HUMAN EXPOSURE STUDY FOR SOME SCENARIOS

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Abstract

In this article The main aim of the research is to investigate EM exposure influence on a human homogenous model located in a car and study possible resonant fields. This problem is very topical, because in some cases the excitation source is located in vicinity to the sensitive tissues. We have investigated several cases when a human with a cellphone is located inside a car and also the case when the EM source is the base station antenna. The problems are solved using the Method of Auxiliary Sources (MAS) with a user friendly program package, created for numerical experiments realization for these particular problems. The results of the numerical experiment are presented and analyzed.

1. INTRODUCTION

With the rapid development of new technologies, such as mobile phones and other communication systems, exposure of users to electromagnetic fields (EMF) has enormously increased in recent years. It is important to study their EM influence on human, because excitation source is very close to the sensitive tissue. Also it is important to obtain some general conclusions about the nature of exposure process, in order to elaborate some safety recommendations and standards. Our goal in this research is to investigate EM influence on human, when is located inside the car and study the fields' behaviour in the near and far zone. There are many factors to consider, like complex body geometry [1], [2], location in an enclosed or semi-enclosed room, wall transparency and users hand position, etc. It is impossible to thoroughly quantitatively consider all these details, but we can estimate most importance of them.

In spite of many works on this issue, the problem is not studied completely. EM absorption by human is measured in terms of specific absorption rate (SAR), SAR values show the radiated power from mobile phone absorbed by the human over a particular volume of body tissue corresponding to 1g or 10 g of body tissues [3] and it is measured in watt per kilogram (W/kg) [4].

In the article [5] are investigated several scenarios with Mummy; one is when the Mummy is located inside of a room while talking over the mobile phone. The other is when the Mummy is located inside of the room but the EM source is a base station located outside. For these cases are studied the influence of the room walls transparency on the formation of the near field inside the room and far field pattern. As the numerical experiments shows, in some cases, the room behaves as a resonator and amplifies the antenna radiated field. The field value may be amplified and be dangerous for the user The Method of Auxiliary Sources is used to solve efficiently all these problems [6].

2. MODELS, METHODS AND RESULTS OF NUMERICAL SIMULATIONS

2.1. Models and methods

During the EM Exposure influence investigation it is forbidden to conduct real experiments on humans. Because of this the main tools of investigation represents the computer modelling based on numerical methods. We use a homogenous dielectric human shaped body 'Mummy' with averaged permittivity and losses values (according to muscle, bone and blood), since their inhomogeneity does not affect the final results significantly. The use of such model is needed to implement the Method of Auxiliary Sources for calculations diffraction problems on human model for the big scenarios, when it is located inside the car. It is important to take into account the possible resonant effects in the car, study SAR distributions for the human model and near and far field distribution in case of mobile phone and base station antenna.

Application of the MAS is deduced to the construction of two couples of closed auxiliary surfaces inside and outside of the Mummy and also inside and outside of the surrounded surface like the car (Figure 1).

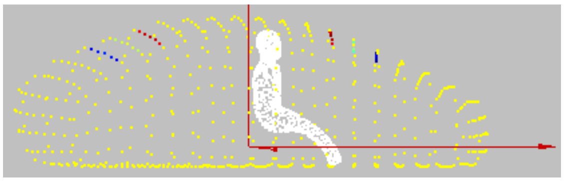


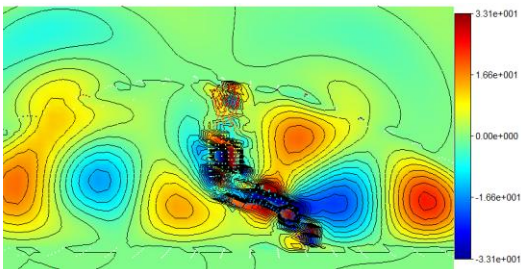
Figure 1. MAS model of cavity with using auxiliary surfaces

The calculations were conducted for frequencies used in the standard mobile frequency range.

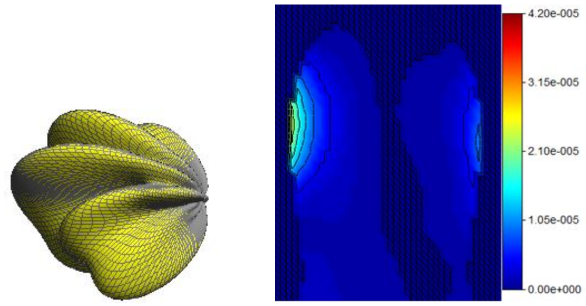
2.2. Results of numerical simulations

In this paper we introduce a new approach to use the MAS methodology. Our final goal is to find the near field distribution inside of the human body as well as inside and outside of the car**.** We consider human homogenous model like Mummy, with complex permittivity, ε=45+i2, (an averaged value considering blood, muscle and bones). Several scenarios have been studied (when source is mobile phone and base station antenna). The EM field incidence angle is 30^0 which means, that base station antenna is located sufficiently near. Obtained results are presented below. Values of the near field distribution and SAR are provided in the relative units.

In the fig.2 a) and fig.3 a) are presented near field distribution in the car, far field pattern and SAR distribution inside of the head at the 300 MHz and 450 MHz, when source is mobile phone are shown on fig.2 b), fig.3 b) and fig.2 c) and fig.3 c) respectively. As it seen from the obtained results at the 300 MHz inside the car is created high reactive field, which might be dangerous for human.

