Scattering Measurement Due to Trunk and Foliage Canopy of Desert Region at 35 GHz

Sandeep Rankawat, J. S. Purohit, D. R. Godara, S. K. Modi

Abstract: ***At the time of propagation of millimeter wave, Scattering phenomenon due to foliage plays an important role as the wavelength approaches to the order of the size of the leaves and edges of leaves. It is important to estimate the propagation attenuation due to scattering when the arid zone foliage leaves and twigs size affect adversely in experimental propagation range. In this paper a 35 GHz transmitter receiver link system is used to measure the attenuation scattering pattern of tree foliage of Ber tree (Zizyphus mauritiana) of western Rajasthan region. Measurements were made to study the angular variations of the positioning of receiver unit around the target tree with trunk and canopy positions. The measurements, which were made for HH polarization configurations over a wide range of the azimuth angle, provide a quantitative reference for the design of millimeter-wave bistatic radar, high speed data communication links, point to point communication systems.***

Index Terms: ***35 GHz, Scattering, Foliage, Trunk, Tropical tree, Western Rajasthan, Millimeter wave, Thar Desert.***

I. INTRODUCTION

Radio propagation is the behavior of radio waves when they are transmitted, or propagated from one point to another, or into various parts of the atmosphere. Radio wave propagation at high data rate fulfils the demand for communication these days. Forested environment with different kind of trees poses a difficulty for the operation of such communication systems. It is necessary to determine coherent bandwidth, fading statics, path loss, scattering and other propagation parameters for better performance of communication devices operating at millimeter wave.

For operating at frequency above 10 GHz, attenuation due to scattering recognized as a major limitation to reliable communication system. For line-of-sight microwave links and satellite communications, scattering phenomenon restricts the path length of radio communication systems and limits the use of higher frequencies.

II. SCATTERING DUE TO VEGETATION

If the size of an obstacle is of the order of the wavelength of the signal or less, mie scattering occurs. An incoming signal is scattered into several weaker outgoing signals. The production of waves of changed direction, frequency, or polarization when radio waves encounter obstacles of the smaller size is called scattering.

At typical cellular microwave frequencies, there are numerous objects, such as lamp posts and traffic signs, that can cause scattering.

Thus, scattering effects are difficult to predict. Rayley Scattering occurs when an electromagnetic signal encounters a surface that is large relative to the wavelength of the signal. For example, suppose a ground-reflected wave near the mobile unit is received. Because the ground-reflected wave has a 180^0 phase shift after reflection, the ground wave and the line-of-sight (LOS) wave may tend to cancel, resulting in high signal loss. Further, because the mobile antenna is lower than most human-made structures in the area, multipath interference occurs. These reflected waves may interfere constructively or destructively at the receiver. The tree leaves and branches also usually contain water and hence result in absorption and scattering of electromagnetic waves as they propagate through vegetation. Foliage can not only introduce attenuation and broadening of beam but also depolarization of the electromagnetic wave. The transmission losses through vegetation are affected by various parameters such as the dielectric, density, physical size and shape. The signal attenuations due to vegetation varies with height and is minimal at the trunk level, propagation results also indicate that signal attenuations increase sharply over shorter vegetation depths. However as the vegetations depth increase, scattering from trees tends to contribute towards the received signal and hence the increase in signal attenuation is not as sharp. In this paper, an experimental effort is done to estimate the attenuation due to single target tree of the region that accounts for the multiple scattering due to small leaves tree.

II. EXPERIMENTAL SETUP

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The millimeter wave link system comprises a Continuous-wave (CW) 35 GHz transmitter using a 100 mW Gunn source with a transmitting antenna of 18 degree beam width and 22 dB gain. Spectrum analyzer is used to measure attenuated power at the end of receiver system.

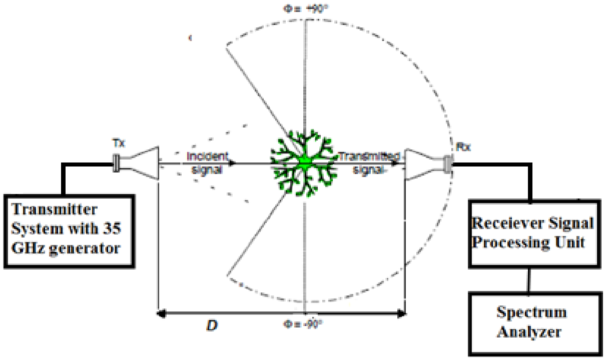

Figure.1 Block Diagram of Experimental Set-up

Physical location of the transmitter and receiver systems, heights of the transmitting and receiving antennas, distance of separation between the transmitting and receiving antennas, and calculated Line of Sight (LOS) propagation link lengths are observed.All the measurements are carried out at a site which is developed at Government Engineering college, Bikaner. The Bikaner district is situated at western part of Thar Desert region of India.

