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Simple Method for Outdoor LOS Propagation Model Using Ray Tracing Tools

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Abstract: Ray tracing tools used to described the signal scattering and the delay happened in the urban street with a low base station are shown to be characterized via MATLAB program using a set of Digital Terrain Model (DTM). The path loss exponents for line of sight condition, has been developed to estimate a field of view from single transceiver to compute the delay between the source and receiver. The frequency and the road width's affects on the path loss are discussed. All sensible explanation for the results is also presented and discussed.

Key words: Ray Tracing Tools (RTT), Digital Terrain Model (DTM), delay

INTRODUCTION

Ray-tracing is already widely applied to site-specific radio propagation modeling for wireless applications (Fernando *et al*., 1996). This software presents the software tool Radio Tracer that uses efficient algorithms to calculate the delay profile in exact multi-path propagation model, due to the building. A fast ray-tracing engine finally guarantees that all ray-paths with up to a desired number of interactions are found. Uniform theory of diffraction is applied once all ray-paths have been calculated to compute electromagnetically parameters such as power delay profiles or overall variations in order to characterize the wireless channel. Ray tracing based prediction of indoor microwave propagation has great potential as a practical and accurate technique to engineer wireless systems. The prediction accuracy of such methods increases with the number of reflections included in a single propagation path. At the same time, the computation time grows exponentially with the number of reflections (Reinaldo *et al*., 1998). Thus, it is critically important to understand the minimum number of reflections needed to achieve the desired level of accuracy.

Most outdoor propagation models used for coverage prediction in mountainous terrain are two-dimensional (2-D) models (Greenstein *et al*., 1999), it considered only the direct path between transmitter and receiver predict and the attenuation (loss) on this path. When radio communication problems are encountered, the configuration of the WLAN transmitter and the receiver can be in the cause of the radio failure. Certain environment must be properly configured for the transmitter and receiver to communicate successfully. If miss configured, the resulting problem appear as no line of sight. The LOS street can be treated as a typical urban environment and many other researchers have performed measurements on the same street (Taira *et al*., 1996).

PHYSICAL ENVIRONMENT

When a cellular system is planned the operator has to carefully select base station location and height above the ground to be able to provide service in order to achieve a good signal prediction. A basic consideration is the physical location of the sites at each end of the link. Because RF signals travel in a straight line, in a clear line of sight between antennas is ideal. Frequently, however, the locations of the desired links are fixed. But incase of building blockage probability is best estimated by ray tracing techniques using real data from detailed building and terrain data bases (Anwar *et al*., 2006). the requirements for ray tracing techniques in this case are briefly described in the Fig. 1. However, in many areas, suitable databases are not available.

The planning of a wireless link involved collecting information and made decisions that the sights proposed to use line-of-sight connection in all the communication

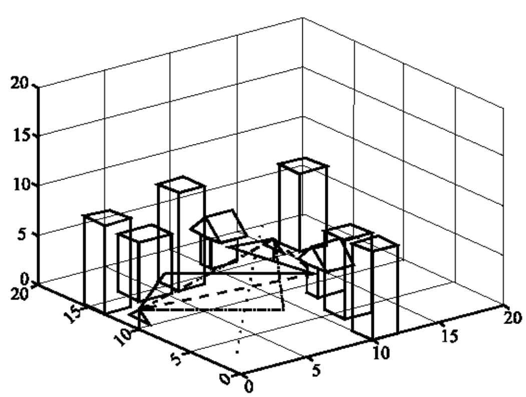

Fig. 1: Perspective view of the ray tracing tools

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between the transmitter and receiver. As accurate coverage prediction can be achieved using ray tracing techniques in areas database of land coverage available. [ITU-R, 1999- 2001- 2003]. To a first order of approximation of 60% of the first fresnel zone clearance is sufficient to ensure negligible additional loss. Figure 1 shows the prototype of point to point link selected to give example to the ray tracing tools.

LINE OF SIGHT CONDITION

Ideal Radio Transmission occurs under conditions whereby a visually clear path exists between Receiver and Transmitter antennas. A visually clear path or line of sight ensures the strongest possible signal with minimal attenuation (reduction) due to environmental factors. To have a clear line of sight there must be no obstacles between the two locations. Line of sight can be verified using binoculars to ensure a clear path between Receiver and Transmitter antennas. However, even under line of sight conditions, signal attenuation occurs depending on the distance between the two antennas as well as proximity of obstacles to the line of sight path. When RF radiates from one antenna to another it spreads out such that an elliptical pattern is created between the two antenna; this elliptical area is known as the Fresnel Zone, Fig. 2 show the details of line-of-sight link with in urban area, involving high antenna transmitter and receiver.

