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Cell Coverage Analysis Using 3D Ray -Tracing

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ABSTRACT:

The idea proposed to deals with the design of an efficient three - dimensional (3D) ray tracing simulation for a fifth - generation (5G) wireless system using 28 GHz Millimeter Wave. Now a days the data usage is increased rapidly. According to the previous results the data usage is increased by seven times.Infact, the ongoing fourth-generation have achieved its best results, So these millimeter wave band are used for that purpose. Among the potential of mm Wave bands, the 28 GHz band is considered to be practical for use in 5G cellular network systems. To ensure the success of such systems, a precise study of the radio propagation channel should be performed before cell deployment. To evaluate the channel characteristics in a particular area is to measure the channel impulse responses at various receiver locations. To implement the above proposed work Ray-tracing simulations are useful and which are widely adopted to model indoor and outdoor radio channels, to reduce the work of campaigning outside. Efficient algorithms were developed for three dimensional (3D) ray-tracing in several early studies. Through this, efficient data traffic is achieved using 5G wireless systems.

Introduction :

In a ray tracing simulation, let us assume that number of rays that transferring from the base station using a ray-optic approximation. Ray tracing simulations can be used for the millimeter band effectively.

The 3D ray tracing reduces the effort and also very better for cell coverage analysis[2]. Because it reduces time consuming measurements campaigns and also give channel impulses immediately.4G is the fourth generation of broadband cellular network technology, succeeding 3G, and preceding 5G. A 4G system must provide capabilities defined by ITU in IMT Advanced. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, and 3D television. 4G technology builds upon what 3G offers but does everything at a much faster speed. The benefits of 4G fall firmly into three categories, which are improved speeds, reduced latency, and crystalclear voice calls. Standard 4G (or 4G LTE) is around five to seven times faster than 3G, offering theoretical speeds of up to around 150Mbps. That equates to maximum potential speeds of around 80Mbps in the real world[3].

Ray tracing:

Ray tracing is a technique for rendering three dimensional graphics with very complex light interactions. This means you can create pictures full of mirrors, transparent surfaces, and shadows, with stunning results.Ray tracing simulation is extensively used for channel categorization in indoor radio wave propagation as it drastically mitigates the site-specific and time-consuming measurement campaigns[1]. In RT modelling, the electromagnetic wave is launched from the transmitter, which is considered as a set of rays, based on geometric optics (GO) and uniform theory of diffraction (UTD). Moreover, the short-wavelength of mmWave is described well by the rayoptics approximation techniques, and therefore, Ray tracing simulation has been widely applied to the mmWave band in indoor WCS.

Analysis of path in Line of sight:

We generally measure the path loss of receiver for every 10 meters with respect to grid lines. With having the transmitter(Tx) in the middle, the 3,721 receiver grid points surrounding it and also the points that are inside the building are removed. So, these 2,400 receiver point which are street level are generated[4].

$$\boldsymbol{PL(f,d)[dB] = FSPL(f,1m) + 10n\log_{10}\frac{d}{1[m]} + X_\sigma}$$

This equation represents the model of distance path loss in the free space close in. Here in the equation the parameters are path loss exponent which is denoted by n and X_σ which stand for mean guassian random variable at zero where σ as standard deviation in decibels. Also FSPL means path loss in free space.

$$FSPL(f,1m)\ [dB] = 20\ \mathbf{loglog_{10}}\ \frac{4\pi f}{c}$$

The measurement and simulation values of n are 2.1 and 1.8 each. So ,clearly n at simulation is lower than the n at measurement. This detail may be rational because high path loss of multipath are generally added, but these are removed from the real measurements because the received signal multipath which are below the noise range cannot be taken[2]. If a directional antenna is taken then the side lode of multipath can't reach the receiver point. But if the received signal of multipath with power 30 dB or less than that can be included in ray-tracing.

Simulation results of ray-tracing:

So, from the observation of non-line of sight regions the values of n in measurements and simulation is 3.0 and 3.64. we get that if distance between the transmitter and receiver is less than 200 meters the path loss model gives single slope .So by this results we get a raise in shadowing factor upto 15.73 dB. If a directional antenna and two side-by-side or adjacent area of receiver points in the measurements ; so, this results in getting the path loss data of the rays with similar paths which are along the receiver.

By this information we get that path loss of the certain receiver point varies with the surrounding or spatial environment around it. So even if the distance between transmitter and receiver is also it can predict the values of characteristics and parameters such reflections and diffraction[3]. The location and the obstacles decides the number of reflection or such things. From the previous reports the path loss depends on the site and its specification. In the above figure the inverted red and blue squares represents the path loss model of threshold distances 140 meters and 200 meters respectively.

