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Research paper

Analysis of rain fade mitigation using site diversity technique in southern tropical region of India

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Abstract

In order to design a reliable earth to satellite microwave link at certain frequencies in tropical region due to multi propagation we come across fading which means variation of attenuation of a signal with time, geographical position and radio frequency. The radio waves propagating through the earth atmosphere is attenuated due to the presence of atmospheric particles such as water vapor, rain drops and the ice particles which absorb and scatter the radio waves and consequently degrade the performance of the microwave link and there is probability of loss of signal strength, to mitigate this problem Site Diversity Technique is used from the different Fade Mitigation Techniques. The analysis of Site Diversity Gain Model based on the measured rainfall data has been done.

Keywords: *Diversity Techniques; Microwave link; Propagation; Rain Fade Mitigation; Site Diversity*

1. Introduction

Propagation of radio waves through the earth atmosphere occurs attenuation due to the atmospheric particles due to moisture and rain drops in the atmospheric condition which absorb radio waves through microwave link performance is degraded by using different types of fade mitigation techniques we can control the unwanted distortions and attenuation of signal in the system There is a classification based on multipath parameters, where Fade Mitigation technique is introduced and which can be stated as to reduce the attenuation of signal Fade Mitigation Technique.

This is a very solid and strong methodology in which it is used for beating blurring progressively which increases advancement for high rate of information which is applied in mixed media administrations and also used for congestion control of X, C, Ku bands of traditional groups in order to improve the connection of execution and also for implementation of important at groups of Ka and V groups. On Earth space path the propagation loss relative to the free space loss in the addition of attenuation in atmospheric gases and also by rain drops and other different kinds of precipitation and clouds. When the elevation angle is above 10 degrees the gaseous cloud and rainfall changes certainly affect on propagation.

1.1. Fade Mitigation Techniques

1.1.1 Frequency Diversity:

Frequency diversity is the process of receiving a radio signal or components of a radio signal on multiple channels different frequencies or over a wide radio channel wide frequency band to reduce the effects of radio signal distortions such as signal fading that occur on one frequency component but do not occur or not as severe on another frequency component. The signal is transmitted using several frequency channels or spread over a wide spectrum that is affected by frequency-selective fading. Replicas sent in bands separated by at least the coherence bandwidth uncorrelated channels as two or more different frequencies experience different fading, at least one will have strong signal. Frequency diversity consumes extra bandwidth and sending information symbol each L symbol times. Only one symbol can be transmitted every delay spread. When one tries to transmit images more as often as possible than the intelligence data transmission, entomb image impedance (ISI) happens. To attain least correlated carrier frequencies are separated by more than the one coherence bandwidth of the channel. The goal is to create those carrier frequencies uncorrelated to each other so that there will not experience same fades. Certainly, if the channels are uncorrelated then the probability of simultaneous fading will be the product of individual fading probabilities.

1.1.2 Antenna Diversity:

Antenna Diversity is any of a few remote decent variety plots that utilizations at least two receiving wires to enhance the quality and dependability of a remote connection. Frequently, particularly in urban and indoor situations, there is no evident viewable pathway (LOS) amongst transmitter and recipient. Rather the signal is reflected along various ways before at long last being gotten. Each of these ricochets can present stage shifts, time postponements, constrictions, and bends that can damagingly meddle with each other at the opening of the accepting receiving wire. Reception apparatus decent variety is particularly powerful at relieving these multipath circumstances. This is on the grounds that various Antenna Diversity.

