Near Field of Antenna Array Program

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Abstract

A lot of lesson's application are physically observable. But electromagnetic's application cannot be observable directly.
This program supplies near field of array, antenna self and mutual impedance, radiation diagram.
Program allows to user simulation of the all parameters effects of antenna. User learns result of specific configuration of the antenna by using this program.

Key words: numeric electromagnetic code, antenna analysis

Introduction

Nowadays, the numeric electromagnetic codes(NEC) are most useful application in the electromagnetic lectures. A lot of lesson's application are physically observable. But the electromagnetic's application cannot be observable directly, may be measured some results. The NEC supplies simulation to understand electromagnetic.

NECs are developed for, generally, special problem. We develop an NEC for thin wire antenna array. This program supplies near field of the array, antenna self and mutual impedance, radiation diagram.

Program allows to user simulation of the all parameters effects of the antenna. User learns result of the specific configuration of the antenna by using this program.

Program Components

This program, mainly, was developed for obtaining desired near field on the selected plane, so it consists optimization algorithm[i] and simulation. In this section program menus will be describe and defined program capability.

Antennas are defined as E shaped antenna(ESA) in the program, since dipole antennas are special form of ESA[ii]. It is considered that antenna can be fed from even it's center or it's end dependent on the requirements[iii]. Configuration is considered that antenna array lies on a definite surface, there are some reflector which are parallel or perpendicular to the antenna plane (Figure 1) and current amplitude of the each antenna is set, individually, by an micro-controller.

(a) Yatay Oxz Düzlemi
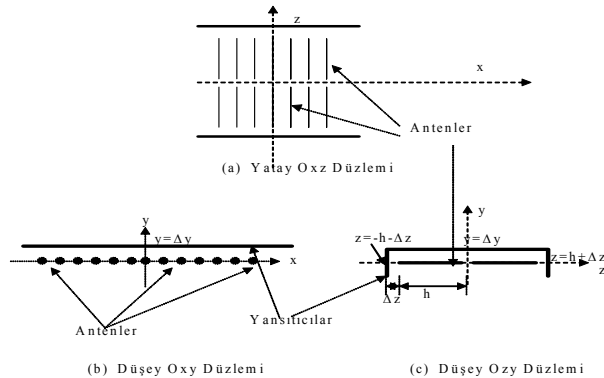
(b) Düşey Oxy Düzlemi

(c) Düşey Ozy Düzlemi

Figure 1 Antenna array configuration

This program computes near field of the array by dependent on antenna length, reflector existence and distance to the antenna, the antenna current amplitude and phase of the operation frequency. Then it simulates the electrical field for the selected component: x, y or z and selected type: by line cross-section or surface.

In the program's main loop, value of the electrical field components are calculated for the selected plane part which is parallel to the antenna plane and the selected antenna current amplitude and feeding type set, then normalized by the self maximum.

In the main page, result of the electrical field is simulated after calculation, automatically. Below parameters were initialized some values, but the user can change values for self needs:

Antenna length, antenna count, antenna distance, frequency, current amplitude of the each antenna, feeding type of the each antenna, y (calculation surface distance to the antenna plane), back reflector (distance to the antenna plane), z reflect (side reflector distance to the antenna ends) , x reflect (side reflector distance to the end antenna), Image no (image antenna level that is used in the calculation by the reflectors).
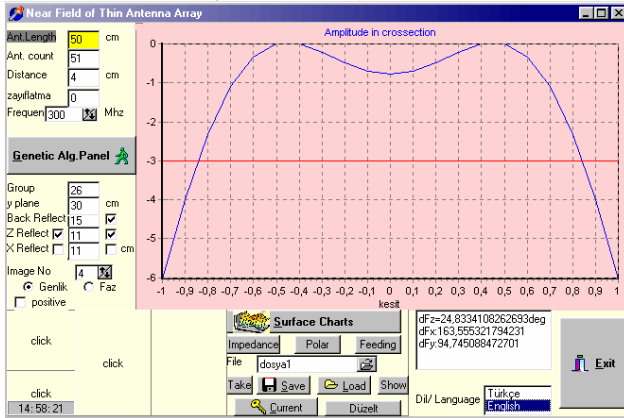

