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BIOLOGICAL EFFECT OF ANTENNA

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Abstract: In this dissertation a novel approach for calculating Specific Absorption Rate is introduced. We consider electromagnetic radiation emitting antenna being simulated in close proximity with human tissue. We use common material properties of tissues i.e. permittivity, conductivity, density & permeability etc. We use different communication frequencies to simulate antenna. We study the effect of variation in electrical & magnetic properties of tissue on specific absorption rate, which is a measurement of rate of absorption of electromagnetic radiations emitted by RF antenna. We apply the method to the study Specific Absorption Rate of electromagnetic radiations (produced by handheld communication devices) in Human tissues.

Keywords: Specific Absorption Rate(SAR), Communication Frequency, Human tissue, Electrical & Magnetic properties of human tissue

INTRODUCTION

1.1 Overview of the problem

Mobile phone industry has significantly gained the market in last few decades. People are in so much habit of keeping mobile phone with them in their daily life, that they call it as “Artificial Limb” also. Mobile phones are two way radio that use radio frequency for transmission and reception of voice and data. As the number of mobile phone users is increasing rapidly, it has become main concern to focus on the effect of radio frequency electromagnetic radiations produced by mobile phone responsible for establishing electromagnetic interaction between human body and mobile phone.

Electromagnetic (EM) radiation produced by mobile phone can be categorized as ionizing radiation and non ionizing radiation. Ionizing radiation is the high energy radiation capable of ionizing i.e. removing bond between atoms and electrons and this can result in tissue damage. While non ionizing radiation is the low energy radiation capable of vibrating atoms & molecules, but don’t have enough energy to ionize molecule. Non ionizing radiation is mainly occurred at low frequency.

1.2 Specific Absorption Rate – SAR

In practice the evaluation of the risks that the antennas’ EM fields may bring to the human body is also important. The best known effect of EM fields on the human body is to cause dielectric heating, for example the findings of the temperature increase in eyes due to absorbed radio frequency (RF) energy. Another concern is that radio frequency radiation can trigger cancer. For example in [13], a risk for breast cancer was suggested for men who were heavily exposed to EM fields, and an increased risk for leukemia was found for the electricians who were exposed to EM fields. Specific Absorption Rate (SAR) is used to quantify the absorbed EM energy by the human body. SAR is defined as

$$SAR = \sigma \frac{E^2}{\rho} \quad (1.1)$$

where σ and ρ are the conductivity and density of the human body tissues respectively and E is the electric field in the tissues. SAR is measured in watts per kilogram (W/kg). In the United States, the Federal Communications Commission (FCC) requires a SAR level at or below 1.6watts per kilogram (1.6W/kg) averaged over 1 gram of tissue (SAR 1g) in head, while the council of the Europe Union sets the limit at or below 2W/kg over 10 gram of tissue (SAR 10g) in head.

WEARABLE ANTENNAS AND HUMAN BODY

The 1980s saw the beginnings of what has now become a revolution in personal communication systems. Although there are several contenders, the first viable voice-only cellular system is thought to have been NMT (Nordic Mobile Telephone) which was an analogue cellular system deployed in Nordic countries, Eastern European Russia. Other early starters included TACS (Total Access communications System) in the United Kingdom and AMPS (Advanced Mobile Phone System) in the United States. Early systems tended to have less than convenient handsets with cumbersome power requirements. Over almost three decades now there has been a generally increasing demand for handsets that are smaller with increased facility and longevity of use. This demand has been satisfied by improvements in technology particularly in the field of miniaturization whereby components of communication system are generally much reduced in size. The majority of current personal communication systems are based around wireless technologies.

Wearable antennas and clothing

As in most wireless systems, antennas play a very important role in WEs. A good antenna design may extend wireless range and reduce power consumption. Therefore the design of suitable wearable antenna (WA) is important especially because of the impacts of the human body. In general wearable antennas with very few if any exceptions have been strongly linked to items of clothing. There have been examples of WAs on rings and as components in prosthesis but these will not be considered here. Further, such antennas have tended to appear in clothing that is more robust. For example antennas in jackets, hats and shoes are far more common than antennas in socks, shirts or undergarments (see Figure 3.1). Antennas can be affixed to the surface of or incorporated with the fabric of most common items of clothing. Typically the further away from the skin an item of clothing is, the less likely it is to be washed and this fact can make life easier for engineers. However, this is not the major motive for their placement, as electrical insulation from the body of a wearer turns out to be a dominant factor in design

Figure 3.1 Wearable antennas on Bluetooth iJacket

METHODOLOGY

All the simulation work has been performed on XFdtd 7.2.2.7 Plateform. One of the most powerful aspects of XFdtd 7.2.2.7 is the flexibility it offers users to customize and organize their projects. Features such as scripting and parameterization make it possible to quickly and efficiently create or modify projects without carrying out tedious steps in the Graphical User Interface (GUI).

