Method for Determining the Geometry of Multi-Band Antennas

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Abstract - **We developed a method and software for the accurate calculation of the fractal geometry of modified antenna is based on affine transformations.**

Keywords - **Multiband antenna, affine transformations, the software application.**

I. INTRODUCTION

The effectiveness of modern communication systems often depends on the characteristics of the antenna. At the same time antenna requirements for the devices are becoming more stringent. Dimensions and broadband properties determine possibility of using of a particular antenna type.

Fractal antenna is have wideband and multi-band properties. The properties of electrodynamics of fractal structures are analyzed, as a rule, based on software packages. In this connection it is interesting to study a class of fractal antennas, in order to create simple method of calculation of multi-band antennas.

II. BODY TEXT

Consider a variant creating a common methodology for the geometric structure of antennas. For this we consider the general form of the Sierpinski napkin, which is shown in Fig. 1.

Constructing napkins feasible through affine transformations [1]:

$$\begin{pmatrix} a_n & b_n \\ c_n & d_n \end{pmatrix}\begin{pmatrix} y_n \\ z_n \end{pmatrix}+\begin{pmatrix} e_n \\ f_n \end{pmatrix}=\begin{pmatrix} y_{n+1} \\ z_{n+1} \end{pmatrix},$$

where a_n, b_n, c_n, d_n, e_n, f_n – coefficients of the matrix, y_n, z_n – the initial coordinates of the point, y_{n+1}, z_{n+1} – new coordinates of the point.

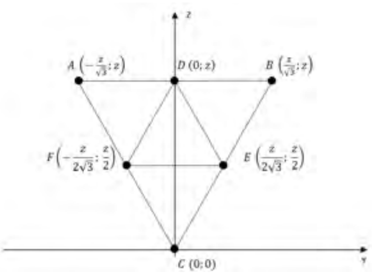

Fig.1 General view of the Sierpinski napkin

The first step is to find the coefficients of the matrices a_n,; b_n,; c_n,; d_n,; e_n,; f_n. To do this, uses the coordinates (Fig. 1) they form the three systems of equations with six unknowns. Results can be written in matrix form.

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$$\begin{bmatrix} \frac{1}{2}, & 0, & 0, & \frac{1}{2}, & -\frac{z}{2\sqrt{3}} & \frac{z}{2} \\ \frac{1}{2}, & 0, & 0, & \frac{1}{2}, & \frac{z}{2\sqrt{3}} & \frac{z}{2} \\ \frac{1}{2}, & 0, & 0, & \frac{1}{2}, & 0, & 0 \end{bmatrix}.$$

The resulting matrix completely describes the fractal set. Since the structure is not completed, the first resonance frequency, found by the formula (1) differs significantly from the others. To complement it, we find two more pairs of coefficients for the affine transformations in the big party.

$$f = 0{,}26\frac{c}{h}d^{\,n}, \tag{1}$$

where *c* – speed of light in vacuum, ***h*** – total height of the structure, δ – the scale factor, ***n*** – an integer, element number resonant slit.

Coefficients found written in the form of a matrix:

$$\begin{bmatrix} 1, & 0, & 0, & 1, & -\frac{z}{\sqrt{3}}, & z \\ 1, & 0, & 0, & 1, & \frac{z}{\sqrt{3}}, & z \end{bmatrix}.$$

Knowing the coefficients of affine transformations, we can construct an antenna with any number of iterations.
To automate was written the program on the engine ***Uniti***, in ***JavaScript***. The general form of a flowchart of the program is shown in Fig. 2.

The program displays the results of calculations in the form of drawing, as well as a text file with the coordinates of all triangles. This file can be used to create and analyze the structure in the package ***FEKO***.

Knowing all the coordinates of the elementary areas, with the help of singular integral equations can be found current distribution on the surface, and, consequently, field the far-field zone.

In Fig. 3, consider the look of the interface the program. On the left side of the formed geometrical structure. H - height of the structure, which depends on the first resonance frequency f and can be found by formula (1) if we know only the frequency and N - the number of iterations. The right side displays the coordinates of the triangles.

As an example, Fig. 3. shows the case of forming the modified fractal antenna, which is different from the fractal Sierpinski antenna absence high-frequency partitioning slits in the upper area of the antenna.

