Super Numerical Electromagnetic Code (S-NEC) Software and Antenna Simulation

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Abstract— **In this paper, we can learn what is the S-NEC and how do we do simulation by it. S-NEC software is one of a specific for antenna design and simulation. Then a wire meander helix antenna with a new structure had been designed and simulated. The length of this antenna in relation to wave length is very small, in addition to this antenna have a high radiation resistance and low imaginary resistance. Also the antenna dimension gets better for having a high efficiency and the most bandwidth in 20 MHz to 24 MHz frequencies.**

Index Terms— **super-NEC software, helix antenna, radiation resistance.**

I. INTRODUCTION

The starting point for this tutorial is the helix antenna. Super NEC has a number of built-in antennas that can be very easily constructed. These antenna assemblies are listed in the menu item Add | Assembly | antennas as shown in Figure 1. To add a helix antenna to the structure, select the menu item Add | Assembly | antennas | snhelix.

A dialog box requesting the parameters of the helix will appear (Figure 2).

The main parameters of the helix are the turn spacing, lengths, base radius and the wire radius. The above dialog shows the default settings for a helix, which is a helix with 5 turns each spaced 0.2 m apart. On pushing the OK button, a segmented helix will appear in the structure editor (Figure 3).

Notice that the first element from down has a yellow marker on its centre segment. This marker is the Super NEC symbol for a source. Super NEC provides both zooming and panning functionality. To zoom in on the structure: push the shift key on the keyboard then position the mouse pointer within the grid displaying the structure, but not over any part of the structure. Push the left mouse button and move the mouse away from you. This will invoke the zoom-in facility. Moving the mouse towards you will give you the effect of zooming out.
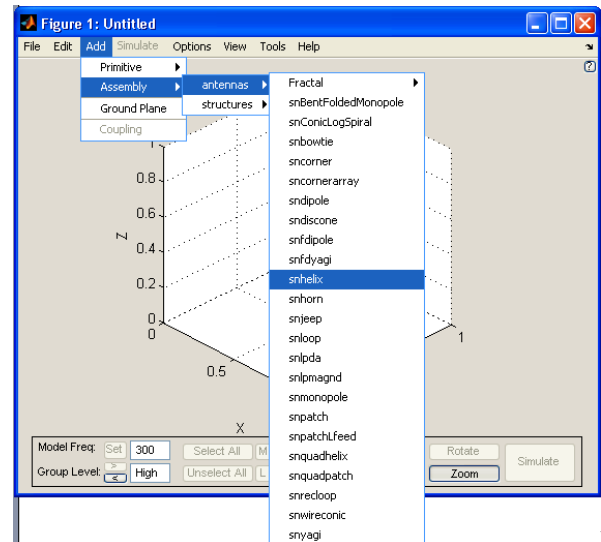

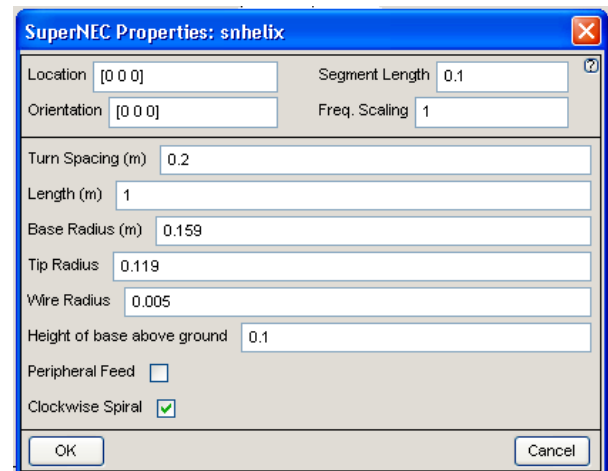Fig. 1 Adding a helix to the structure.
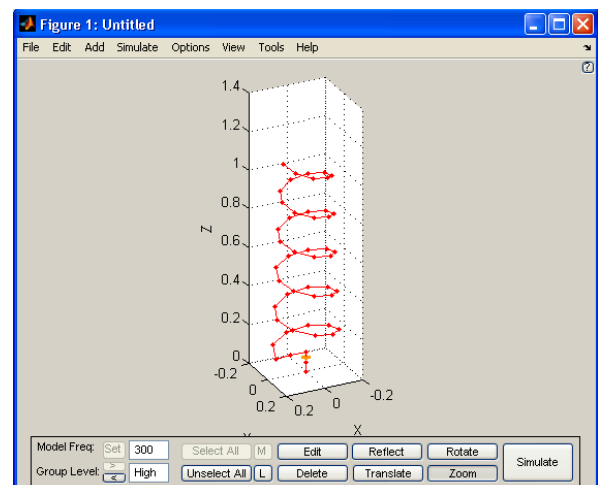