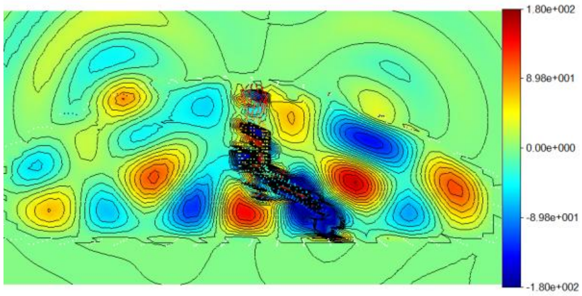


a)

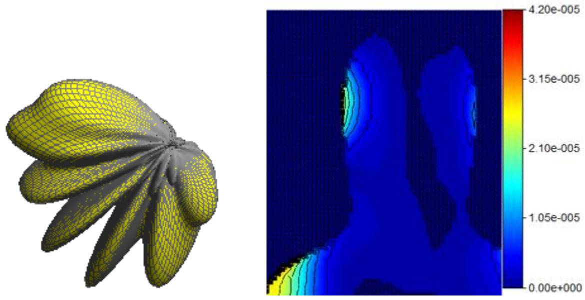


b) c)

Figure 2. Near field distribution in the car (a) and far field pattern (b), SAR distribution inside of human head c) at 300 MHz (source is inside the car).



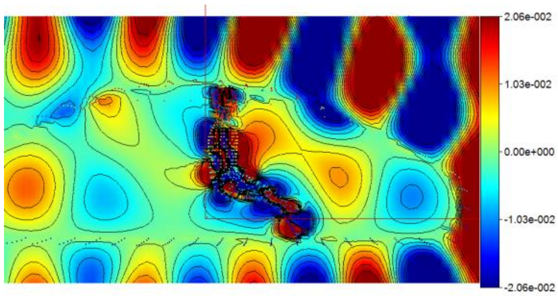
a)



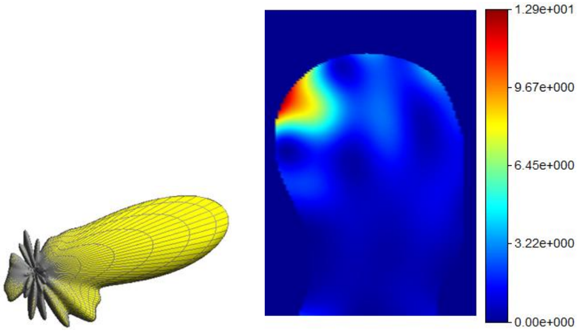
b) c)

Figure 3. Near field distribution in the car (a) and far field pattern (b), SAR distribution inside of human head c) at 450 MHz (source is inside the car).

The near field distribution for the case when the source is the base stations is shown of fig. 4 a). The far field pattern and SAR distribution inside of human head at the 450 MHz are presented on fig. 4 b) and c) respectively.

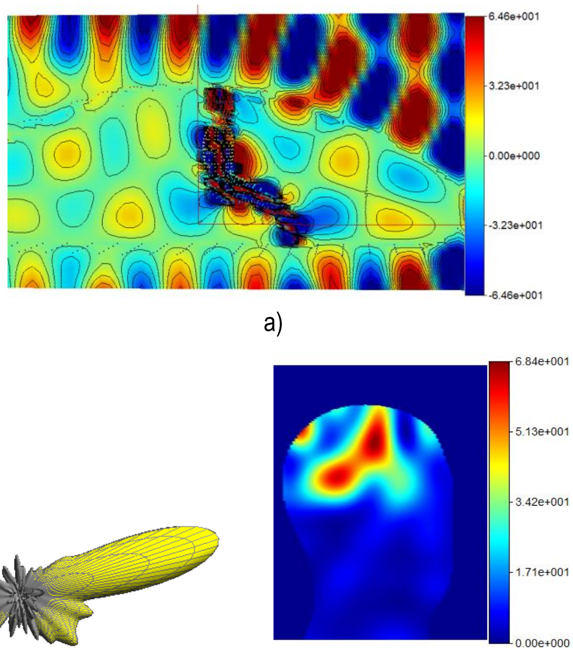


a)



b) c)

Figure 4. Near field distribution in the car (a) and far field pattern (b), SAR distribution inside of human head c) at 300 MHz (source is base station antenna).



a)

b) c)

Figure 5. Near field distribution in the car (a) and far field pattern (b), SAR distribution inside of human head c) at 450 MHz (source is base station antenna).

At the 450 MHz frequency, in case when source is base station antenna, obtained results are presented on the fig.5. The near field distribution for this case is shown on fig.5 a). For far field pattern we got result which is presented on fig.5 b) and SAR distribution inside of human head is shown on fig.5 c).

3. CONCLUSION

Main conclusions which follow from the study are following: It is not desirable speak on phone for a long time if user is located inside the car. The calculations, conducted with the created program package, showed the presence of resonance and reactive fields in several big scenarios which could be dangerous for a human.We study electromagnetic exposure problem for one human model, in some cases the results will not be applicable for other models. Every human is unique and differs in form, dimensions, weight and so more studies may be needed to make a firm conclusion.

4. ACKNOWLEDGMENT

This study is supported by Shota Rustaveli National Science Foundation grant: YS15_2.12_56.

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