Complex Adaptive Systems, CS 591

Assignment 3: Fractals

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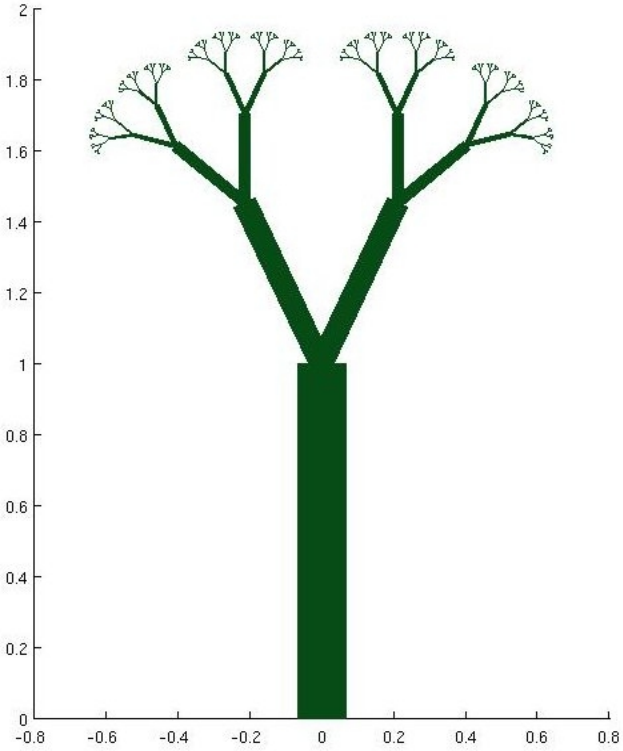
ABSTRACT:

This assignment aims at gaining experience with self repeating structures called Fractals. Different parameters are tried and the behavior is studied. Also, we calculated various features like fractal dimension of the resulting tree and studied its behavior by altering the parameters.

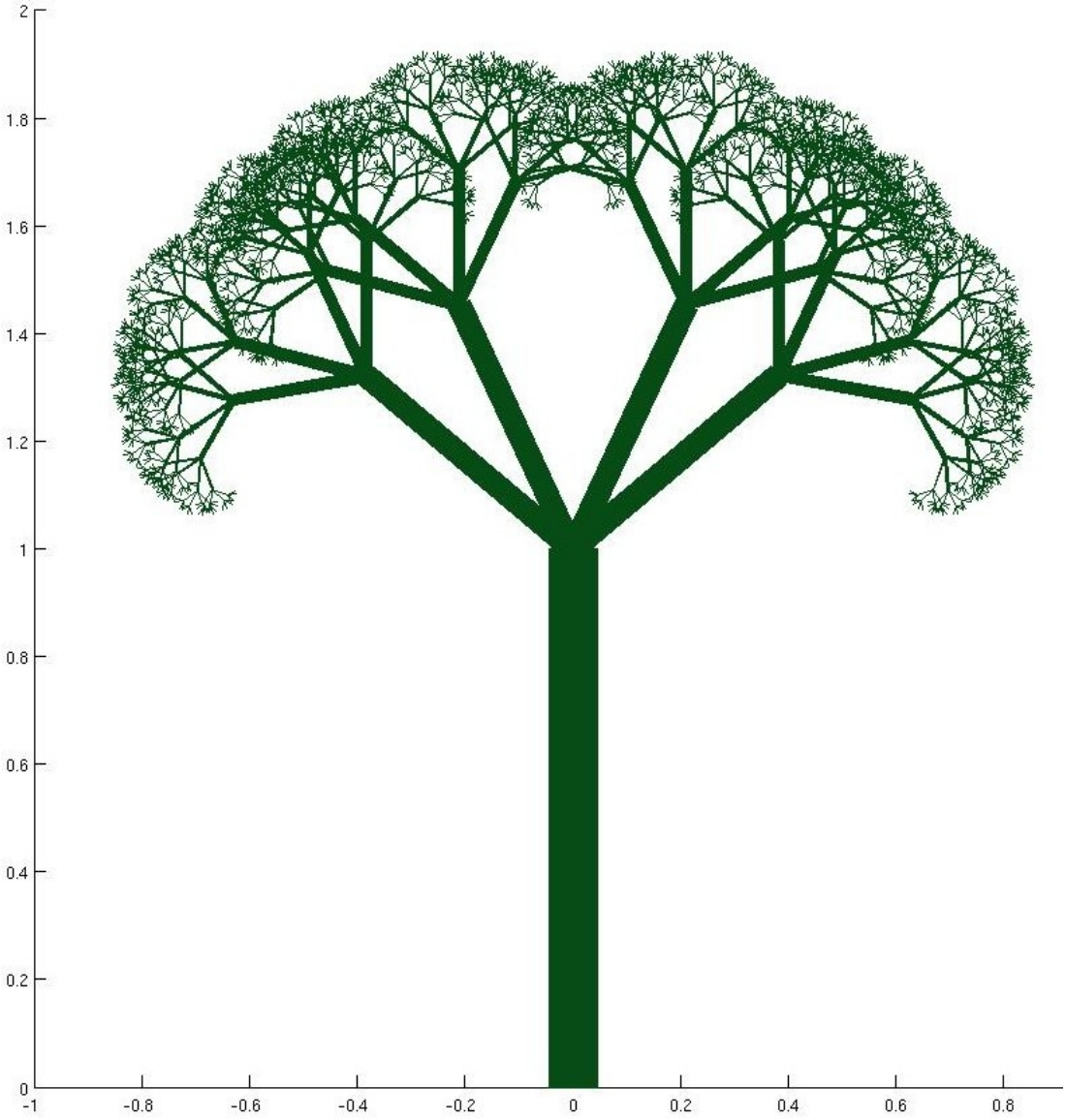
RESULTS:

