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Extended Abstract

Radio Wave Propagation Through Foliage

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I. INTRODUCTION

Wireless technology continues to experience rapid growth and development. With the ever increasing demand for wireless services and applications, more advanced tools are necessary to ensure the performance of these wireless systems. One of the most important tools for system development and radio planning are the radio propagation channel models. These models allow system designers and radio planners to better understand the mechanisms of the propagation of radio waves, which aids in ensuring the quality of service of present wireless systems, as well as in predicting the performance of future wireless systems.

The propagation of radio waves is largely dependent on the obstacles that are present in the propagation environment. These obstacles introduce absorption, scattering and diffraction to the propagating radio waves, which may degrade the performance of the wireless system. In general, the propagation environment can be categorized into two types: the urban environment, in which the most significant type of obstacles are man made structures such as buildings, and the rural environment, in which vegetation structures such as trees are the dominant form of obstacles. Much work has been done in studying the urban propagation environment, with a large number of different models available in literature. The rural environment on the other hand somewhat falls behind in the number of models available. It is in this type of propagation environment that this paper focuses on.

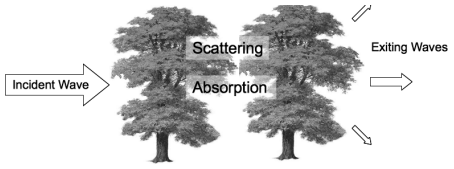

Figure 1. Radio wave propagation through foliage

II. PROPAGATION THROUGH FOLIAGE

In rural environments, the most dominant type of obstacles present in the propagation channel is in the form of foliage. The leaves, branches and trunks of trees serve as complex obstacles for the propagating radio waves. The propagating wave incident on these random scatterers experience absorption and scattering before arriving at the intended receiver. Due to the complex physical geometry as well as the random nature of these obstacles, a significant challenge is presented in modeling their effects on the propagating radio waves.

A. Radiative Energy Transfer Model

An approach to modeling the effects of foliage in the propagation environment is through the use of the Radiative Energy Transfer (RET) model. The absorption and scattering that is experienced by the propagating wave is described mathematically by equation (1), where I is the intensity, dω' is the differential solid angle, ds is the differential scattering volume, σ_t is the total cross section, σ_s is the scattering cross section and $p(s,s')$ is the scatter function [1].

$$\frac{dI}{ds} = -\sigma_t I + \frac{\sigma_s}{4\pi}\int_{4\pi} p(s,s')I\, d\omega' ds \qquad (1)$$

B. Discrete RET Model

One of the limitations of the RET model is that it assumes that the propagation medium is homogenous. In the physical foliage propagation medium, the scattering and absorption parameters are not homogenous. To address this limitation, the medium can be discretized to allow different RET parameters for each discrete element of the discretized medium [2]. This allows the model to more accurately represent the physical foliage medium.

C. Evaluation of RET Parameters

The accuracy of the RET model is largely dependent on the parameters σ_t, σ_t, and $p(s,s')$. One of the challenges in the application of the RET model is the selection of these parameters. These parameters are typically extracted from empirical measurements [2]. It is proposed that the leaves and branches be modeled as dielectric discs and cylinders and evaluate the fields that are scattered to determine the RET parameters. This method is used in remote sensing in evaluating the backscatter of foliage [3].

III. CONCLUSIONS AND FUTURE WORK

This paper introduces the concept of the Radiative Energy Transfer model for modeling the foliage propagation medium. It is proposed that discretization of the medium and electromagnetic approximation for evaluating the RET parameters are proposed for the model to more accurately represent the foliage propagation environment.

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