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PREDICTION OF RAIN ATTENUATION USING ARTIFICIAL NEURAL NETWORKS

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Abstract: Artificial neural networks are of most widely used processing model and large collection of large number of neural units. Each and every neural unit in a neural network is connected to large number of neurons called axons.at higher frequencies rain attenuation plays a dominant role in signal degradation especially greater than 10 GHz.in this paper rain attenuation is calculated at 25 GHz using Ann's model and compared with standard ITU R model. In comparison to ITU R model the results show that Ann's model is comparatively better. Theoretical and practical values are compared in the considered location

Keywords: Rain attenuation, artificial neural networks, rain attenuation using Ann's

1. Introduction

Design of any communication system requires the improvement of a link budget. In this process, it contains some losses due to atmosphere. Factors that lead to signal loss during its transmission through the earth's atmosphere include rain attenuation, ice depolarization, cloud attenuation and water vapor attenuation. Among all these impairments rain attenuation is important above 10 GHz frequencies it causes maximum attenuation in the reliable communication links designing process. The rain attenuation [1] prediction process the considered time percentages are 0.001%to 5%at frequency 25 GHz. Time percentages is calculated by using ITU-R P 837. The artificial neural networks also for same considered time percentages and same frequency also considered. The inputs are rain rate (mm/hr), elevation angle (deg), latitude (deg), polarization angle (deg), earth station height (km).

I. Rain Attenaution Prediction Models

The rain attenuation is a function of frequency and is highly related with rain rate .The rain rate calculation is done by using ITU R P [837] [3]. The two methods to predict the rain attenuation are physical and empirical methods. These methods use rain fall rate and effective path length from various places .Different attenuation prediction methods are available from geographical and climatic conditions. In this paper calculation of rain attenuation is done by using ITU-R P. [618] [2],at the frequency 25 GHz and rain rate from 0.001%to 5%probabilty range of an average year in (mm/hr).

II. Artificial Neural Networks

Artificial Neural Networks are a computational approach and used for prediction process. Its model is simple in architecture and more accurate in the prediction process .artificial neural networks mainly contains three layers those are Input layer, Hidden layer, Output layer. In each layer all neurons are connected and contain individual weights and bias values. The applications of the artificial neural networks are pattern recognition, data mining and etc.

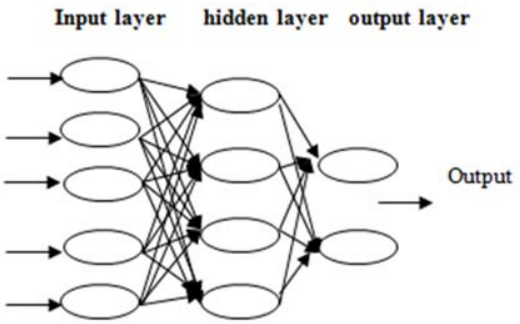

Figure 1: Artificial Neural Network Diagram

2. Method For Estimation Of Rain Attenuation

In this paper the considered location latitude and longitude values are16.46 N and 80.54 E respectively [6]. Percival disdrometer can be used to measure and record the 1-minute integration rainfall rate intensity (mm/hr.) and it is also specifies rain drop size. Using the spectrum analyzer the satellite signal strength will be measured and the information can be recorded by data logger. The required inputs for the calculation of rain attenuation is

latitude (deg),frequency(GHz), Rain rate(mm/hr.), polarization angle(deg),elevation angle(deg),height above mean sea level(km) are tabulated below with values

Table: 1 input parameters and its values

Parameters	Values
Frequency	25 GHZ
Rain rate	R 0.01%
Elevation angle	64.5 deg
Station height above mean sea level	0.029 km
Latitude	16.46 N
Longitude	80.54 E

The calculated rain attenuation values by using ITU_R P.618 is tabulated in Table 2

