DESIGN HALF WAVE DIPOLE ANTENNA FOR GSM APPLICATION WITH SAR EVALUATION

تصميم هوائي ثنائي القطب للتطبيقات GSM مع حساب معدل الامتصاص النوعي

هدى ابراهيم حمد
مدرس مساعد، قسم هندسة الألكترونيك ، كلية الهندسة، جامعة ديالى
ihhhuda@yahoo.com

الخلاصة:
بزيادة استخدام الاجهزة الاسلكية ، جهاز الهاتف النقال الذي تستخدمه مختلف الفئات العمرية والاشعاع المنبعث من الهاتف النقال يؤثر على رأس الاطفال والبالغين . في هذه البحث تم دراسة وتحليل نسبة معدل الامتصاص النوعي لمختلف اعمار الانسان باستخدام هوائي ثنائي القطب الذي يعمل بترددات ٩٠٠ و ١٨٠٠ MHz وفقا للتطبيقات GSM. بالاضافة الى ذلك، هذه الاختلافات بين نسب معدل الامتصاص النوعي تم تقيمها للامتثال للمبادىء التوجيهية للسلامة الدولية. النتائج توضح بان معدل نسبة الامتصاص النوعي عند ١ غرام و ١٠ غرام تزداد بزيادة حجم رأس الانسان.

الكلمات المفتاحية: هوائي ثنائي القطب ، معدل الامتصاص النوعي

ABSTRAC

The increasing use of wireless devices, cellular phone device used by different age groups and the radiation emitted from the cellular phone affected the head of children and the head of adults. The study of the specific absorption rate between different human ages by a half-wave antenna operating at frequencies 900 and 1800 MHz for GSM applications was analyzed in this study. In addition, these differences are assessed for compliance with international safety guidelines. The results show the specific absorption rate at 1 g and 10 g increase by increasing the size of the human head.

KEYWORDS*:* half wave dipole antenna , spesfic absorption rate (SAR).

1. INTRODUCTION

The mobile cellular systems has been developed , concern for human health has increased due to the impact of the radiation emitted from the mobile device. Although these rays are not ionizing but are capable of producing thermal effects on the human head. These effects are associated with the Specific Absorption Rate ,which determines the amount of energy that the human body absorbs when exposed to Radio Frequency (RF) electromagetic field, which permeates the human body through skin tissue, , so it is important to investigate potential health risks because of Skin tissue exposed to mobile radiation of various frequencies (900 at 1800 MHz)[1].

The SAR is decribed from the derivative by excess the absorbed energy with attach time excess in content in the element size of the specific density relative to the IEEE as shown in eq. (1) :

$$SAR = \frac{d}{dt}\left(\frac{dg}{ds}\right) = \frac{d}{dt}\left(\frac{dg}{\rho\, ds}\right) \qquad (1)$$

Where dg is symbolize to the incresing energy, ds represent increasing mass and ρ symbolize to the density .

The SAR is generally measured in watt per kilogram (W /Kg) unit or milliwatts per gram (mW/g) . to express of the SAR for induced electric field as in the equation below :

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

where E , σ and ρ express strength of the electric field (V/m), describe the conductivity of tissue (S/m), and represent the density of tissue (kg/m^3) ,respectively.

To protect the human from radiation exposure to mobile devices, it is necessary to set standards for the ratio of radiation absorption. The standards SAR in the institute of electrical and electronic engineers at 2 W/Kg every 10 grams For human tissue either Federal Communication Commission of the United State the SAR criteria are set to 1.6 W/Kg every 1 gram For human tissue [2]& [3].

In a previous study [4], various types of antennas used in mobile phones were compared. The antenna was placed close to the human head and hand. Each antenna has calculated for different distances from the human head (0-20 mm). The results of the comparison between the four antennas calculated the absorption rate specified within the health safety standards. Two different lengths of monopole antennas and these antennas are mountable on the plastic-coated handset and have typical dimensions for modern mobile phones in 835 and 1900 MHz. The impact of the tilt angle of the handset was measured relative to the vertical and the results were compared with the walker when the antenna was placed vertically with the head. It was observed that the rate of absorption of children is more absorbent than adults[5].