The information is n values such as 3.08 and 3.24 with corresponding threshold distances as 140 and 200 meters. So, if the n and threshold distances are correlated then it means that they are inter dependent on each other.

Analysis of propagation in populated environment:

SRKR College simulation scene:

By using the 3D ray tracing technique to create a channel band of millimeter wave in sagiramakrishnamraju college (Bhimavaram)[4]. As the place is a college is always crowded with the people and also it posses many building and open area . It also contains many blocks , hostel and indoor stadiums etc also each building has four to five floor in it. So this site has all qualities of modern environment and we calculate all the 300 transmitter positions in the college which has a radius of 400 meters in ray tracing simulation. Generally these transmitter positions are fixed in a position where real base station is located. However in the ray tracing simulation technique we calculate the signal strength and efficiency of the signal at the receiver is by computing the number of reflections and diffractions occurred[1]. So the reflections or the diffractions that crosses the 400 meter range won't be included in the simulation obtained. As per the expectations the radius of the cell coverage is 200-300 meters only. We have to eliminate the points of grid which are inside the structures or building. Since the receiver can be any position it is taken as a level of street. Not considering the positions of the transmitters we calculate the path losses and receiver points which exceed the count of 2,500 . The positions of transmitters and receivers will be shown in the upcoming figures and also the simulation shows the upper side view of the whole site coverge.

According to variousreflecton co- efficients , er. . On the basis of the data obtained it must be adapted for each band individually[2]. Because of wavenumber (k) and early reflection coefficient's presence , the calculation of diffraction co-efficient will entirely takes place in different setup[3]. As the wavenumber is dependent on carrier frequency , the two bands whose PLs will get distinguished in the region where the different rays are dominant multi paths[1].

Omni directional Outage probability transmitter – receiver distance

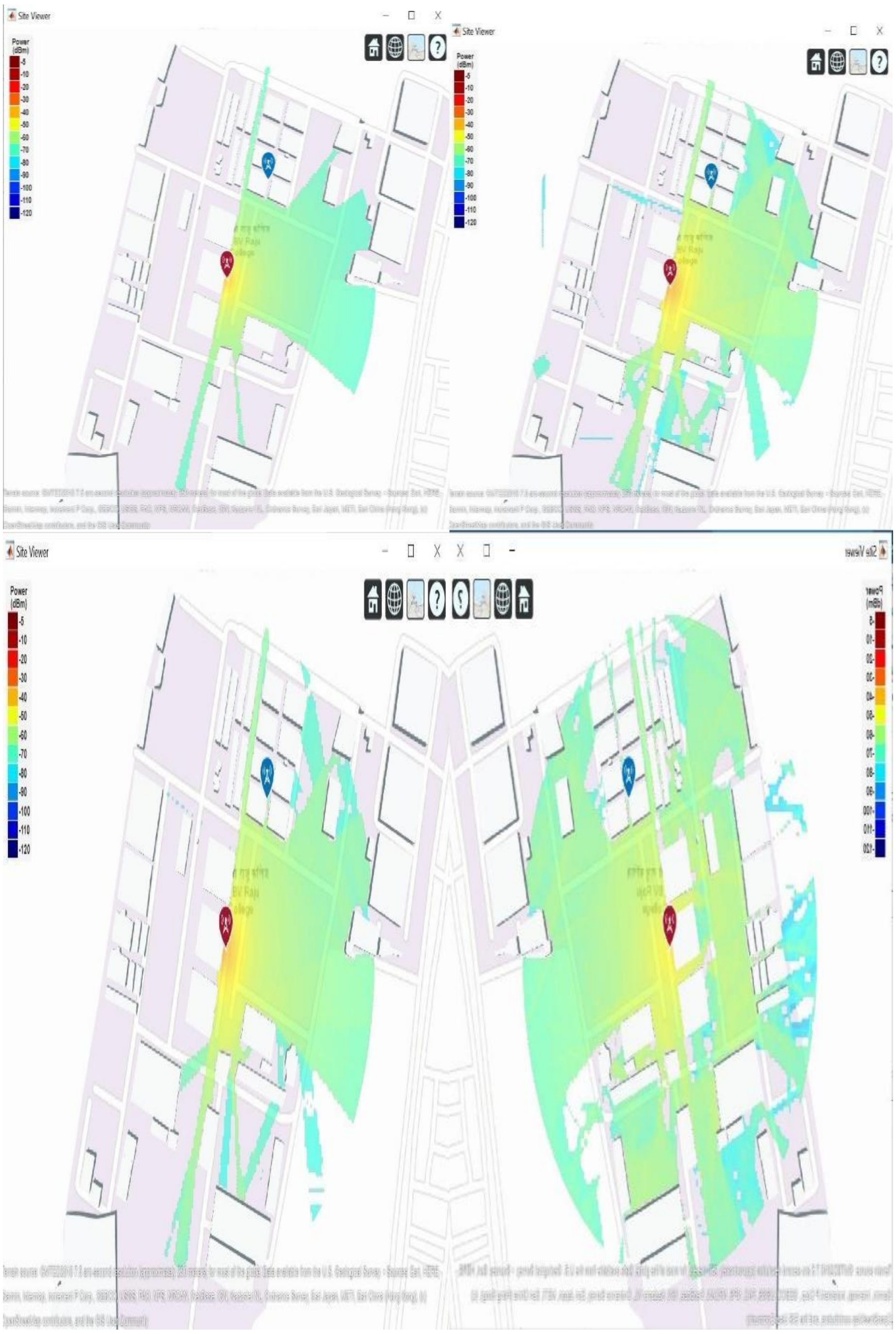
In order to estimate the possible coverage distance for an effective cellular network communication , we have to analyse the outage probability[2] . During the installation of mm Wave cell base station's location is applicable or when we are in a need of a new base station for mobile network operation it is an important criterion.