It is widely accepted that, in line-of-sight (LOS) case, directional antennas reduce the delay spread as compared to omni directional antennas (Theodore, 2002).

RAY TRACING METHOD PROFILE

The ray tracing method represents the most commonly used approach in the calculation of propagation models for urban environments. Some research efforts are underway to help in continued improvement of accuracy and extension of generality Ray Tracing tools to enhance the environmental problem. The term multi-path arises from fact that, through reflection, diffraction and scattering, radio wave can travel from a transmitter to a receiver by many paths. Avery rough estimate of the maximum delay time to be expected in a given environment may be obtained simply for the dimensions of the area from the fact that time (ns) for radio pulse respond to travel distance d is approximately.

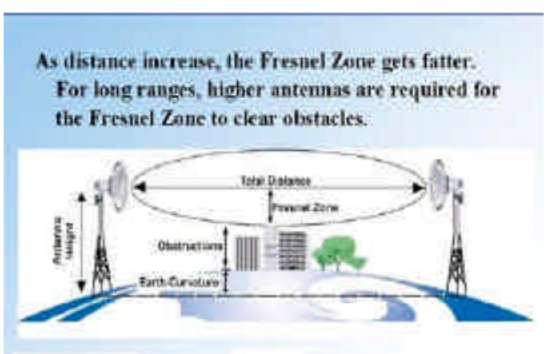

Fig. 2: Line of sight condition

The power received at distance d, $P_r(d)$, is given by the power flux density times the effective aperture of the receiver antenna and can be related to the electric field using Eq. 1 (Theodor, 2002).

$$P_d(d) = \frac{(E_g)^2}{120\pi} A_e \tag{1}$$

Where $P_d(d)$ is the power received in the distance d. E_g is the total transmitted electric field after reflection and is effective aperture.

$$\left[G = \frac{4\pi Ae}{\lambda^2} \right] \tag{2}$$

By assuming that the electrical field is vertical (Theodore, 2002), the reflection coefficients Γ

$$\Gamma = \frac{-\varepsilon_r \sin\theta_i + \sqrt{\varepsilon_r - \text{cons}^2\theta_i}}{\varepsilon_r \sin\theta_i + \sqrt{\varepsilon_r - \text{cons}^2\theta_i}} \tag{3}$$

Where ε_r is the relative permittivity and $\theta_i = \theta_o$ in the case of reflection method.

The Eq. 3 used to compute the reflection coefficient of the path as shown in Fig. 3.

Referring to Fig. 3, h_t is the antenna transmitter and h_r is the antenna receiver. E_i is transmitted electric field (constant for all material parameters).

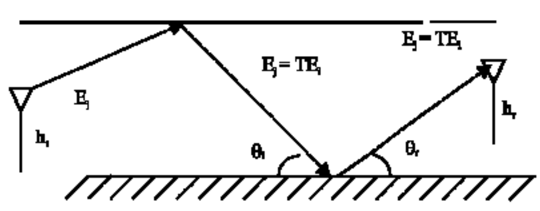

Fig. 3: Electrical field ray reflection model

2D SIMULATION FOR RAY TRACING MODEL

The 2-D simulation consider the diffraction from the building and earth between the transmitter (T_x) and the receiver (R_x) to calculate the average delay, by looking for the line-of-sight (LOS) path in between as shown in Fig. 4. The first step in the automatic generation of the entire ray consists in finding the shortest path to reach the receiver. Figure 4 shows the GUI window when we run the program in two dimension ray, with assume that the frequency is 3 GHz and the reflection permittivity is normal wall.

The advancement presented in this part is the introduction of an algorithm that is capable of analyzing a reflection line profile, which is obtained by critical an urban environment along a vertical plane. The algorithm usually presents the simulation such as uniform height of buildings, uniform spacing of buildings and flat terrain considered.

3D SIMULATION FOR RAY TRACING MODEL

Point to point ray tracing prediction tool is used in this paper to compute full-3D propagation. it is an efficient 3-D ray-tracing tool for the prediction of RF propagation developed. Buildings are considered as arbitrary vertical design with a surface characterized by a permittivity and conductivity. Buildings can have sections of different heights. Terrain isn't taken into account as arbitrary horizontal polygons. Because it is assume the area is flat. The propagation is computed using to calculate the delay. It is also accounts for up to a chosen order of combinations of multiple reflected rays by building walls and multiple diffracted rays by vertical and horizontal edges of buildings. The map of the area included building, trees, the transmitter location and the receiver are shown in Fig. 5. this figure show the same GUI parameters concerning to Fig. 4, but the different is the dimension required to be 3D.

