Analysis of Antenna and its Radiation effect to the Nature

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Introduction

In the modern days, mobile phone is an indispensable gadget and without this life seems to be incomplete due to several advantages. The whole world is connected through this device as internet plays the most vital role .There are N number of application for different purpose can be installed in mobile phone to carry-out the daily routine work. The usability of this device is seen in hospital, banking sector, marketing, weather forecasting, sensex, social media, movies and more over in communication. Though this is quite instrumental for making life simple and smooth but at the same time it incur many health related hazards. Currently in India more than 80 crores of mobile phones are available for the above said purpose. Those cell phone are exchanging their information through cell phone tower whose count may reach to approximately 5 laks. This trends of installation of new set of tower is increasing day by day without considering its limitations.

Towers and its power

The base stations normally possesses directional antennas which aremounted on the roofs of buildings. All these antenna are oriented in such a way that the signals made available towards ground level. In many cases towers are mounted close to residential, hospitals, schools areas etc to facilitates good service for the user for entire day and night. As result of that everybody stays inside the radiation range. Less is the distance more will be the intensity of radiation. Recent status convey that majority population reside within these high radiation zones. In generalize sense all cell phone operators (Airtel,Ideaetc) uses 2 to 12 carrier frequencies depending upon the amount of information. For every carrier the power associated with is roughly 20W. In actual practice in a particular location there are more than one operator are installed. If we consider 5-6 carrier per operator then at an average one can receive 500 W. In addition to that , mostly they use directional antennas having gain = 18 dB.

Radiation pattern of the antenna:

Antenna is a device which converts electrical energy to electromagnetic radiation. Radiation is normally takes place due to time varying nature of current. As we know current is rate variation of charge and this is better explained as acceleration and deceleration. Radiation phenomena is more pronounce at high frequency. No matter how slow the variation of current but the radiation [1-4] always being there, may be less or more. It is very clear that if frequency of current fluctuation is at higher rate the amount of radiation increases proportionately. All antenna through electromagnetic energy to the space and the intensity of the radiation in terms electric fields measured as a function of φ and θ is called radiation pattern. This parameter is an indication of how much power thrown to the space with respect to a particular direction at the far field. As we know any field (E or H) has three component in terms of distance 'r', two angle φ and θ pertaining to a spherical system. But if we analyze rigorously then only two component exists at far field and those are φ and θ. This parameter is also explain about directional dependency of how much power radiated in any direction. More over radiationpattern implies the maximum radiation. This picture is clearer if we plot the main lobe where most of the power goes. Though main lobe contain the maximum part of power but always leakage happened and it become maximum locally which is called side lobe. The side lobes are always available for all practical antenna. From current study it is observed that all side lobe radiation create more problem and need to be suppressed which ultimately reduce SAR value.

The power available in main beam can be calculated from its half power beam width(HPBW)

If we consider a distance of R meter as far field then the power density can be calculated as

$$P_D = \frac{G_T P_T}{4\pi R^2} \text{watt}/\text{m}^2$$

Where P_D stands for power density

$G_T$is the gain

$P_T$represents transmitter power

Though HPBW can explain about radiation capability for an antenna it is not possible to quantify how much power confined in that direction. Hence we introduce another parameter called directivity referred as D.

$$D = \frac{U_{max}}{U_{av}} = \frac{4\pi U_{max}}{\iint U(\theta,\varphi)d\Omega}$$

dΩ is the solid angle on the spherical surface, U_{max}be the maximum radiation intensity and$U_{av}$is the average radiation intensity.