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Characteristically a reception apparatus assorted variety plot requires extra equipment and coordination versus a solitary antennas framework however because of the shared trait of the flag ways a decent lot of hardware can be shared. Likewise with the different flags there is a more noteworthy preparing request put on the beneficiary, which can prompt more tightly outline necessities. Ordinarily, be that as it may, flag unwavering quality is vital and utilizing various antennas is a compelling approach to diminish the quantity of drop-outs and lost associations. Antenna Diversity is a transmission demonstrate strategy utilizing more than one reception apparatus to get or transmit the signs along various proliferation ways to make up for multipath impedances. Due to multipath proliferation, obstruction impacts between various transmitters, the signal quality may firmly shift notwithstanding for every little difference in the spread conditions, influencing the connection quality. These blurring impacts can bring about an expanded loss of the association amongst transmitters and beneficiaries. Applying Antenna Diversity transmission strategies in such situations enhance the dependability of a remote channel. Decent variety plans give at least two contributions at the beneficiary with the end goal that the blurring marvels among these sources of info are uncorrelated. In the event that one radio way experiences profound blur at a specific point in time another autonomous or if nothing else exceedingly uncorrelated way may have a solid flag at that info Reception apparatus assorted variety can be acknowledged in a few ways. Contingent upon the earth and the normal obstruction, planners can utilize at least one of these strategies to enhance signal quality. Radio wire decent variety is a strategy for consolidating numerous, autonomous, blurring signals in an assorted variety beneficiary. It is an intense system for enhancing recipient execution within the sight of multipath blurring.

1.2. Diversity Combining Techniques

1.2.1 Switched Combining Technique:

The switched combining technique requires just a single collector radio between the N branches. The collector is changed to different branches just when the SNR on the present branch is lower than a predefined edge. Whereby, other joining procedures require N collectors to screen the got prompt signs level of each branch when there are N component radio wires. Because of size limitations, battery life and multifaceted nature, the exchanged joining system is by and by actualized in portable terminals with assorted variety radio wires. The ideal execution that an exchanged combiner can accomplish is like that of a determination combiner.

1.2.2 Equal Gain Combining Technique:

Both exchanged and choice joining systems just utilize the flag from one of the branches as the yield signal. With a specific end goal to enhance SNR at the yield, the signs from all branches are consolidated to shape the yield signal [5]. In any case, the signal from each branch isn't in-stage as shown in Fig.1.

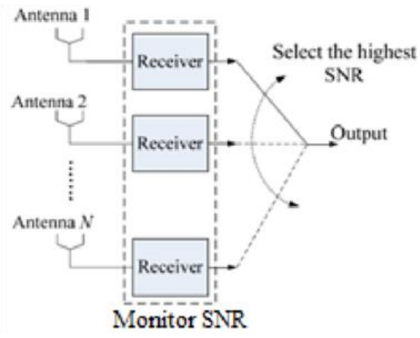

Fig. 1: Equal Gain Combining Technique

1.3. Signal Processing Technique:

Signal handling concerns the investigation, combination, and adjustment of signs, which are comprehensively characterized as capacities passing on data about the conduct or properties of some wonder, for example, sound, pictures, and organic estimations. For instance, signal handling systems are utilized to enhance signal transmission constancy, stockpiling proficiency, and subjective quality, and to underscore or recognize parts of enthusiasm for a deliberate signal. By handling we mean working in some design on a signal to separate some valuable data. For instance when we hear same thing we utilize our ears and sound-related way routes in the cerebrum to remove the data. The signal is prepared by a framework. In the case specified over the framework is organic in nature. We can utilize an electronic framework to endeavor to copy this conduct. The signal processor might be an electronic framework, a mechanical framework or even it may be a PC program. The word advanced in computerized signal preparing implies that the handling is done either by computerized equipment or by an advanced PC.

Commotion decrease is the way toward expelling clamor from a signal. All account gadgets, both simple and computerized, have qualities that make them vulnerable to commotion. Commotion can be arbitrary or background noise no intelligibility, or intelligent clamor presented by the gadget's instrument or handling calculations. In electronic account gadgets, a noteworthy type of clamor is murmur caused by arbitrary electrons that, intensely impacted by warm, stray from their assigned way. These stray electrons impact the voltage of the yield signal and in this manner make recognizable commotion.