Fig.2 Entering the helix parameters.

Fig.3 The default Super NEC helix.

To pan the view of the structure must push the control key on the keyboard and then position the mouse as was done for zooming then move the mouse to the left, right, up or down to pan the view.

On the bottom left hand side of the structure editor window is the text 'Model Freq :'. The number to the right of this text specifies the frequency at which the structure is modelled. In this case, it is set to 300 MHz. You can change this figure to generate a model of the antenna at a different frequency. Try changing the number to 400 and then push the 'Set' button. Note that the number of segments used to model the antenna increases [1].

The 'Group Level' setting for the model is currently set to high. Reduce the level to 2 by clicking on the button with the '<' label. Now use the mouse to select part of the structure (left click whilst the mouse pointer sits on top of part of the structure). Note that you are able to select individual the wires making up the structure. Reduce the group level to 'low' and again select part of the structure. You are now able to select the individual segments.

Select the segment with the source attached and push the 'Edit' button. A dialog box for editing the segment will appear as shown in Figure 4. Note that this segment is excited with an applied field voltage source with a value 1+0i. Now cancel the edit box. You can also edit the segment by double clicking on the segment in the structure editor. Now increase the group level setting, select the last wire element of the antenna and push the 'Edit' button (or double click on the last element). The edit box for the subassembly 'snwire' appears. You can now change the length (or some other parameter) of the wire by changing the values in the edit box. If you increase the group level back to high and double click on the structure, the edit box for the helix antenna will appear. If you push the OK button, then the helix will be regenerated and any changes that you have made to the elements of the helix will be lost [2].

We will now create a stacked array of these helix's. The stack will be vertically oriented and the spacing between antennas will be 1 m. To do this must select all, push the translate button and fill in the resulting dialog box as follows(figure5).

Push the OK button and observe the result, The structure should now be restored to that shown in Figure 6.

We will now assume that this modification we made to the structure was incorrect. To undo this modification push <control-Z> (the control key and then the Z key). To redo the operation push <control-Y>.

Let us assume that we wish to model this structure from 20MHz to 24MHz and determine its radiation pattern in this frequency range. To set these simulation settings call the Edit | Simulation Settings menu item like figure7.

