3G Antenna close to a human head's model

1. Description

Specific Absorption Rate (SAR) is a measure to estimate the absorbed energy by human body when a person is under the exposure to an electromagnetic field. Reliable estimation of SAR values has become a very important concern. It is impossible to measure SAR in-vivo, but reliable SAR values can be easily obtained from Electric field data. This measure has found a high interest in the past decade as the cellular phones are gaining more and more popularity. As the harm of intensive exposure of microwave to the brain is well established, it has become very crucial to have a reliable tool to calculate the SAR before designing the cellular devices.

In this study, we simulate a 3G antenna next to a modeled human head in HFWorks; Specific Absorption Rate (SAR), electric field distribution along with other parameters are presented within this report.

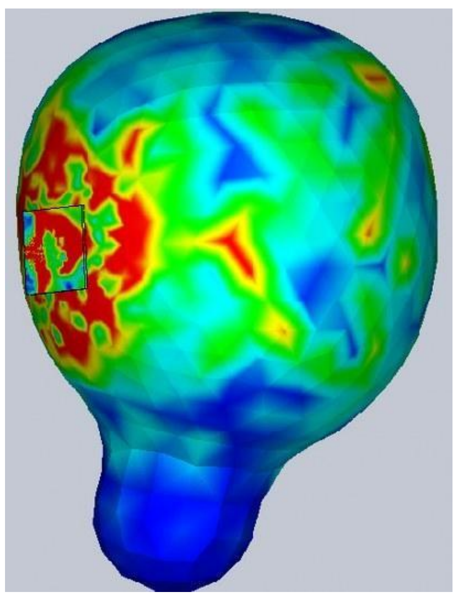


Figure 1: Model of human head exposed to UMTS antenna radiation

2. Simulation

Through this simulation, we should be able to get an approximate idea about the 3G generated fields' absorption in human bodies, more precisely around the human brain. The SAR is calculated by HFWorks in antenna simulations as it always refers to exposure of human bodies to radiation sources. This application deals with the impact of 3G or UMTS (at 2.1 GHz) signals on a model of a human head.

3. Load/ Restraint

We can define specific materials to model human bodies based on approximations and measurements. we can freely choose radiation surfaces from the defined head's model, keeping in mind that these surfaces will be relevant to any post-study radiation plots. Numerical modeling of human head-cellular phone is a very important problem. "Analyzing possible range of variations of the induced field strengths in various tissues requires an extensive effort, since local field strengths strongly depend on various parameters: operational frequency, antenna power, mutual positions of device and human head, design of the device, size and the shape of human head, distribution of tissues within the head and the electrical properties of the tissues".[1]

4. Results

At the frequency 2.1 GHz (UMTS), what matters to the simulator is the impact caused by the antenna on the modeled head and not the antenna itself. So the radiation patterns of the antenna are irrelevant in this task. However, the simulation has to run using a radiation of an antenna of common in order to get interpretable results.

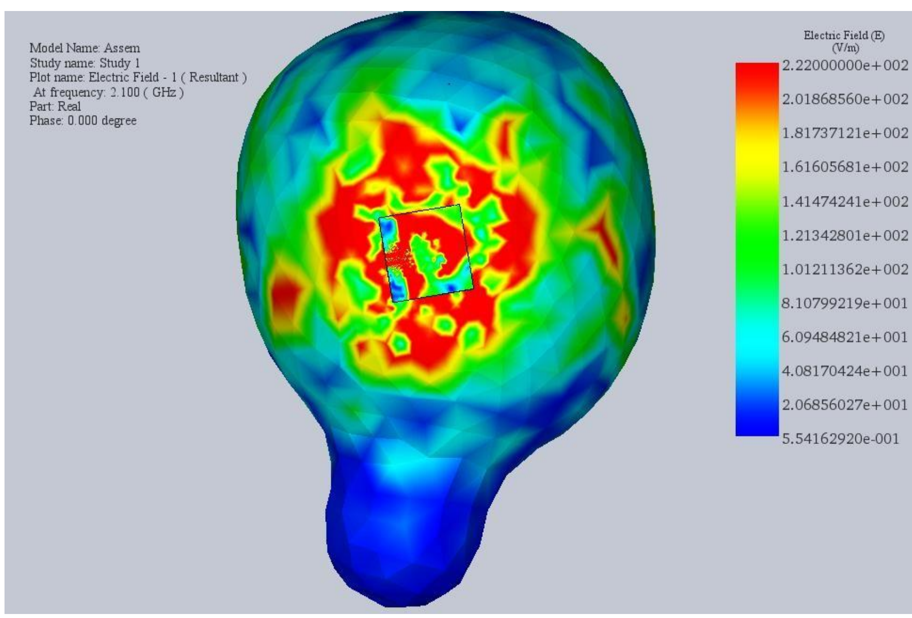
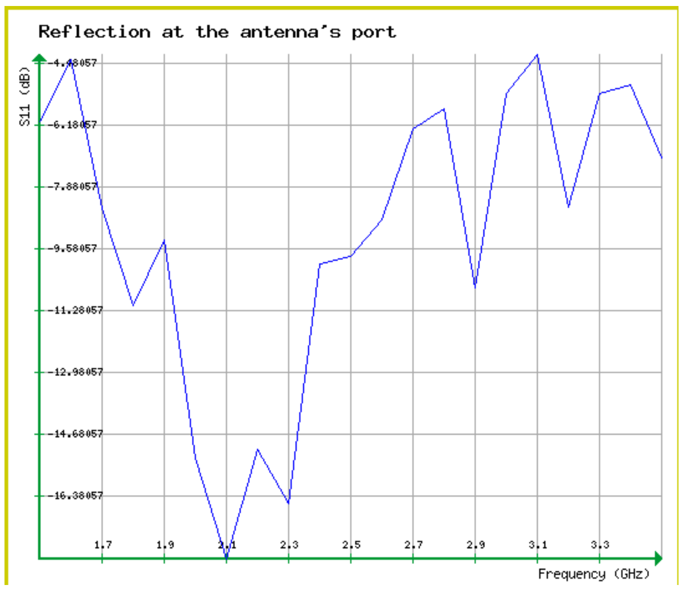