plot 1: N =8 , n = 2 , theta = 25°



plot 2:

N = 6 , n = 4 , theta = 25°



Calculating Fractal Dimension:

We used the following formula to calculate the Fractal Dimension

$$D = \log N / \log(r)^1$$

In our method, we took N as the number of branches a tree can have.

And “r” to be the value of the branching factor (2,4,8)

N	“n”	# leaves	Area of the leaves (in square units)	Area of whole tree (in square units)	Ratio of leaf area to whole network area	Fractal Dimension
2	2	4	7.5	67.5	0.11	2.8
2	4	16	30	120	0.40	2.19
2	8	64				2.06
4	2	16	1.875	152	0.01	4.9
4	4	256	30	480	0.06	4.2
4	8	4096				4.06
8	2	256	0.2	770	2.5 e-04	8.9
8	4	65536				8.2
8	8	8^8				8.06
10	2	1024	0.03	1730	1.7 e-05	10.9
10	4	4^10				10.2
10	8	8 ^ 10				10.06

Table 1 Summary of the parameters and results.

*Note : Some Simulations are still running

Mathematical Description:

Area Relation:

So, from our results it is clear that we can infer,

> “Area of the Whole network is **directly proportional** to number of leaves.”

This means that, as the number of leaves increases, the area of the whole tree also increases and vice versa. Inversely, as the # of leaves decreases the area of the whole tree also decreases and vice versa.

We can rewrite the above relation with a proportionality constant, K to get the following equation.

Area of the whole network = K * (# of leaves.)

K depends on N and n.

Example, when N =2 and n=2, we have K = 16.9
When N = 4, n = 2, we have K = 9.5

Fractal Dimension Relation:

As we see from the table, the fractal dimension increases as the Number of depth level increases. But it decreases as the number of branching factors increases.

I.E., fractal dimension is directly proportional to Depth of tree and Inversely proportional to branching factor.

Conclusion:

Thus different fractal structures are produced and their complex behavior requires further study.

CONTRIBUTIONS:

1. Brian Stinar : Programming, Calculations (Partial).
2. Ratheesh : Calculations, Programming (Partial).

REFERENCES

1. **“**Fractals and the Fractal Dimension.” http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Fractals.html .

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