The usage two types of antenna such as helical and linear antnna in evulation specific absorption rate (SAR) . The linear antenna include (half and quarter wave length monople used in mobile devices. the evaluation SAR between two head human models (adult and children) and change of several parameters thats effects on this evaulation[6]. The several parameters of design antenna used in the cellular phone such as radiation , directivity and SAR. The study influence of different size of human head for the adult and children on these parameters. A complete comparison was made of coefficients between the adult human head and some of the heads of children obtained as a percentage of an adult human head[7].

In [8] attempt to limit the health dangers due to power absorbed by tissues and influence thermal emitted from cellular phones. moreover ,to reduce the specfic absorption rate used resistive sheet put on the frontal side of the handset The usage two human head model to calculate SAR for the children and adult with similar medium conditions. The evaluation specific absorption rate with high resolution (MRI)- based whole body models. The half wave diople antenna used radaitor device. The change of disatnce based on power density due to variation value of SAR with distance . the expermint form was evolve to depict the relation between the input power and distance for limitation specific absorption rate value [9] .

The head of the adult is different from the head child in terms of volume , form and remoteneness of the tissue. The basic differences between the different impact rays on the childreen and adults. The dimension of the child is lesser compared with adult head ,but the tissue is thinning. The results were compared in the case of children and adults [10]. In this paper present design and simulation half-wave diople antenna in the frequencies 900 MHz and 1800 MHz for GSM applications using CST Microwave studio 2014 and then calculated the specific absorption rate in different dimensions of human head (4 years , 9 years old and adults) when the mobile device is close to the human head.

2. Half wave dipole antenna design

The half wave diople antenna is the first antenna used in the mobile device. It is consist of two similar connector elements that have a connector in the shape of a rod or wire and the material used is copper to make the conductor and gap between two connector elements . The *l* is the whole length of the half wave dipole antenna , d is the thickness of the conductive and g is the supply gap as shown in Fig (1). The impedance of the half wave diople antenna is 73 ohm.

The antenna dimensions are dependent on the resonance frequency and vary by frequency. The resonance frequency used in the design of a half-wave antenna is 900 and 1800 MHz. The design of the antenna depends on several components illustrated by the equations below:

The wave length $(\lambda) = c/f_0$ (3)

The length of the antenna $(l) = \frac{143}{f_0(MHz)}$ (4)

Supply gap of the half wave dipole antenna $(g) = \frac{l}{200}$ (5)

Radius of the conductive (r) = λ / 1000 (6)

Where f_0 is the resonant frequency (MHz) and c= $3*10^8$ m/s. The second equation shows the calculation of antenna length and the third equation refers to the calculation of the antenna feed plus the fourth equation to calculate the radius of the conductive sequentially[11,12].

3. Simulation and results

The half-wave dipole antenna is designed using copper material between the conductive elements and using computer simulation technology studio 2014 (CST software 2014) for antenna design. The dimensions of the antenna are calculated using the equations mentioned above (from equation 2-4) and the frequencies used in the design of this antenna are (900 and 1800 MHz) are shown in table (1). The design results of this antenna were the basis for calculating the specfic absorbtion rate (SAR) of human head tissues for different ages of children in addition to adult age.

The S- parmeter and radiation pattern of half-wave dipole antenna and the directivity calculated at azimuth angle. This antenna covers frequencies GSM (900 and 1800 MHz) for all human head forms (child 4 years, child 9 years and adults) can be shown in Fig (2-8) .

In Fig (9-14) show maximum values of SAR over (10g and 1g) of all age for the human head when the mobile device on near from the human head. From the result observed the adult head be largest SAR distrbution in (900 and 1800 MHz) from other children head in the same frequency.

The values of maximum specific absorbtion rate over 1g and 10g have been evaluated in GSM 900 MHz and 1800 MHz for all dimension human head and are listed in Table (2). It observed the great value of the SAR increases with increasing frequency for all dimensions of the human head. The value of the SAR 10g 900 MHz is 4.68 W/ Kg increasing to 6.92 W/Kg in 1800 MHz at the same standard.