1.4. Adaptive coding Technique

The technique which is adaptive coding allows to different of entropy encoding techniques for lossless information pressure. They are mostly appropriate to gushing data, as they are adapted to limited alterations in the qualities of the data, and first ignore the information to compute a likelihood demonstrate. The price for these promising circumstances is that the encoder and decoder must be more complex to keep their states synchronized and more computational power is estimated to continue to remain in the encoder/decoder state. All information pressure methodologies include the usage of a model, an expectation of the synthesis and analysis of the information. Whenever the information coincides the expectation made by the model, the encoder can mostly transmit the substance of the information at a lower data cost, by referring to the model. This general statement is somewhat deceptive as general information pressure calculations which are not really tantamount to pressure procedures normally called versatile. Run-length encoding and the commonplace JPEG pressure with run length encoding and predefined Huffman codes don't transmit a model. Ton of different strategies adjust their prototypes to the present document and need to pass the information by notwithstanding the encoded information, in light of the fact that the encoder as well as the decoder have to utilize the model. In adaptive coding scheme, the encoder and decoder are rather furnished with a pre-existing meta-display on how they would modify their models in light of the genuine substance of the information, and generally begin with a clean slate, implying that no underlying model should be transmitted. The encoder and decoder modify their models whenever the data is transmitted, so that unless the character of the data changes periodically, the model becomes more adapted to the information, it has capability and compresses it more efficiently advancing towards the efficiency of the static coding.

The new concept of developing an error correcting coding scheme is proposed in order to achieve an extremely high reliable communication through atmospheric turbulence. The method is based on applying adaptive error correcting codes to recover lost information symbols caused by fading due to turbulent channel. The reason of proposing channel coding is to be able to detect or even to correct transmission errors if we append additional information so called redundant information to the information sequence. In order to find effective codes, we must first characterize the transmission channel, which significantly degrade transmission quality. Usually, the fading time-constant is much higher than the bit-duration. The fading process can be described by the “mean number of fades per second (NOF), “mean duration of fades” (DOF), and the “Probability of fades” (POF).

Using the binary intensity modulation the receiver performance, described by the receiver sensitivity and the noise processes of the detector is very important to calculate the error probability. The noise for a 1 and 0 level is different if we are using an avalanche photo-detector (APD). Additionally, the noise depends on the current mean received power. Note that since the transmitter. Block coding can improve the bit error rate (BER) if the received power is rather high. Using block codes there is a threshold after which the coded transmission is better than the transmission without coding. This is because of the redundant bits which must additionally be transmitted using codes. The fade time caused by randomly varying communication channel is usually much shorter than the duration of a code block, so that the code should correct as much as possible errors which occur during a fade. With block codes we can improve the BER significantly.

1.5. Space Site Diversity:

This is particularly useful for the versatile correspondence it enables various clients to share a restricted correspondence range and stay away from co-channel impedance. The signal is transmitted more than a few distinctive proliferation ways. On account radio transmission, this can be accomplished by transmitting by means of different wires. On account of remote transmission, it can be accomplished by receiving wire decent variety utilizing various transmitter radio wires (transmit assorted variety) and additionally different accepting receiving wires (gathering decent variety). In the last case, a decent variety consolidating procedure is connected before additionally flag handling happens. On the off chance that the reception apparatuses are far separated, for instance at various cell base station destinations or WLAN get to focuses, this is called full scale assorted variety or site decent variety. On the off chance that the radio wires are at a separation in the request of one wavelength, this is called small scale assorted variety. In space applications of communication systems, which use low frequency bands to the power margins aid the system to work at desired performance level, unless the weather dependent path attenuation. For elevated frequencies the high power margins are required but are not possible to construct either technically or cost efficiently. Site Diversity is general term used to depict the usage of at least two geologically isolated ground terminals in a space correspondence connect to beat the impact of way weakening amid extreme rain period. Site Diversity enhances the general satellite connection execution by exploiting the constrained size and degree of exceptional rain cells. The prediction models of site diversity:

2. Diversity Gain

The prediction of diversity gain (dB) in simplified method between the pair of sites can be calculated with the empirical expression [ITURP.618].