Figure 8 shows the simulation settings editor with the simulation frequencies set to start at 20MHz, end at 24MHz and go up in 1MHz intervals. To set the radiation patterns, click on the last line of the summary list box (Radiation Patterns: <click here to add>). The bottom part of the dialog box changes to the radiation pattern editor as shown in Figure 9. Select the 3D pattern in 4 degree increments from the predefined patterns list box and push the Add button. The simulation settings dialog changes to that shown in Figure10.
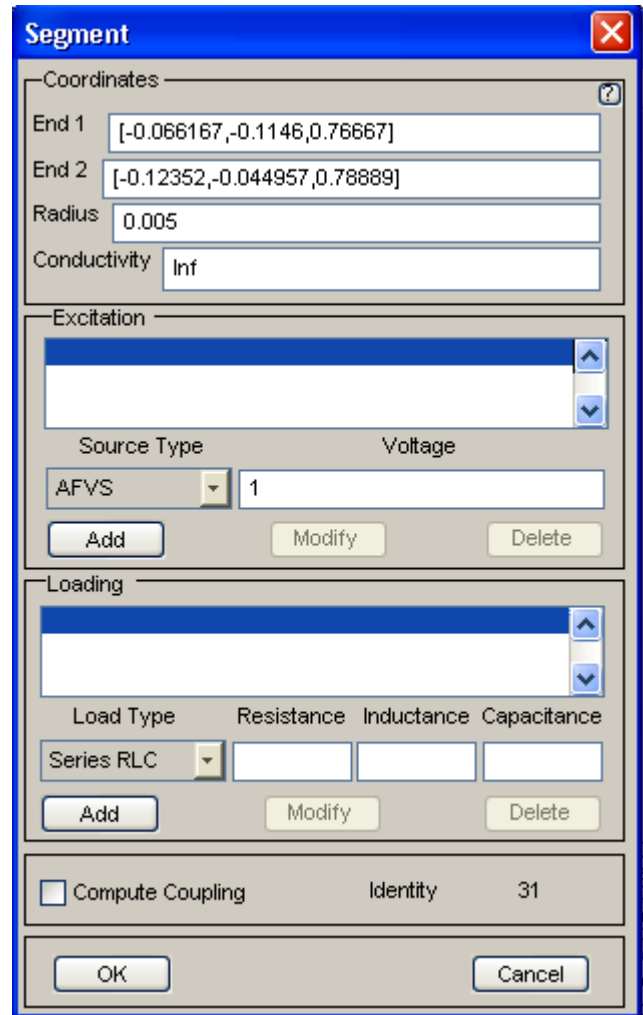

Fig.4 The segment edit box.
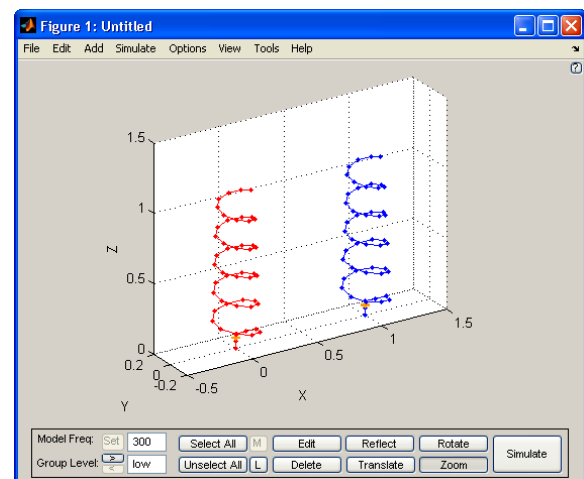

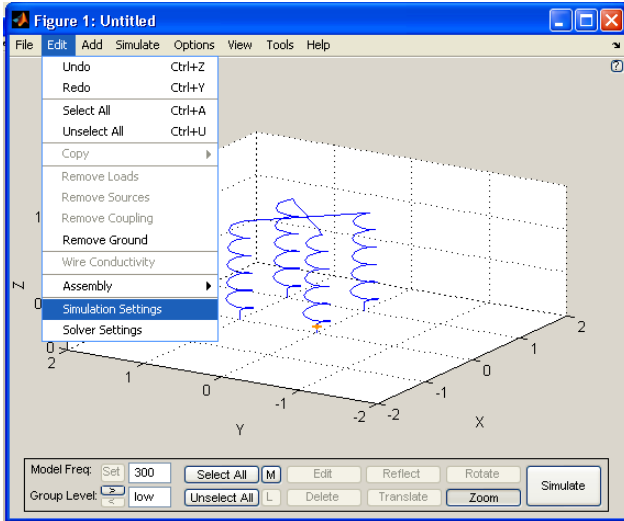Fig.5 Creating 1 duplicates of the structure.

Fig.6 The translated structure.

Fig.7 Calling the simulation settings editor.