Example of Simple SAR Calculation

For simple SAR calculation, one need to perform the following steps:

Model a tissue with a dipole

1. Define the properties of the environment
2. Add a feed to the dipole and simulate its effects
3. Add a point sensor and measure E-field at the center of the tissue
4. Add an SAR sensor and retrieve SAR data

A) Getting Started

This section briefly describes how to set the display units for the SAR project.

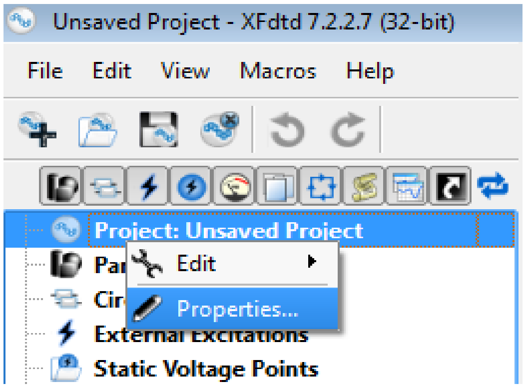

Figure 4.1: Defining units as per requirement

In the PROJECT PROPERTIES EDITOR window, navigate to the DISPLAY UNITS tab:

- ✓ Select SI METRIC in the UNIT SET drop down list.
- ✓ Change the units as per requirement.

✓ **Modeling the Tissue**

The Tissue will be created with a cylindrical EXTRUSION with a radius of 250 mm in the +Z direction.

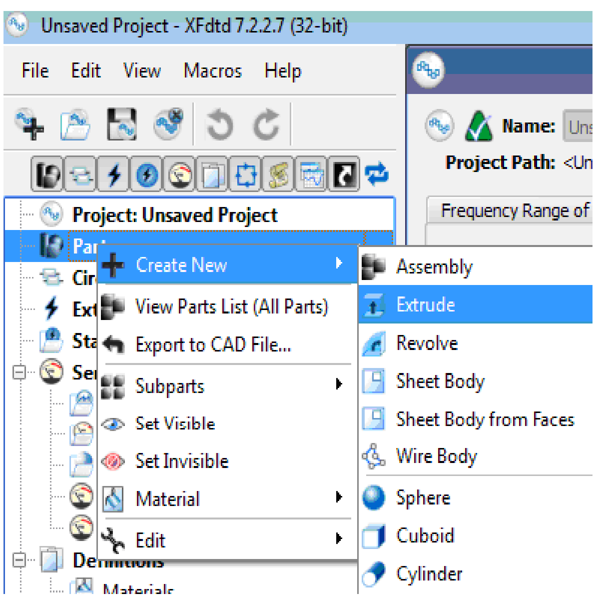

Figure 4.2: Selecting the geometry tool to perform an extrusion

E-field Results

For viewing E-field results retrieved from the center of the TISSUE.

- To filter the list accordingly, select the following options in the columns in the top pane of the RESULTS window. (You may need to change your column headings first.)
  - SENSOR: E-field at Tissue Center
  - RESULT TYPE: E-field (E)

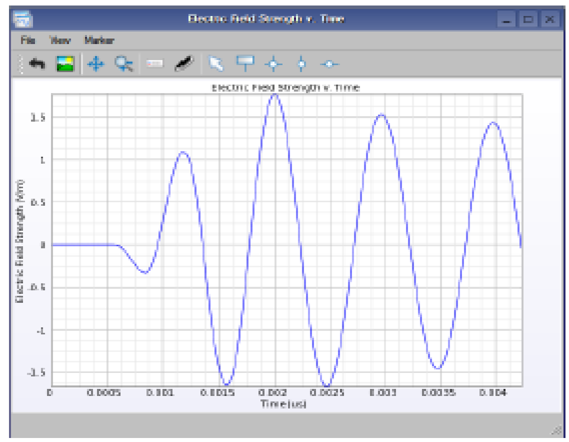

Figure 4.17: E-Field Results

Right-click on the result and select

CREATE LINE GRAPH

Figure 5.2 shows the variation in return loss with changing operating frequency. Graph shows that highest return loss of 17.67dB is achieved at 850 MHz operating frequency. The lowest return loss value is achieved at 1800 MHz frequency, which is approximately 0.75 dB, while that in case of 1900& 2100 MHz is about 0.78 dB and 1.06 dB respectively.

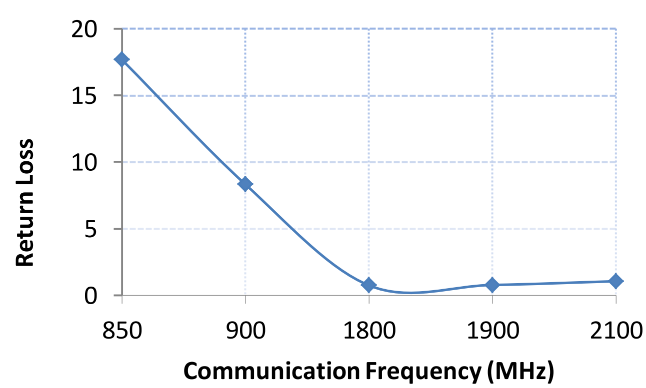

Figure 5.2 Variation in Return Loss with varying frequencies

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