Figure 2: Inner Electric field distribution

We might have an inaccurate 3D electric field plot due to a bad choice of chart scale. so we define the minimum and maximum values and things will get clearer. We can animate the 3D plot by varying its phase to see how changing the omega T phase affects the distribution of the field.

The S11 coefficient is illustrated in the figure below, showing that the considered antenna is compatible with and responds to the UMTS frequency band.



5. Specific Absorption Rate

This quantity is calculated in order to experimentally evaluate the compliance of portable devices and mobile devices with local absorption guidelines. The correlation between the electric intensity of the body E (root-mean-square value; r.m.s. value) and SAR is represented with the following formula:

$$\mathrm{SAR} = \sigma \frac{E^2}{\rho} \; [W / kg]$$

Where, σ represents the conductivity [S/m] of various human tissues and ρ is the density [kg/m^3] of human tissue.

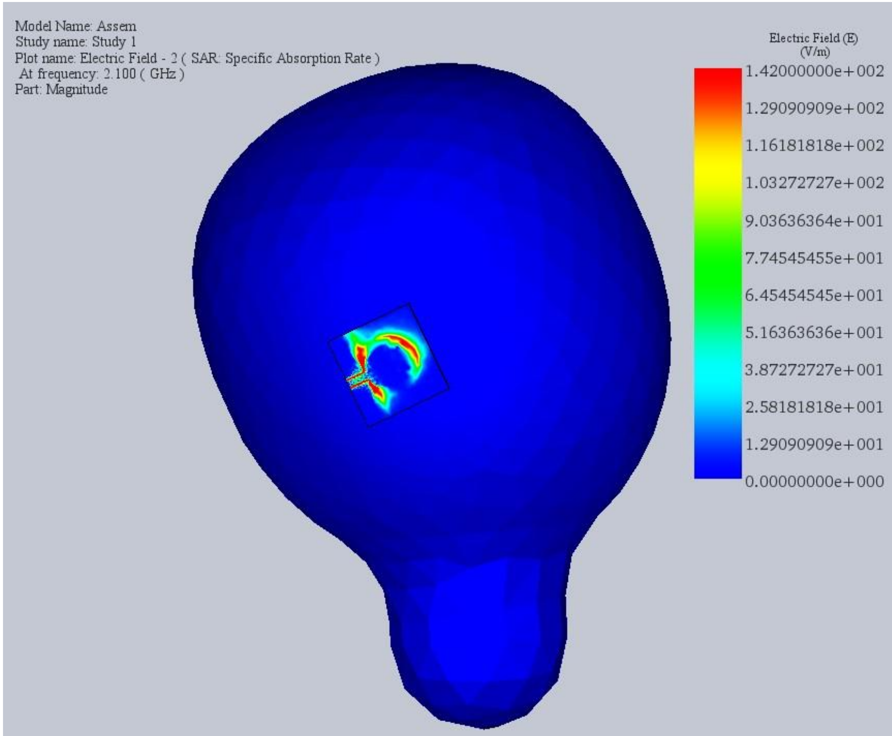


Figure 3: SAR 3D plot using E field

This figure shows a representation of areas where we deal with intensive radiation absorption by the human tissue noting the value of the electric field's magnitude. SAR is computed based on the electric field distribution, the density of the tissue and the conductivity of the surface.

6. References

[1] Specific Absorption Rate (SAR): Distribution in the Human Head at Global System Mobil (GSM) Frequencies. Seddik Bri, Samira Kassimi, Mohamed Habibi, Ahmed Manouni. 2011