For the calculation of diversity gain the following parameters are required such as:

d: separation of two sites (km)

A: path change for a single site (dB)

f: frequency (GHz)

theta: elevation angle (degrees) .

ψ: azimuthal angle

Step 1: In step1 the calculation of gain by the spatial separation is obtained.

$Gd=a(1-e^{-bd})$

where:

a = 0 78 *A – 1 94 *(1 – e–0 11 *A)

b = 0 59 * (1 – e–0 1 *A)

Step 2: In step2 the calculation of gain which is contributed by frequency dependent is obtained from the equation shown. Gf = e–0 025 *f

Step 3: In step3 the calculation of gain in which elevation angle is shown.

G(theta) = 1 + 0 006 (theta)

Step 4: In step4 the calculation of gain term which base line dependent is obtained from the equation has shown.

Γψ= 1 + 0 002 (chi)

Step 5: Finally, In step5 the overall net diversity gain as the product is computed and that can be obtained from the equation shown, hence the diversity gain is calculated.

G = Gd * Gf * G(theta) * G(chi)dB

Therefore, this equation which is used to implement Gain diversity by initializing the input parameters and resultant is discussed in the results with proper specifications.

3. Results and Discussion

The results of Gain diversity with different parameters are taken which are distance, frequency, angle of elevation and attenuation. Table 1 shows distance and gain diversity while the values of attenuation, frequency and the elevation angle(theta) are kept as constant ,here distance varies from 3km to 18km are taken.

Table 1: Plotting Distance (km) and Gain Diversity (dB)

S.No	Distance (km)	Gain diversity
1	3	31.9
2	6	37.8
3	9	38.9
4	12	39.16
5	15	39.204
6	18	39.2116

Table 2 shows frequency and gain diversity while the values of attenuation, distance and the elevation angle (theta) are kept as constant, here distance varies from 25 to 50 (GHz) are taken

Table 2: Plotting frequency (GHz) and Gain diversity (dB)

S.No	Frequency (GHz)	Gain diversity
1	25	39.2
2	30	46.4
3	35	53.6
4	40	60.3
5	45	67.5
6	50	74.45

Table 3 shows angle of elevation (theta) and gain diversity while the values of attenuation, distance and the frequency are kept as constant ,here distance varies from 60 to 110 (degrees) are taken.

Table 3: Plotting angle of elevation (degrees) and Gain diversity

S.No	Angle of Elevation (degrees)	Gain diversity
1	60	37.5
2	70	39.5
3	80	40.86
4	90	42.517
5	100	44.17
6	110	45.83

Table 4 form shows attenuation and gain diversity while the values of angle of elevation(theta), distance and the frequency are kept as constant, here distance varies from 30 to 55(dB) are taken.

Table 4: Plotting attenuation (dB) and Gain diversity (dB)

S.No	Attenuation (dB)	Gain diversity
1	30	39.2
2	35	46.4
3	40	53.6
4	45	60.6
5	50	67.57
6	55	74.4

3.1. The resultant graph is shown between Distance vs Gain Diversity:

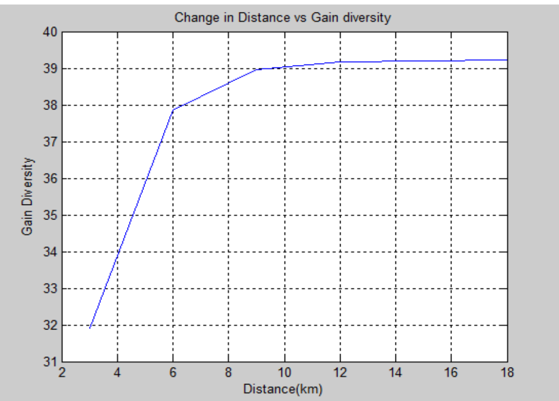

Fig. 2: Change in Distance (km) (i.e., from 3km to 18km) vs Gain Diversity (dB)

The Figure2 demonstrated as distance increases the gain diversity also increases the minimum distance should be ranges from 4km to 6km then only the improvement of gain diversity can be viewed and also the gain diversity remains unchanged from 8km to 18km.