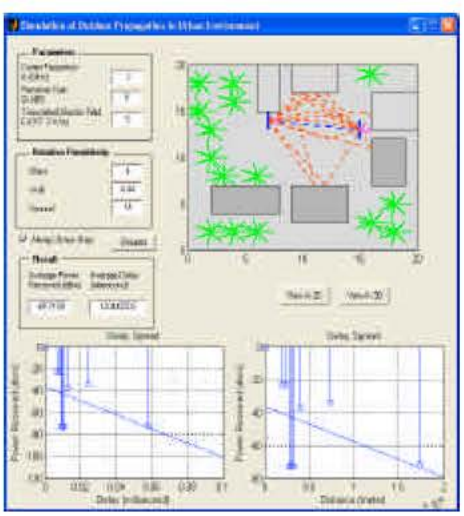

Fig. 4: 2D GUI ray tracing rools

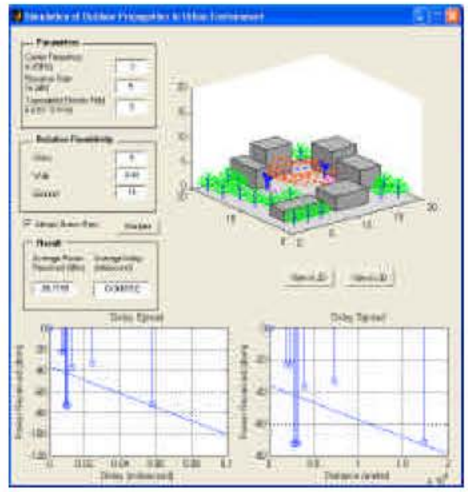

Fig. 5: 3D GUI ray tracing tools

In the middle of the buildings which intersect the vertical plane, the model considers the ones that are between the transmitter and the receiver, all the buildings behind the transmitter and one building behind the receiver are ignored.

RESULTS AND DISCUSSION

A path profile is established from topographical maps, which translated into an elevation profile of the land between the two sites in the path. Earth curvature assumed to be flat. Figure 6 show the directive pattern in the horizontal plane and the 3D Ray Tracing Profile is simplest approximation of a building obstruction along the path joining the transmitter to the receiver. There are some diffraction at the side of the building model. From computational viewpoint, even through this appears to be a very simple case, the field coefficient diffracted past these way consider twelve rays for applied. Figure 6 is only show the output of the GUI from Fig. 5.

Figure 7 represent 2D ray tracing profile as extension to the case of 3D system analyze. This profile may be regards as the simplest case of multiple rows of building by ignoring the uniform height. Figure 7 is just make the simple out put from the GUI represented in Fig. 2.

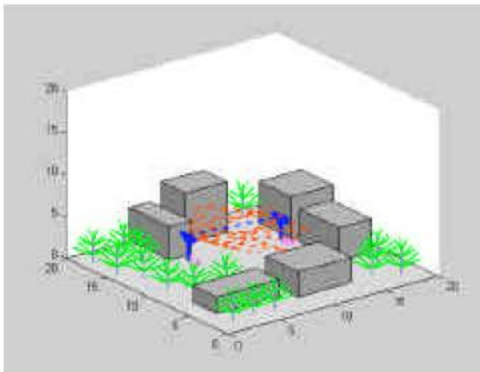

Fig. 6: 3D Ray tracing structure

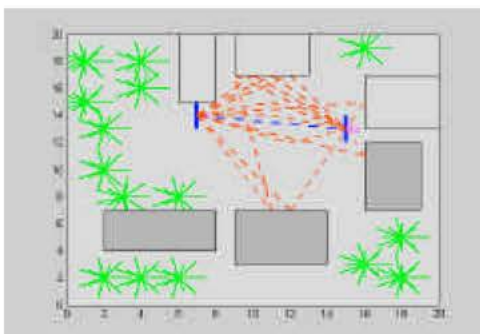

Fig. 7: 2D ray tracing structure

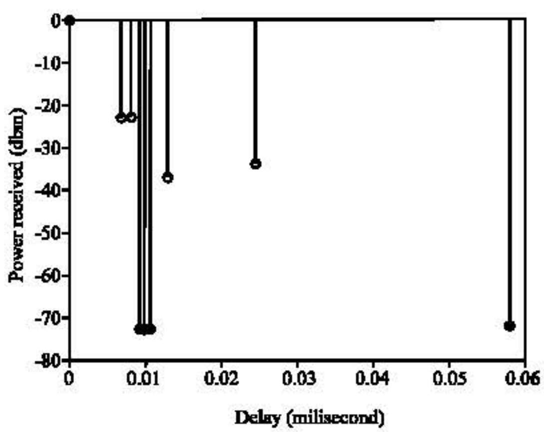

Fig. 8: Power received versus delay profile

The Power Received Versus Delay Profile are shown in the Fig. 8 respectively depend on given similar diagram in both 3D and 2D ray tracing. The different line shows the different signal time reach to the receiver side at the certain power.