Figure 2 Program main page

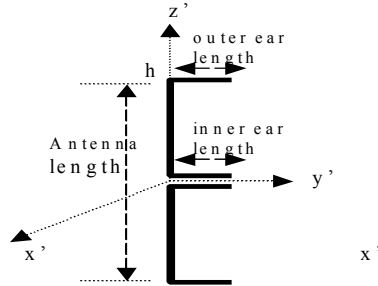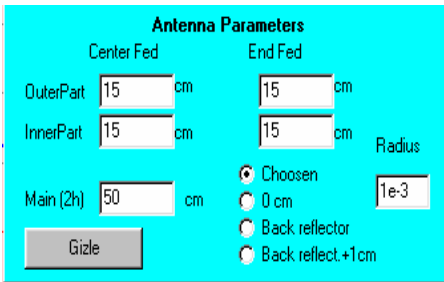If "*antenna length*" is clicked then antenna length parameters can be changed(Figure 3).

Figure 3 Antenna parameter windows

Program supplies an optimization window for desired electrical field on the desired surface. This is useful for specific application. User can change numerical resolution for calculation surface.

Simulations

Program gives 3 dimensional view of the electrical field values. Surface charts windows simulates 3D electrical field components.
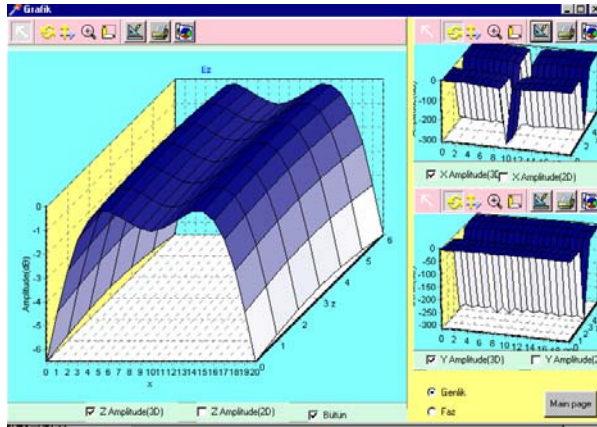
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Figure 4 Surface chart window

Impedance window calculate and simulate impedance of the single or multiple antennas. This page gives self impedance, mutual impedance versus antenna main length or ear length, ground effect to the antenna impedance, array impedance while reflectors even exist or not. These calculation can be made for lossy antennas. This page allows comparisons for different configuration to the user. Figure 5 shows center fed dipole antenna impedance depending on the antenna length with the antenna radius 0.001λ. This figure can be founed in the literature[iv].
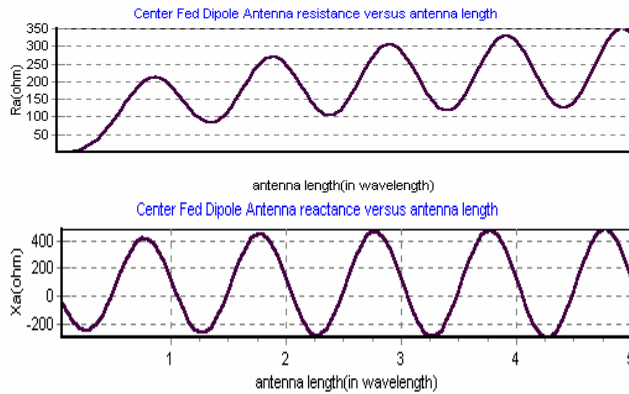

Figure 5 Center fed dipole antenna impedance depending on the antenna length, antenna radius is 0.001 lambda.