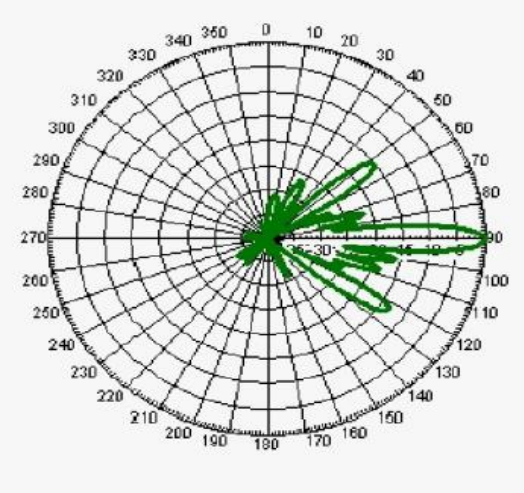

Figure 1Radiation pattern of a directional antenna with main and side lobes

Gain

Directivity mostly varies as a function of radiation intensity. In other way the power radiated is almost same as the power fed at the input end. But in reality as all antennas are made up of conducting material and those are not ideal in nature,so there always have some Ohmic loss due to current flow on the antenna surface[8]. Now if the power fed at the I/P is P_I and Ohmic loss taken as P_L then total power is expressed as

$P_I = P_L$+W

Here we can also calculate efficiency by using formula as

η=W/P_I

Now power gain is further expressed as G_P

$$G_P = \frac{U_{max}(Actual)}{U_{av}\ for\ lossless\ case}$$

cell tower radiation and its effect to biological species

In presence of electromagnetic radiation, a human body retains radiation since it comprises of 70% liquid. It is just like cooking in a microwave where water get heated first with other material subsequently. The impact of microwave in term of absorption is considerably high for human body that contain liquid (water, blood).As it is known that microwave range wavelength assumed to be around 1- feet to 1 -meter in dimension , it is more likely to affect our body organs. In research it is found that many organs of body get affected due to localized heating. There are many situation this effect is more pronounce to small kids and pregnant women. This is because their scull is too soft and easily the wave penetrate and damage the cell. Many health issues are reported due to cell phones [12] and cell towers radiation. Present study divulge about how drastically the problem associated with male fertility. The sperm generation rate is reduce by a factor of 30% for those who are using continuously mobile phone. Not only this but also the motility, semen quality, viability reduce significantly. Sometime the intensity of the radiation produce DNA [6-7]breaks in sperm which leads to cancer. Beside this the radiation due to mobile phone and cell tower cause electromagnetic interference [9] which is not at all desirable. A mobile hand set in active condition usually transmit 1 to 2 Watt of power irrespective of whether it is functioning in GSM or CDMA mode. There is a significant parameter call SAR(Specific Absorption Rate) which explains about the amount of radiation an individual receiving from a cell phone. The accepted value for this is around 1.6W/Kg and according to this use of mobile phone should not exceed 6 minutes per day. Though this is the fulcrum but safety margin of 3 to 4 need to be followed. If such margin is followed then any individual should not use mobile phone for a span of time as 18 to 24 minutes per day. If this is not being followed and someone using continuously for example more than 20/30 then ear lobes get heated. As a consequence of that the ear may damage gradually, and it may leads to health hazard, hearing loss , sleep disorder and in worse case censer.In today's life mobile phone is very essential gadgets which are fascinating our lifestyle. One cannot thing their life without this. Though it is much important instrument but sometime it's bring misery or adverse effect to life by suffering cancer like diseases[13]. Cellular handset emitted EM energy when mutual interaction between mobile phone and human head. As result of that human tissue get affected worst by absorbing such harmful radiation. This parameter is known to be SAR and due to that power get absorbed by tissue which leads to increasing temp. So keeping this in mind it is necessary to reduce this value as maximum to safe human life [10-11]. For transmission and reception of the signal or handsets all mobile phone are embedded with small antenna. from the literature survey it is understood that SAR [14-18] value is solely depend upon antenna performance for example when handset brought close to head its VSWR value, radiation pattern and gain are influenced. Recently inclusion of metamaterial plays vital rule in antenna performance. By suitable design of this artificial structure it is possible to improve SAR value.

The miniaturization problem with the metamaterial based electrically small antennas at low frequencies spellbound the interest of many researchers in the past decade. A technique, named as Stepped Impedance Resonator (SIR), is developed in this direction to find the solution of this problem. In order to employ these antennas at low frequencies, metamaterial unit-cells of these antennas are modified with this technique. A recent study reveals that only 0.75 miniaturization factor or 25% reduction is achieved by using the SIR technique on SRR. So, it is one of the design where more miniaturization is possible by developing metamaterial unit-cell with the help electromagnetic structure simulator "High Frequency Structure Simulator (HFSS)" is used to model this unit-cell structure. This is the Finite Element Method (FEM) based Simulator[5], employed for determining the electromagnetic behavior of a structure and also provides the details about the various aspects of modeling and running simulations. So as to calculate the electromagnetic material parameters such as permeability and permittivity of the proposed structure, Matrix Laboratory (MATLAB) software can be used.