Ray tracing algorithm account fix profiles as a building diffract the signal and calculate the average delay

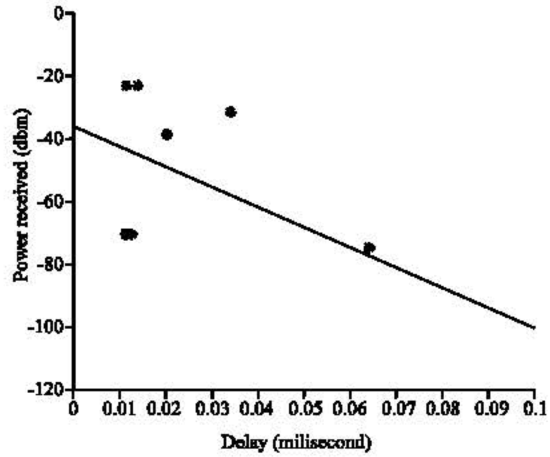

Fig. 9: Average delay

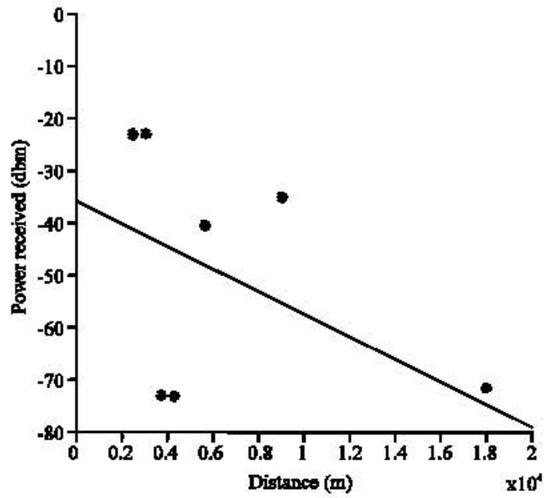

Fig. 10: Power received versus delay profile

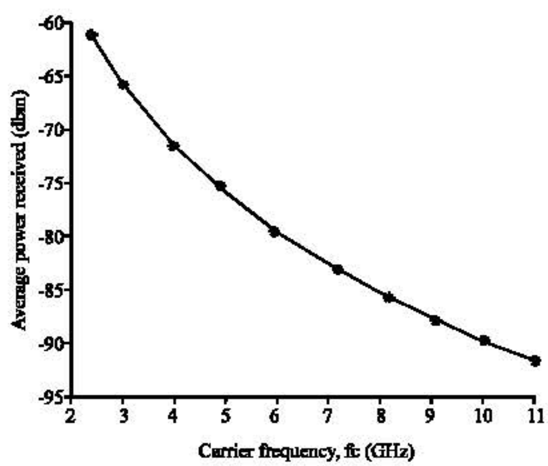

Fig. 11: Carrier frequency versus average power received

in Fig. 9 due to the multi-path case. Ray tracing calculate the delay for the receiver locations owing to the very low level of multi-path considering the received power. This figure point up the average delay happened with convince power emulated.

Ray tracing simulations have shown that the multi-path problem appears to be slight in the conditions under which the system will be operating. Figure 10 shown that the power receive versus distance have been considered during ray trace simulation and only 2 m are considered to build in the simulation, because it considered as only proto type. In the future study I will introduce the different environment to be involved.

Building diffraction may be regarded as harmful multipath. Figure 11 shows the carrier frequency against the power received, from this graph we have to conclude that; when we increase our frequency the average power received will decrease and the coverage could be obtained by the addition of diffracted signal to reach the receiver side. Regarding to this case building blockage probability is best estimated by ray-tracing techniques using real data from detailed building and terrain database.

Some limitations are recognized in the current modeling and there are a number of ways in which the model may be expected later. At this model, no terrain has been taken into consideration.

CONCLUSIONS

In this study a ray-tracing based propagation simulator for point to point in outdoor environments has been presented. The speeding up techniques used have been described. They are based on computer graphics techniques using MatLab software as a language to build the system to mange the delay profile. The algorithm used in this tool greatly reduces the number of tests and operations to be carried out on the elements of the environment under study. A path profile is established from topographical maps, which, by reference to the sea level of the map, can be translated into an elevation profile of the land between the two sites either to be point to point or point to multi points in the path. Earth curvature can be added, as can know obstacles. But in this system, I have ignored the earth is flat.

Additional work is going to carry out to take into account other propagation mechanisms will present in outdoor environments, for example, to model scattering by big objects such as building, trees, rain, etc. and also simple elements such as cars, poles, humidity and temperature will be introduced in the simulator to represents real objects. Furthermore, wall or front spread scattering effects will be introduced using Matlab techniques.

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