. We do not know how our brain works but if we will ever find out I will be because of a fractal application.

REFERENCES

[1] Benoit Mandelbrot, Fractal Geometry of Nature, New York, W.H.Freeman, 1982

[2] William McWorter, Creating Fractals, Byte, 1987

[3] H O Peitgen, The beauty of Fractals, 1986

[4] http://mathworld.wolfram.com/

[5] http://mcgoodwin.net/julia/juliajewels.html