Fig.8 Setting the simulation frequency range.
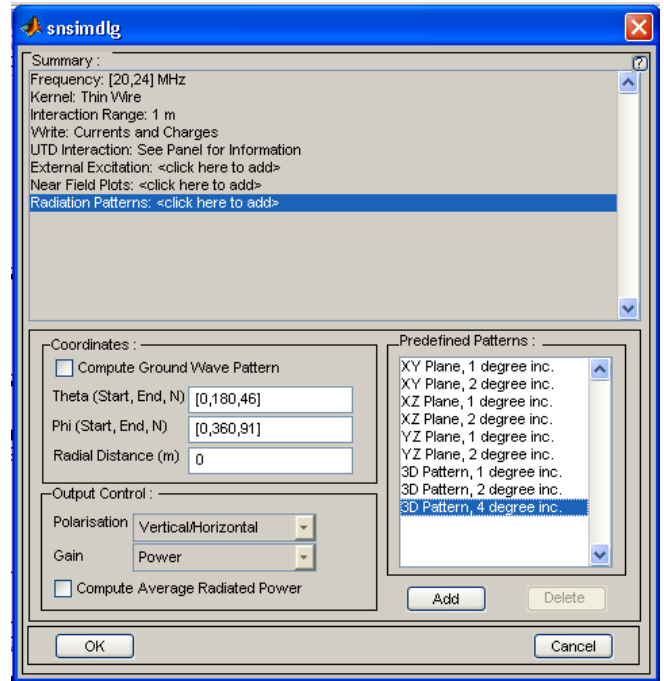
Fig.9 The radiation pattern editor.

Fig.10 Adding a radiation pattern.

This concludes the simulation settings requirement of the simulation and the OK button can be pushed. Super NEC supports three models of a ground plane, namely, a perfect ground, a ground modelled using fresnel reflection coefficients and a ground modelled using the Sommerfeld integrals. Ground cliffs are also supported, however, these features of the landscape are only taken into account in the far field calculations. Any one of these ground models can be added to the model. To do this must use the menu item Add | Ground. The dialog box as shown in Figure 11 will appear. then select the ground model you wish to use from the type-radio buttons.
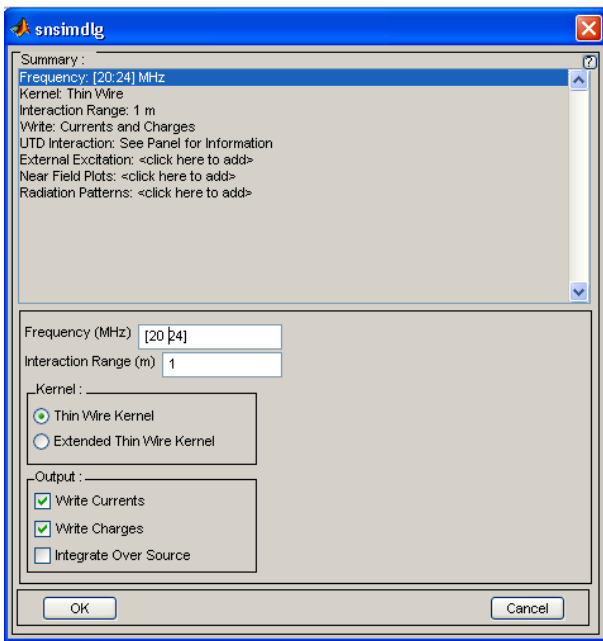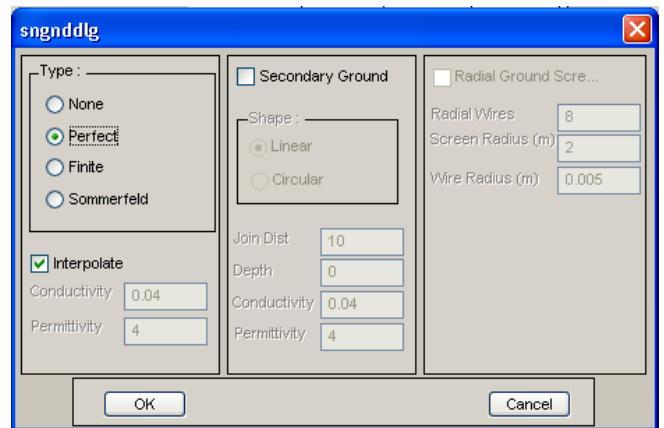
Fig.11 The ground specification dialog box.