Figure 6 shows the end fed antenna impedance versus antenna main length. Here, the antenna ear length is 0.1λ and the antenna radius is 0.001λ. In figure, the antenna main length changes from 0 to 5λ, horizontal axis is resistance, vertical axis is reactance. The user can see that the end fed ESA has capasitive characteristic, at least for 0.1λ length ear part.
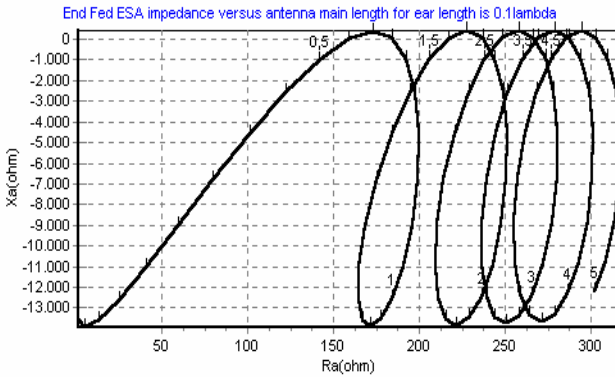
Figure 6 End fed antenna impedance versus antenna main length

Figure 7 shows the E shaped antenna impedance versus antenna height from wet clay ground. Similar graphics for perfect conductor ground and center fed antenna given by Krauss[v]. Here, solid line is center fed ESA, thin line is end fed ESA, the antenna ear length is 0.1 lambda and antenna radius is 0.001 lambda. This specification allows to the user that he observes and compares the ground effect to the antenna resistance.
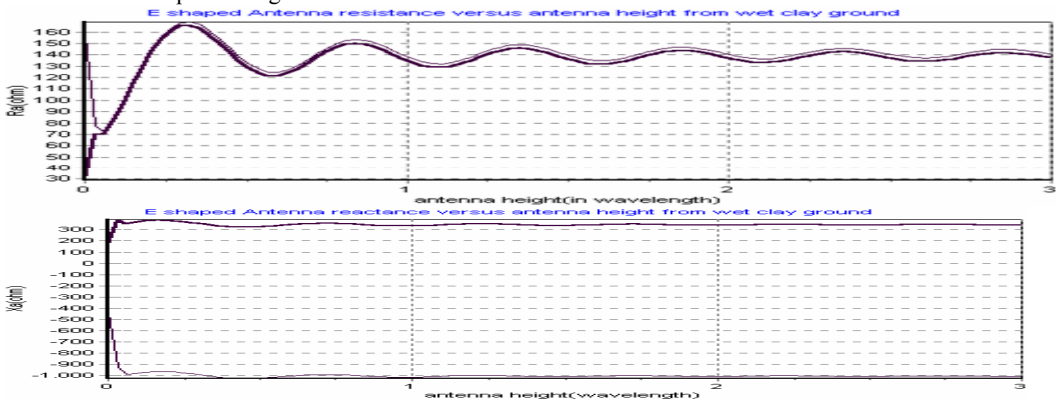

Figure 7 E shaped antenna impedance versus antenna height from wet clay ground.