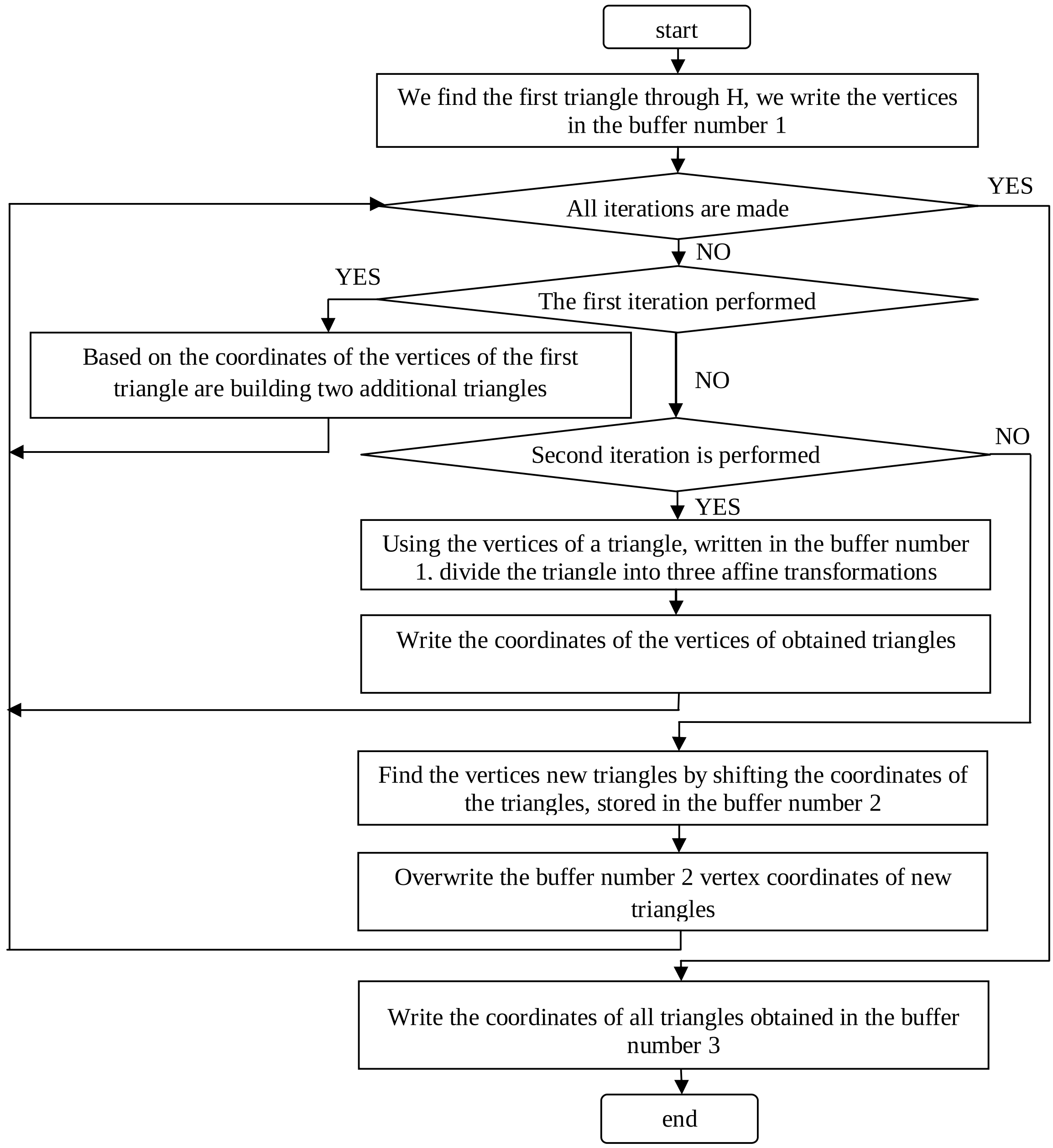

Fig.2 - Block diagram of the program

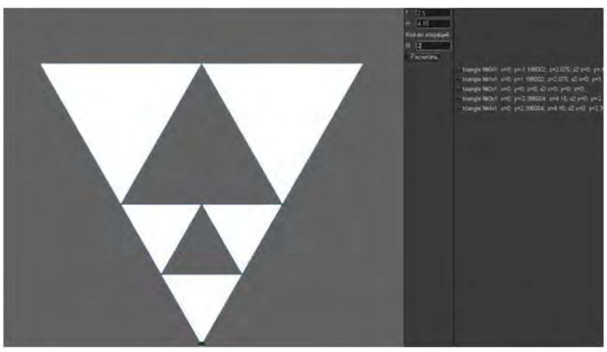

Fig.3 The program interface

III. CONCLUSION

Proposed a method and software for the accurate calculation of the fractal geometry of the modified antenna is based on affine transformations.

The technique can be used in preparing the structures for electrodynamic analysis packages (eg, FEKO), and for further calculation of the radiation fields in the structure of the far field.

REFERENCES

[1] Zaslavsky A.A. Geometric transformations / A.A. Zaslavsky. — M.: MTsNMO, 2004. — 86 p.