If you select a finite ground (one that is modelled using Fresnel reflection coefficients) then you may choose to add a radial ground screen as well. This screen acts in parallel with the finite ground. You may choose to add a secondary ground or ground cliff by checking the 'Secondary Ground' check box (except if you choose not to have a primary ground). Fill in the conductivity and permittivity of the ground (not required if you have chosen a perfect ground). Press the OK button to accept the ground.

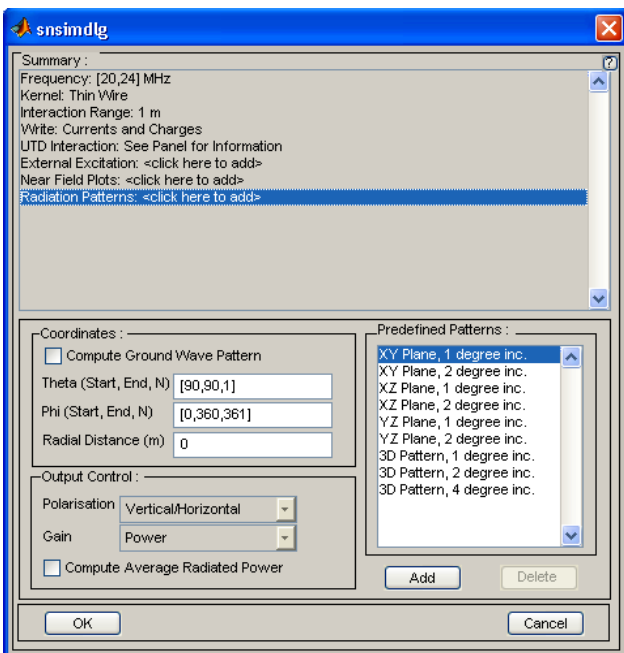Note that the interpolate check box is used to specify

whether or not currents of segments whose ends are connected to the ground are interpolated in their image.

If the View | Ground menu item is checked, then the ground will be displayed as a large brown plate-like structure. You can disable the view of the ground by un-checking this menu item.

The join distance parameter for the secondary ground is the distance from the origin at which you want the secondary ground to start. If the shape of the secondary ground is linear, then the primary and secondary grounds join at a line that runs parallel to the y-axis. The join distance, in this case, specifies the distance down the x-axis at which the primary and secondary grounds meet.

The conductivity and permittivity of both primary and secondary grounds are specified in units of S/m and F/m respectively [3].

The 'Radial Wires' characteristic of the radial ground screen is used to state how many wires are to be used in the modelling of the ground screen.

The ground can be removed from the model by selecting the menu item Edit | Remove Ground. Alternatively, if the ground is visible in the structure editor (the View | Ground menu item is checked), then one can double click on the ground and change its type to 'None'. This effectively removes the ground from the model.

You now return to the structure editor. To simulate the structure, push the simulate button at the bottom right hand side of the editor. You will be requested to save your work, after which the simulation will proceed. The simulation takes place in a DOS box similar to Figure 12.
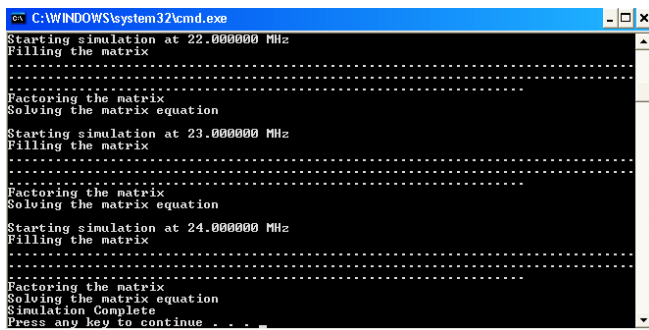

Fig.12 Running the simulation in a DOS window.