4. Conclusions

The impact electromagnetic between the half wave dipole antenna and different ages of the human head has been analysed in this paper.Comparative study of distribution specific absorption rate (SAR) for children and adults when exposed to the cellular phone radiation. Half wave dipole antenna is designed at (900 and 1800 MHz) for GSM applicatios when the mobile phone is near from the human head. The obtained result that the SAR for 1gram and 10 gram in adults is higher than children in the GSM applications.

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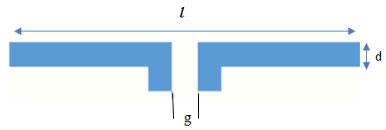


Fig (1): General structure of the half wave dipole antenna

Table (1): dimensions of the half wave dipole antenna

Parameters	$f_\circ = 900$ MHz	$f_\circ = 1800\ MHz$
λ	333.33mm	166.667mm
L	158.889mm	79.44mm
r	0.33333mm	0.166667 mm
g	0.794445 mm	0.3972mm

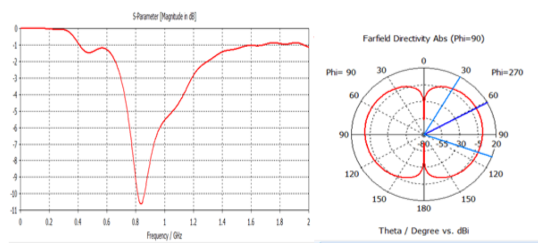


Fig (3): S- parameter and directivity for half wave dipole antenna at 900 MHz for 4 years child's.

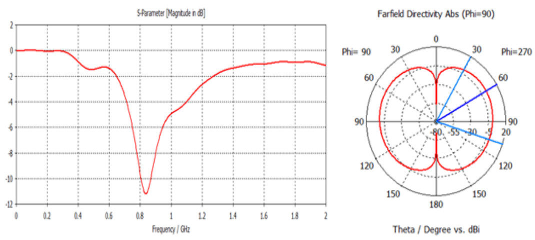


Fig (4): S- parameter and directivity for half wave dipole antenna at 900 MHz for 9 years child's.

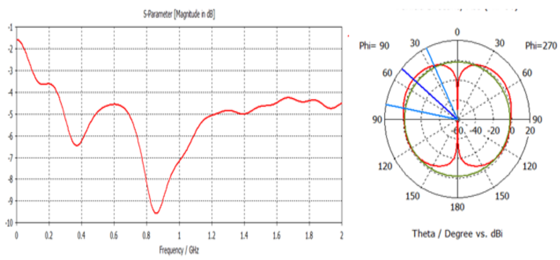


Fig (5): S- parameter and directivity for half wave dipole antenna at 900 MHz for adults.

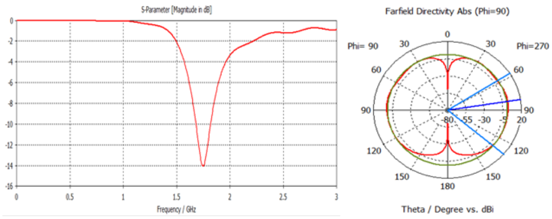


Fig (6): S- parameter and directivity for half wave dipole antenna at 1800 MHz for 4 years child's.

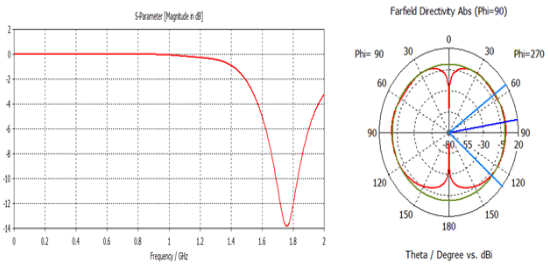


Fig (7): S- parameter and directivity for half wave dipole antenna at 1800 MHz for 9 years child's.