Table: 2 rain rate, %of time and attenuation values of ITU-R model

% of time exceed	Rain fall rate	Attenuation (dB)
0.001%	138.12	26.16
0.01%	79.5	9.56
0.1%	26.85	5.27
1%	3.65	1.83
5%	0	0

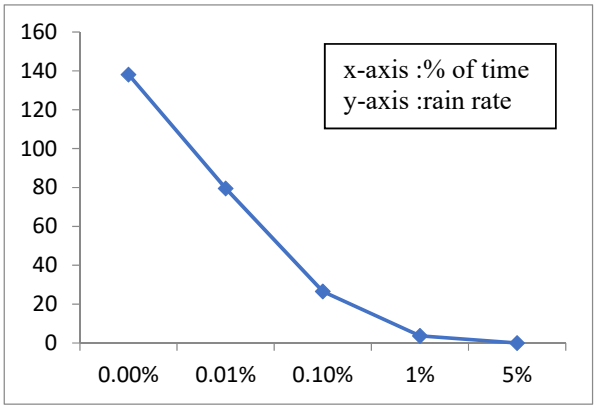

Figure: 2 variation of rain rate with % of time

The rain fall rate is calculated by using ITU-RP837.And the rain fall rate variation with respect to time percentage if rain rate increases the time percentage decreased

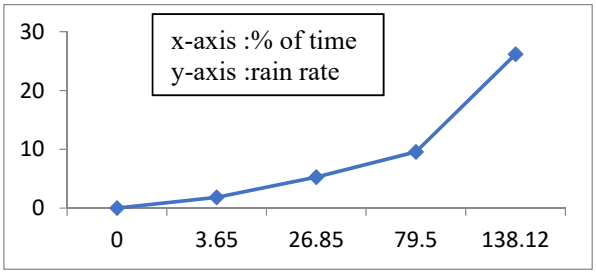

Figure 3: rain rate and attenuation values comparison graph using ANNS

The attenuation of the signal is calculated by using ITU-R p.618. if the rain rate increases the attenuation must be increases at all frequencies.

3. Calculation Of Rain Attenuation By Using Artificial Neural Networks

Artificial Neural Networks gives the best results in prediction process [4] by using the mat lab neural networks tool box (nn tool). The rain attenuation is calculated by using the required input values for the nn tool .The required inputs for the nn tool is input values , target values and sample values are considered in the matrix format .By using the nn tool the obtained neural network diagram is obtained for the input values. The diagram is shown below.

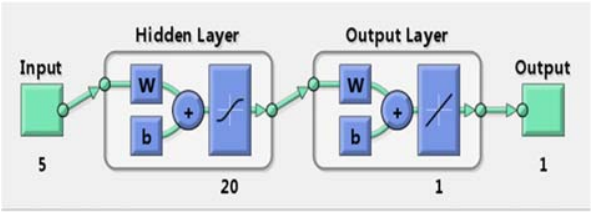

Figure 4: Neural Network Diagram By Using NN Tool

Table: 3 ANNS %of time, rain rate and attenuation values

% Time exceed	Rain rate	Attenuation
0.001%	138.12	14.48
0.01%	79.5	8.85
0.1%	26.85	4.04
1%	3.65	0.038
5%	0	0

Neural network training is the important task in the nn tool .the weights and bias values are obtained. By using the simulation process the rain attenuation values must be predicted those values are tabulated below.