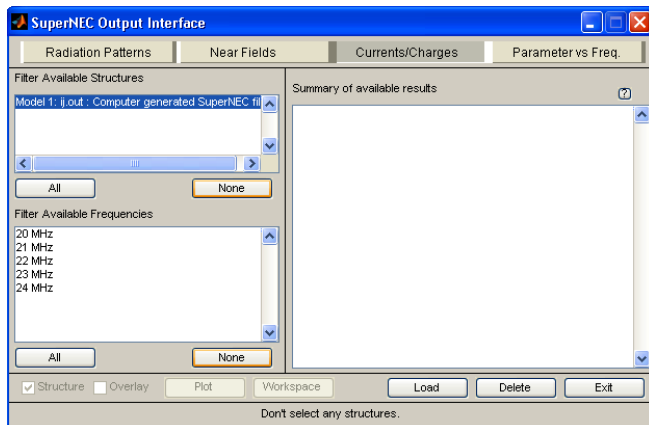The output viewer as shown in Figure13 will appear.

Fig.13 The output viewer.

Push the 'All' button below the 'Filter Available Structures' list box and also the 'All' button below the 'Filter Available Frequencies' list box. The 'Summary of available results' list box will change as shown in Figure 14.
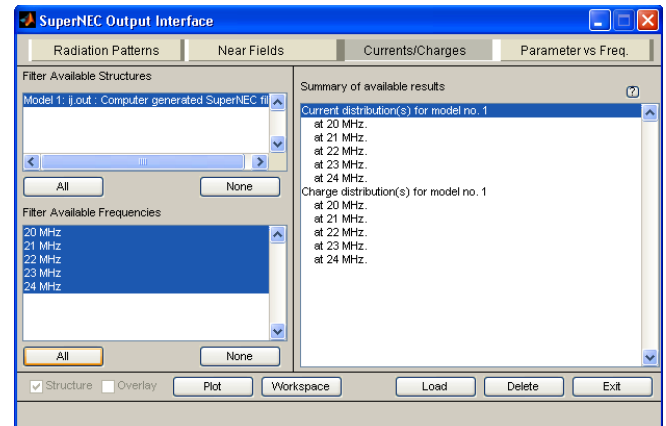

Fig.14 Showing the available currents and charges for display.

The top line of the list box is highlighted. This corresponds to selecting all the current distributions for plotting. To see these current distributions push the 'Plot' button. A window similar to Figure 15 will appear. The slider at the bottom right-hand side of the screen can be moved to view the currents at the other simulation frequencies [4],[5]. The slider at the bottom right-hand side of the screen can be moved to view the currents at the other simulation frequencies. Return to the output viewer and push the 'Radiation Pattern' tab at the top of the viewer. The 'Summary of available results' list box will change as shown in Figure 16. Tick the check box labelled 'Structure' at the bottom left hand side of the window. If the 'Plot' button is now pushed, then the radiation patterns overlaid on the structure will be plotted. This is illustrated in Figure 17.
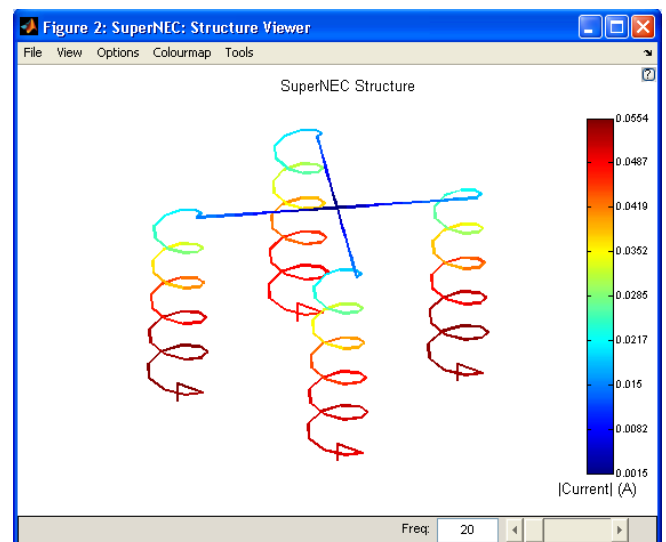

Fig.15 The current distribution.