RESULT

Measurement Of Attenuation due to Scattering

1. BER TREE (*Zizyphus mauritiana*) Canopy

Wind speed = 4km/hr , Temperature: 23.2°C,
Height of foliage: 3.5m ,Depth of foliage: 2.4m,
Distance between Tx And Rx: 8.8m,
Reference Level: -12dBm
(a)Across canopy/leaves-
Height of transmitter: 3 m Height of receiver: 3m

Table 1. Measurement of attenuation at different angles for canopy of Ber tree

Sr. No.	Angle (Degree)	Received Power (-dBm)	Attenuation (dB)
1	0	66.4	54.4
2	30	76	64
3	60	85.2	73
4	90	54.4	42.4
5	120	66	54
6	150	41.6	29.6
7	180	26.4	14.4
8	210	36.4	24.4
9	240	47	35
10	270	45.2	33.2
11	300	48	36
12	330	52.8	40.8
13	360	66.4	54.4

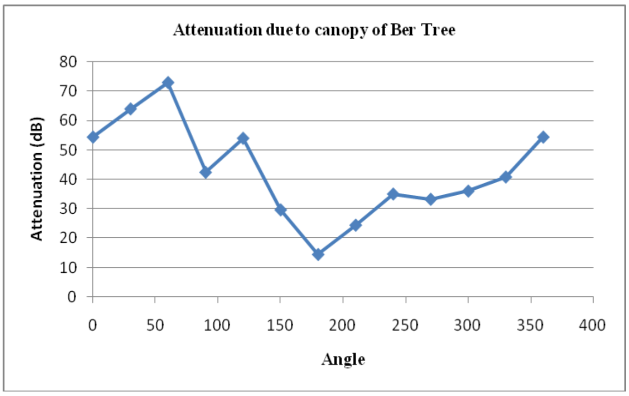

Figure 2.Graph to represent the attenuation due to canopy of Ber(*Zizyphus mauritiana*) tree

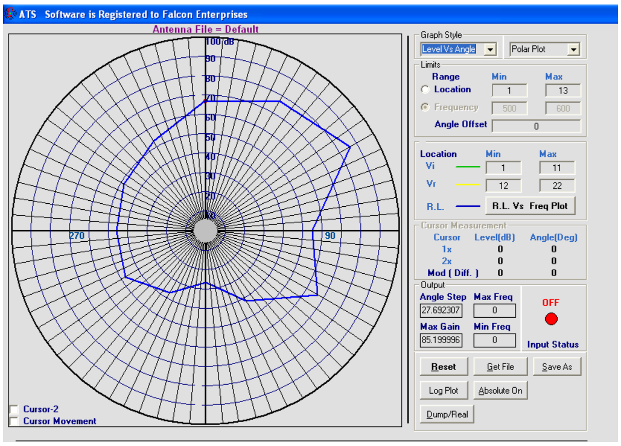

Figure 3. Polar-plot for the canopy of Ber (*Zizyphus mauritiana*) tree.

2. BER TREE (*Zizyphus mauritiana*) Across trunk

Height of transmitter: 1 m,
Height of receiver: 1m
Diameter of Trunk: 0.4 m

Table 2. Measurement of attenuation at different angles for trunk of Ber tree.

Sr. No.	Angle (Degree)	Received Power (-dBm)	Attenuation (dB)
1	0	38.4	26.4
2	30	39.6	27.6
3	60	46	34
4	90	35.6	23.6
5	120	39.5	27.5
6	150	37.4	25.4
7	180	20	8
8	210	42.8	30.8
9	240	22.4	10.4
10	270	32	20
11	300	30.4	18.4
12	330	26.8	14.8
13	360	38.4	26.4

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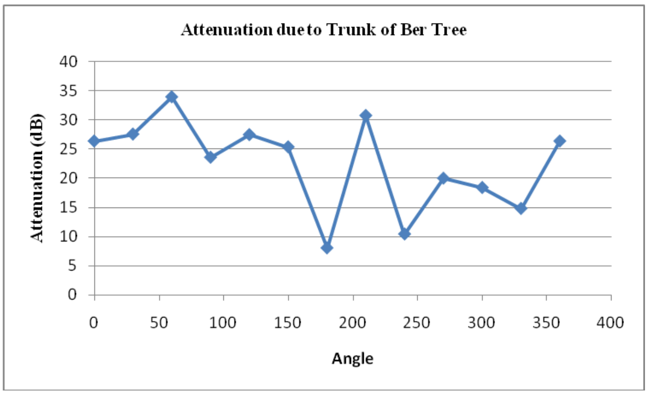

Figure 4. Graph to represent the attenuation due to trunk of Ber (*Zizyphus mauritiana*) tree.

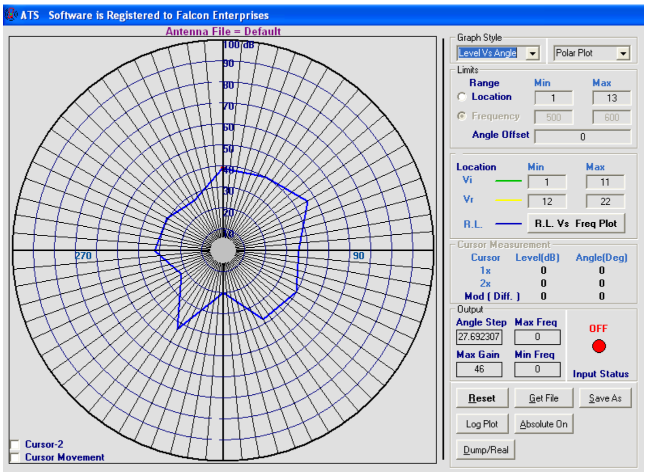

Figure5 Polar-plot for the trunk of Ber (*Zizyphus mauritiana*) tree

III. CONCLUSION

An outdoor path loss measurement was conducted for Ber tree to examine the wave propagation through trunk and canopy of tree. A minimum attenuation at 180° angle or at Line-of-sight angle and maximum attenuation at 60° angle in case of Ber tree canopy and signal will be attenuate from 73db to 14.4dB is observed. In case of trunk of same tree a minimum attenuation at 180° angle or at Line-of-sight angle and maximum attenuation at 60° angle and signal will be attenuate from 30.8 db to 8 dB is observed. The amount of attenuation is depending upon leaf structure of arid foliage. Signal scattering is more for 90° both side with compare to the back position for this case. So, here it shows that the canopy affects more the signal instead of trunk.

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