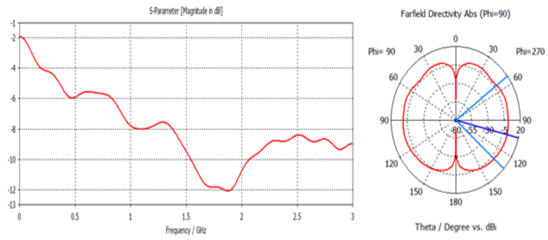
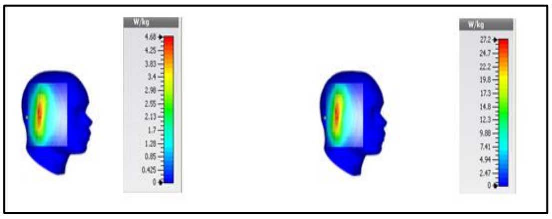
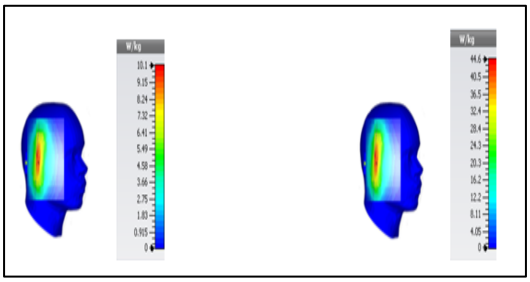


Fig (8): S- parameter and directivity for half wave dipole antenna at 1800 MHz for adults



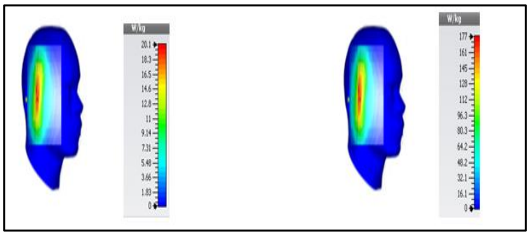
a)10g b) 1g

Fig (9) distrbution SAR for 4 years at 900 MHz a)10g b)1g



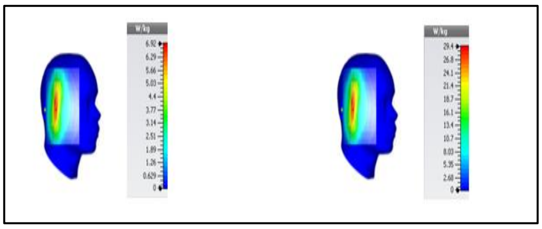
a)10g b) 1g

Fig (10) distrbution SAR for 9 years at 900 MHz a)10g b)1g



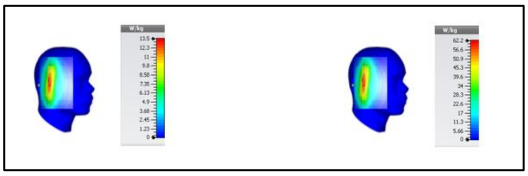
a)10g b) 1g

Fig (11) distrbution SAR for adults at 900 MHz a)10g b)1g



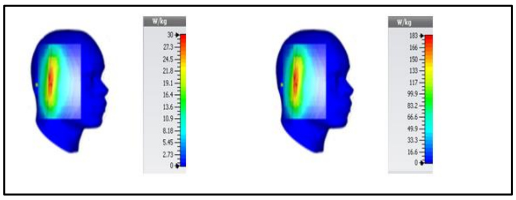
a)10g b) 1g

Fig (12) distrbution SAR for 4 years at 1800 MHz a)10g b)1g



a)10g b) 1g

Fig (13) distrbution SAR for 9 years at 1800 MHz a)10g b)1g



a)10g b) 1g

Fig (14) distrbution SAR for adults at 1800 MHz a)10g b)1g

Table (2) values of SAR

Age	SAR value at 900 MHz		SAR value at 1800 MHz	
	1g	10g	1g	10g
4 years	27.2	4.68	29.4	6.92
9years	44.6	10.1	62.2	13.5
Adult	177	20.1	183	30