II. DESIGNED HELIX ANTENNA

There is a relation between antenna dimension and signal wave length and usually this factor is one of the serious problems in antenna designing. When the antenna length

becomes much smaller than antenna wave length, the efficiency of antenna is decreased severely and its radiation resistance is reduced and reserved reactive energy near the antenna increase extremely.
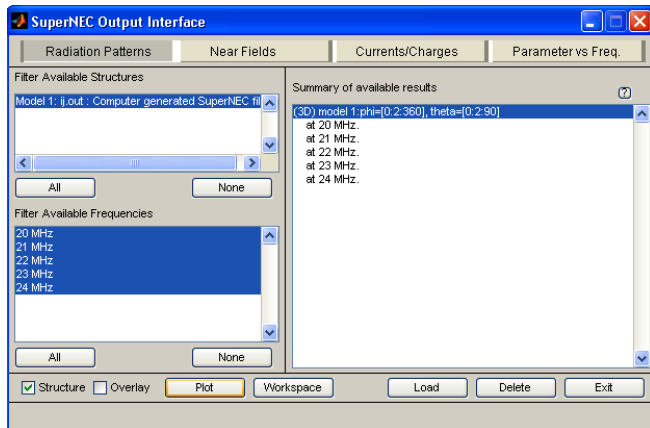

Fig.16 Showing available radiation patterns.

In the 2 cases, some problems will arise in the impedance matching between the small antenna and feeder. This matchless causes a extra reactive energy and a narrow bandwidth [6],[7]. In this paper, an antenna is designed and simulated that its length relation with wavelength is short, and have a much radiation resistance, low imaginary resistance therefore reserved reactive energy near the antenna is less, also efficiency and bandwidth is good. This antenna had been designed for 20 to 24 MHZ frequency band and the antenna wavelength is 13.6 m.
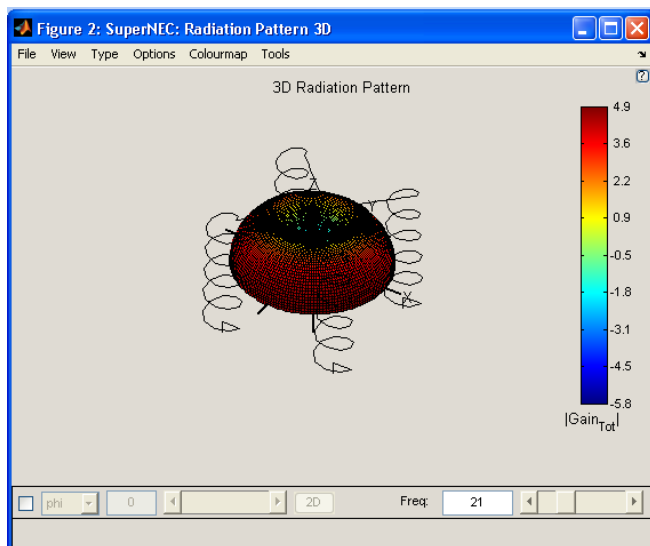

Fig.17 The radiation pattern and helix antenna.

Antenna field depends on the surface under the antenna current curve. Then for increasing antenna field, must be increase antenna length or increase top loaded to antenna. Increasing top loaded to antenna causes increasing surface under the antenna curve that it depends on radiation resistant [8]. Now, we can design a new antenna as in figure 18. Because this antenna has two big tops loaded then its radiation resistant is too much. Also mutual impedance is maximum when elements placed procession in 4 angle of square with the side of 1 meter that connected together diagonal [9]. And other parameters is contain height of

maximum spot from ground is 0.45 m, the minimum spot from the ground is 0.1 m, the turn spacing is 0.2 m, the radius of wires is 0.005 m, the diagonal of square is 1.44 m and the angle of placing each of the antennas is 45 degree. Because by this scheme increase the surface under the antenna current curve and increase the total impedance of antenna system.
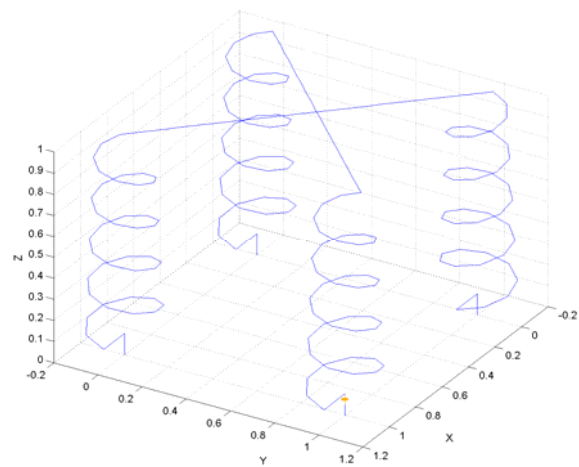