Specific Absorption rate (SAR)

SAR is define as the rate of absorb energy by unit mass of biological tissue. So it is necessary to decreases the interaction of EM energy towards the human head for mobile handset when it use. There are some factors which will influence SAR value like size, power, radiation and type of antenna used. This can be reduced by inculcating metamaterials structure with varieties of antenna. This is also achievedby using Stepped Impedance Resonator (SIR) technique. All these can be modeled through different simulators.

Numerical Techniques

The complex computational problems of the antenna design are solved with numerous available numerical methods. For the computation [19] of induced field, a few numerical methods use a differential form of Maxwell's equations while other use the Maxwell's equations in integral form. The fundamental theory of these numerical techniques is to create the antenna models and to evaluate their results which can improve the performance of antenna.

Method of Moments (MoM) is a very flexible and popular technique which is applied to linear, planar, and three-dimensional structures for estimating their parameters by making a mesh over them. The most fascinating feature of this method is that it calculates only the boundary values, not the values all over the space. In this method, first of all segmentation is assigned to the antenna structure and selects a suitable source function to denote currents on these segments. By imposing the boundary conditions with an appropriate set of testing functions, a set of equations is created. The other advantage of MoM is its applicability to the Green function problems.

Fast Multipole Method (FMM)- Fast Multipole Method (FMM) can be a substitute to Ewald summation or MoM and based on multiple expansion technique. It is a more accurate simulation method than MoM because of its less memory and processor power. In order to speed up the MoM, FMM can also be used.

Finite Difference Time Domain (FDTD) Finite Difference Time Domain (FDTD), standard computational electromagnetic technique, requires less amount of work for implementing the FDTD solver than MoM or FEM solver and implement nonlinear properties in a natural way. Individual can realistically execute oneself in a reasonable time frame by using this technique and solutions can cover a wide frequency range with a single simulation run owing to time domain method but with small time step. In FDTD, electric field is solved in instantaneously of time and magnetic field is solved in the next instant and this process is repeated frequently. The typical hexagonal mesh used in the simulation process of FDTD .

Finite Element Method (FEM) The Finite Element Method (FEM) is utilized to get the approximate solution of integral equations and partial differential equations (PDE). It is beneficial for the problems in which analytical solution cannot be achieved for example complex geometries, loading and material properties. The solution of FEM is based either on removing time derivatives entirely or interpreting the PDE into an equivalent ordinary differential equation. FEM is more popular than other numerical techniques because of its versatility and flexibility and uses the computationally efficient approximations to Maxwell's equations for determining performance of antenna.

In FEM, any shape or domain is sighted as an assembly of simple geometric shapes known as finite elements and then approximation functions are produced systematically on these finite elements. The group of these finite elements is called as mesh. By generating the mesh in FEM method, geometry of the antenna can be accurately defined. The outline of any complex shaped domain can be fitted very easily with the triangles of higher orders or their combinations with or without curved sides comprised in the subdivisions of this method. The FEM method has also some disadvantages: A huge quantity of time is required for execution of program when number of elements is increased. The time needed to prepare input data and to interpret result is also substantial.

Pseudo Spectral Spatial Domain (PSSD)

PSSD resolves the Maxwell's equations by propagating it forward in a chosen spatial direction. The fields are then detained as a function of time and any transverse spatial dimensions. The random dispersion in propagation medium to be rapidly and accurately modeled with minimal effort since the fields is apprehended as functions of time. Conversely, choice to propagate forward in space, rather than in time, carries some refinements.

Conclusion

In this article, radiation effect on biological species and its processional measure were considered to some extent.Apart from this, the chapter also explains about the worse effect of radiation which are not known to

the common man. In addition to this,some of techniques on antenna design through modern simulation tools were also discussed, where SAR value can be significantly reduced.

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