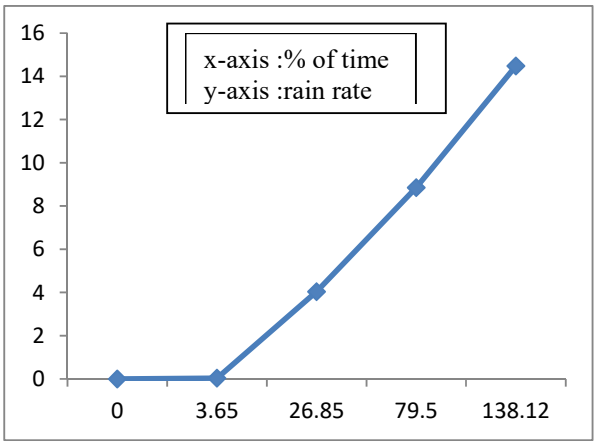

Figure 5: rain rate and attenuation values comparison graph using ANNS

4. Results

Rain attenuation is calculated by using ITU-R model and using artificial neural networks with different rain fall rates at frequency 25 GHz, elevation angle is 64.50. The rain fall rates are calculated by using ITUR p.837.Based on geographical latitude and longitude the rain attenuation is calculated theoretically. With the mat lab neural networks tool box (nn tool) rain attenuation is calculated. the comparison of the both attenuation values will be made those values are tabulated below and the comparison graph is also shown below.

% Time exceed	Rain rate	Attenuation (ITU-R p.618)	Attenuation (artificial neural networks)
0.001%	138.12	26.16	14.48
0.01%	79.5	9.36	8.85
0.1%	26.85	5.27	4.04
1%	3.65	1.83	0.038
5%	0	0	0

Figure: 6: Values comparison of attenuation values for ITUR and artificial neural networks

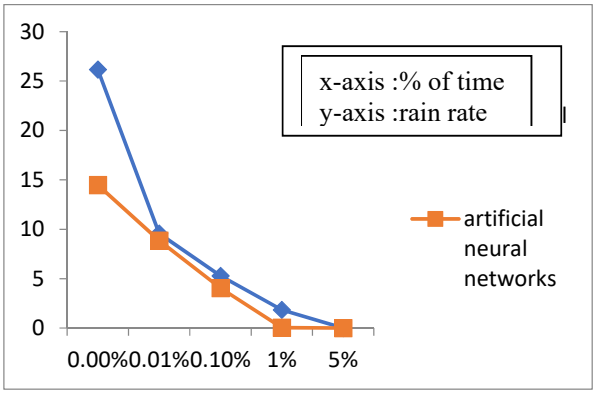

Figure: 7 ITU-R and ANN's attenuation with %of time comparison

The graph describes the relation between rain attenuation and the time percentages. the time percentage is considered from 0.001%to 5%. if the time% increases the attenuation also increases the attenuation is calculated by using the ITU-RP.618, nn tool and the comparison of both values are shown.

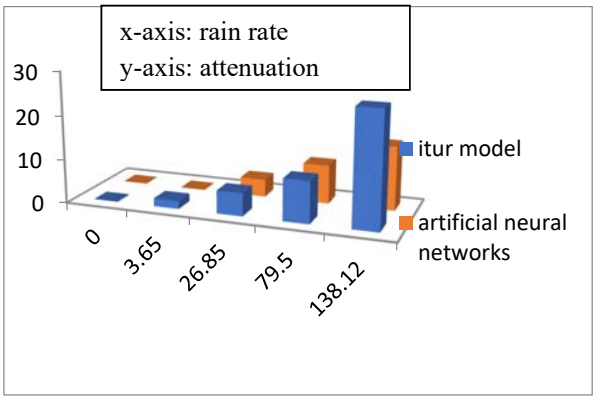

Figure: 8 ITU-R and ANN's attenuation with rain rate comparison

Graph describes the comparison between rain rate and attenuation of ITUR model with ANNS. Rain rate is calculated by using ITUR p 837. If rain rate increases attenuation also increases compared to ITU -R model the attenuation is less in ANNS.

5. Conclusion

The importance of the higher frequency bands like Ku band & Ka band is becoming more important in present days for satellite communications. at these frequencies due to the different impairments will cause the signal attenuation like cloud attenuation, gaseous attenuation, rain attenuation, troposphere and ionosphere scintillations etc. among all the impairments rain attenuation is the main .in this paper rain attenuation is calculated theoretically by using ITU-R p.618 and by using the artificial neural networks also rain attenuation is calculated and Comparison will be made for the both of the values. The artificial neural networks give the best results in this paper.

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