Interaction between two types of antenna and Human head Phantom

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ABSTRACT

In this paper the penetration of electromagnetic fields in human head are simulated. Two models are described and compared. Three model human head model with dipole and PIFA antenna as an exposure source. The simulations are done at 900MHz using HFSS software. Also some effective parameters that use to measure the fields on human body are described.

Key word: Three layer human head model, HFSS

Introduction

Nowadays the electromagnetic waves play important roles in the life of human communities. The EM waves are applied in many kind of systems such as mobile and RADAR. Because of electrical properties of biological systems such as human body, the EM fields can affect on their tissue and lead to biological effects. It is important to observe that the fields can change the structure of cells and damage them.

In some study, we studied effects of some parameter on SAR. These parameters are for example frequency, size of biological tissue, source exposure and etc. In references [1]-[3] it can be seen. Also some researches are about human health effects of electromagnetic fields. The effects are divided into thermal and non-thermal. For example Blood Brain Barrier (BBB), DNA strand breakage, cancer, brain tumor, pearl, buzzing in the ears are some of these effects.[4], [5].

All of the electromagnetic waves, i.e. ionizing and non -ionizing can affect the human body. These effects can be probable or definitely. The definitely effects of beams appears when the exposure level exceed from threshold levels. So the standard level in the entire world provided to protect human health.

In this study we want to simulate a three layer human head model and compare the E-field strength and SAR distribution between this model and six and one human head model. [6]

Effective parameters on electromagnetic penetration in human body:

The parameters that use to measure the value of penetration of fields in human body are electric field strength (V/m), magnetic field strength (A/m), Specific Absorption Rate(Watt/kg) , power density (Watt/ m2) and etc. SAR is a measure of the rate at which energy is absorbed by the body when exposed to a RF electromagnetic field. SAR is usually averaged either over the whole body, or over a small sample volume (typically 1 g or 10 g of tissue)

The investigations on the adverse effects of electromagnetic fields on human body should encompass such factors as the field strength, frequency, and exposure environment, time factor of exposure, source structure, geometry and size of tissue and wave polarization.

Material and Method

In the commercial systems for SAR measurement a dipole antenna and a shell full of human head equivalent materials is used. This model is named phantom that are in many shapes. But the human head consists of many various layers those have various electrical properties. Our model is including a shell and three layers i.e. (skin, skull and brain). We use a dipole antenna and a PIFA antenna as an exposure source. The characteristics of these models are in Fig1 to Fig 3 and also Table 1 and Table 2.

Results:

The results of simulations are shown in this section. Figures 4.A to 4.C and 5.A to 5.C show the results of E-field strength for PIFA and Dipole antenna respectively. The summary of results shows in Table 3.

The results show that the maximum value of E-field strength is in the nearest layer to antenna i.e. skin in both model. Also the value of E in minimum in the inner model i.e. brain. These results are also similar to [5].

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Table 1: Three layers dialectical properties [8].

<table>
<thead>
<tr>
<th>Tissue</th>
<th>ε</th>
<th>σ</th>
</tr>
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<tbody>
<tr>
<td>skin</td>
<td>40.7</td>
<td>0.65</td>
</tr>
<tr>
<td>skull</td>
<td>20.9</td>
<td>0.33</td>
</tr>
<tr>
<td>brain</td>
<td>41.1</td>
<td>0.86</td>
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Table 2: Dipole antenna properties [5].

<table>
<thead>
<tr>
<th>Dipole antenna</th>
<th>Dimension(mm)</th>
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<tr>
<td>Dipole length</td>
<td>149mm</td>
</tr>
<tr>
<td>source</td>
<td>1mm</td>
</tr>
<tr>
<td>Dipole radius</td>
<td>3.6mm</td>
</tr>
</tbody>
</table>

Fig. 1: A. PIFA antenna [7]  
Fig. 1: B. Dipole antenna.

Fig. 2: Three layer human head model within a shell.

Fig. 3: Human head model and PIFA antenna.

Fig. 4: A. E-field strength in brain with PIFA.

Fig. 5: A. E-field strength in brain with dipole.

Fig. 4: B. E-field strength in skull with PIFA.

Fig. 5: B. E-field strength in skull with dipole.
Table 3: Comparison between E-field strength between two model (human head and PIFA and dipole antenna).

<table>
<thead>
<tr>
<th>tissues</th>
<th>E-field - PIFA</th>
<th>E-field - Dipole</th>
</tr>
</thead>
<tbody>
<tr>
<td>brain</td>
<td>7.44</td>
<td>171.7</td>
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<tr>
<td>skull</td>
<td>13.7</td>
<td>177.9</td>
</tr>
<tr>
<td>skin</td>
<td>15.9</td>
<td>188.2</td>
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References