Figure 8 shows the radiation impedance of 51 elemented array. Impedance values are given from center to end.
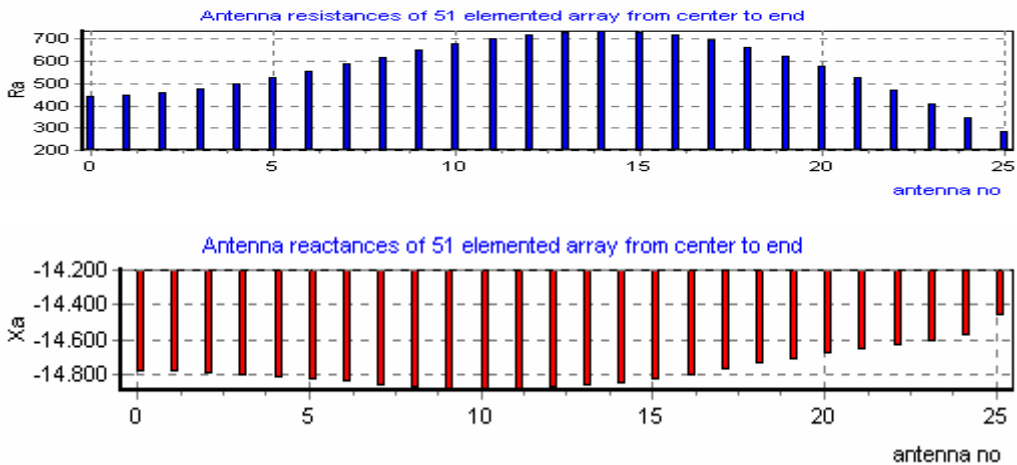

Figure 8 Radiation impedance of array elements

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Polar window gives the radiation diagrams for the user defined configuration, allows comparisons for different configurations to the user, calculates half power beam width or gain comparisons[vi], versus antenna length, of the center fed and end fed antenna for user defined antenna length parameter

Figure 9 shows radiation diagram of dipole antennas. Figure compares lossy antenna and feeding effects. In the figure, upper hemisphere is center fed dipole antenna, lower hemisphrere is end fed dipole antenna, solid line is for attenuation constant 0, thin line is for attenuation constant 1Np/m. Configuration which gaves this result is: propogation canstant is 6.28, attenuation constant is 0 or 1Np/m, the antenna radius is $10^{-5}\lambda$, the antenna length is 3.5λ. Figure summarizes feeding and attenuation effects to the user.
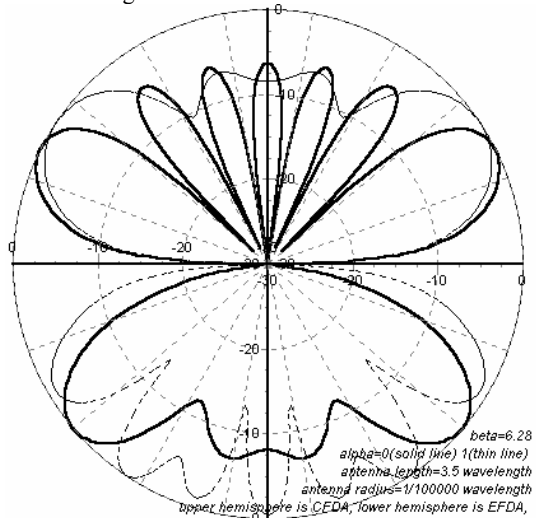

Figure 9 Radiation diagram of dipole antennas.
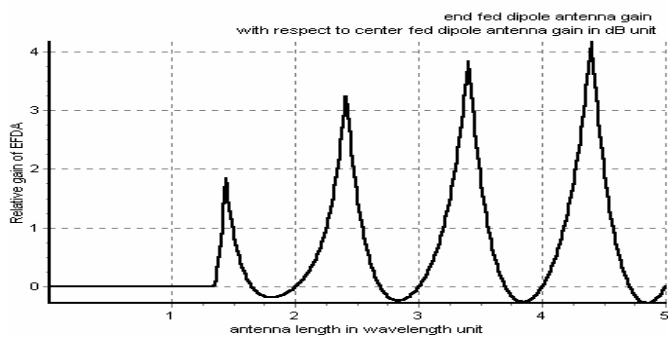Figure 10 shows antenna gain comparisons.

Figure 10 Antenna gain comparisons

Conclusions

This program teaches to the user all result of the thin wire ESAs. The user can see all result that he imagines an antenna configuration. This program may be assistant about thin antenna in the antenna education. There are a lot of type simulation which are be able to configured by user.

References