Fig. 18 Designed helix antenna

Each helix antenna section that placed in angles of square has a self impedance and a mutual impedance due other section of antenna. The method of placing antenna ground resistance decrease the total ground resistance.

III. SIMULATION OF DESIGNED ANTENNA

Now by the S-NEC software design and simulate a new helix antenna. Computers work for us like a good machine. The antenna real impedance diagram is shown in figure 19 and the imaginary impedance is shown in figure 20.
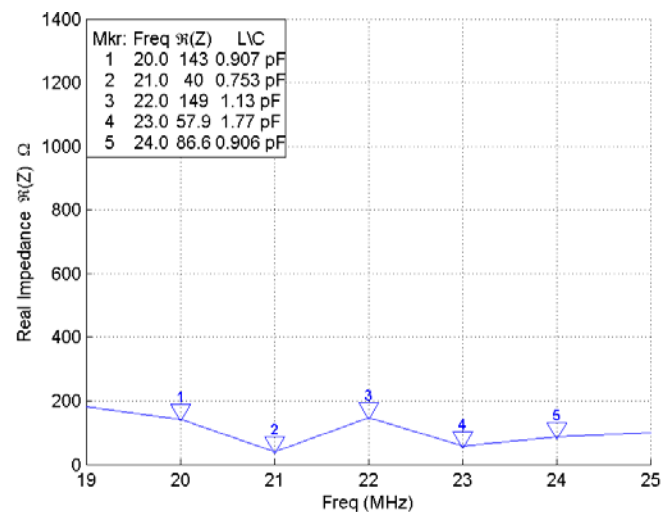

Fig. 19 antenna real impedance diagram

It is observed that in designed confine, real resistance is much and the swings are low. It means the antenna bandwidth is great [10].

IV. CONCLUSION

In this paper, we learn the super nec software completely and then designed a new helix antenna and simulate it by this software. Radiation impedance in central frequency is 148.9 Ω this caused the waves rays comfortably from antenna.

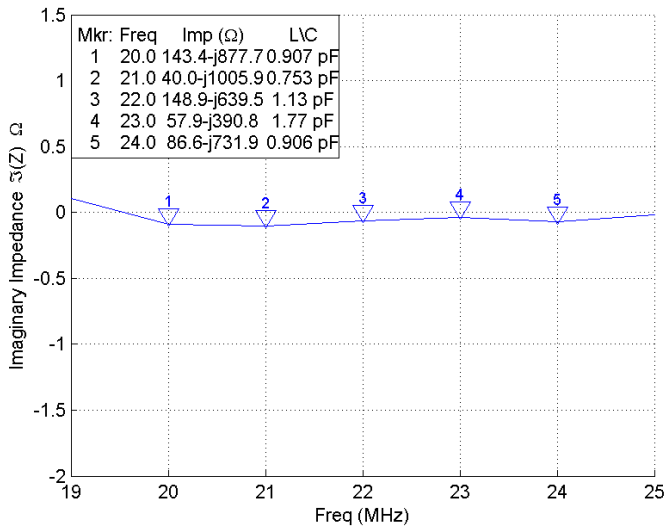Imaginary impedance is low therefore reactive energy near antenna decrease.

Fig. 20 antenna imaginary impedance diagram

Antenna length is very smaller rather than its wavelength. For better clearly we can compare it with a monopole antenna because a monopole antenna with the same designed antenna radiation impedance is 6.62 times larger. And imaginary impedance of design antenna is 4.086 times smaller than imaginary impedance of monopole antenna. The value of designed antenna imaginary impedance is 639.5 Ω and monopole antenna imaginary impedance is 2613 Ω.

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