In milli meter-waveband due to intrinsic high FSPL , will result in the decrement of cell, radius less than that of LTE band cells[1]. According to the ongoing research results show that when wireless communication techniques viz, massive multiple input output , spatial transforming , adaptive antennas are used radius 200m might be possible. Also the studies stated that , the maximum measurable PL should be approximately 160-180 dB , and outage value will be set[4]. According to the channel measurement system the maximum measurable PL must be changed. In consequence to this , with respect to the commercial wireless devices , their received signal sensitivity is higher. Some other downlink, uplink budget examples were differentiated w.r.t GSM , HSPA , LTE and as a result 160dB will be our maximum PL. In view of link budgets of mm Wave systems the PL was set to 150dB and receiver points with PL values greater than 150dB will be considered as outage points[3].

Based on the count of receiver points present in each bin , the division of LOS , NLOS , 25m bins ,along with the consideration of outage points as bar graphs. Whose Transmitter receiver distances are greater than 200m their LOS ratio becomes constant as the no. of transmitter points will determine the no. of LOS points. the difference is applicable to those high-rise environment.

According to the measurements of transmitter and receiver positions the LOS and outage models will be obtained, but here we designed a high rise base station with the help of ray tracing[3]. As the building's rooftop will have the LOS path to the ground mounted on it, though transmitter is placed on the building which leads to low LOS probability at shorter distances[1]. Alongside, the existing NLOS points were blocked by other buildings, as the meter of minimum distance bin was fixed range between 0-25m. From the short diffraction and reflection paths in the closest circumstances, NLOS points will get appropriate signal strength. Cumulative probability will be around 1 and it is inversely proportional to transmitter-receiver distance[4]. As we know that LOS and outage points are exponential functions, they'll vary according to the functionality even though the number of receiver points is site specific and local scatterrers are ignored. The outage point will be 50 % for a radius of 200m.

RESULTS:



V. CONCLUSION:

Through this paper we have got the results of 3D-ray tracing simulations of the 28GHz mm Wave band. For not loosing paths we've decreased the computational overheads between transmitter and receiver and separated the 3D space into vertical and horizontal domains

REFERENCES:

1. A. I. Sulyman, A. T. Nassar, M. K. Samimi, G. R. Maccartney, T. S. Rappaport, and A. Alsanie, "Radio propagation path loss models for 5G cellular networks in the 28 GHz and 38 GHz millimeter-wave bands," IEEE Communications Magazine, vol. 52, no. 9, pp. 78–86, September 2014.
2. Z. Zhang, J. Ryu, S. Subramanian, and A. Sampath, "Coverage and channel characteristics of millimeter wave band using ray tracing," in Communications (ICC), 2015 IEEE International Conference on, June 2015, pp. 1380–1385.
3. J. H. Jung, J. Lee, J. H. Lee, Y. H. Kim, and S. C. Kim, "Ray-tracing aided modeling of user-shadowing effects in indoor wireless channels," IEEE Transactions on Antennas and Propagation, vol. 62, no. 6, pp. 3412–3416, June 2014.
4. J. H. Lee, J. S. Choi, J. Y. Lee, and S. C. Kim, "Permittivity Effect of Building Materials on 28 GHz mmWave Channel Using 3D Ray Tracing Simulation," in GLOBECOM 2017 - 2017 IEEE Global Communications Conference, Dec 2017, pp. 1–6.