3.2. The resultant graph is shown between Frequency vs Gain Diversity:

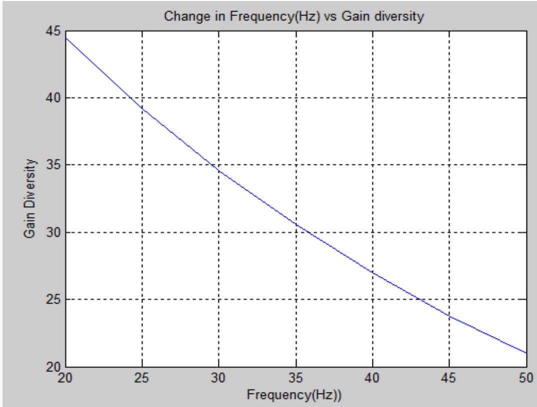

Fig. 3: Change in Frequency (GHz)(i.e., from 20GHz to50GHz) vs Gain Diversity(dB)

The Figure 3 demonstrated as frequency increases the gain diversity decreases the minimum frequency should be 20GHz then only the improvement of gain diversity can be viewed and also the gain diversity gradually decreases up to 50GHz.

3.3. The resultant graph is shown between angle of elevation vs Gain Diversity:

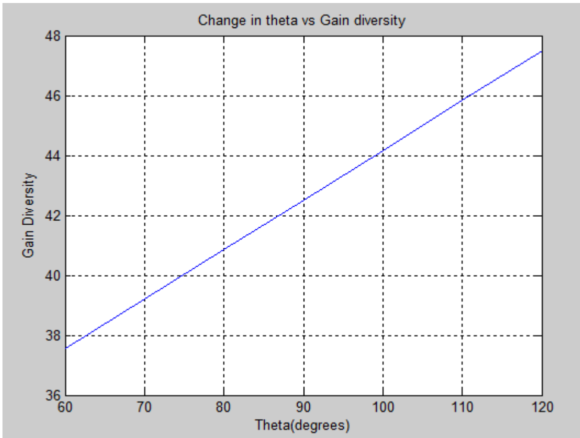

Fig. 4: Change in angle of elevation (degrees i.e., 60 degrees to 120 degrees) vs Gain Diversity (dB)

The Figure 4 demonstrated as angle of elevation increases the gain diversity also increases the minimum elevation angle should be 120 degrees then only the improvement of gain diversity can be viewed and gradually increases from 60 degrees

3.4. The resultant graph is shown between attenuation (dB) vs Gain Diversity:

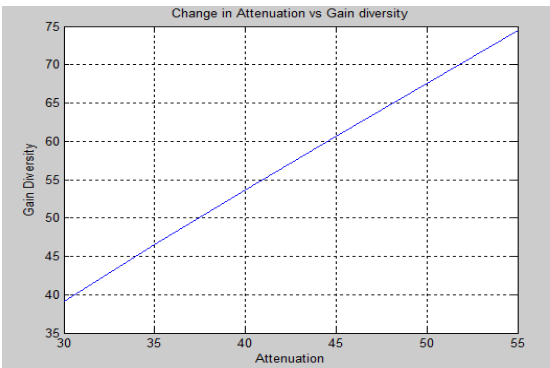

Fig. 5: Change in attenuation (dB i.e., 30dB to 55dB) vs Gain Diversity (dB)

The figure 5 demonstrated as attenuation increases the gain diversity also increases the minimum attenuation should be 55dB then only the improvement of gain diversity can be viewed and gradually increases from 30dB

3.5. Improving the signal strength by switching the location without any losses:

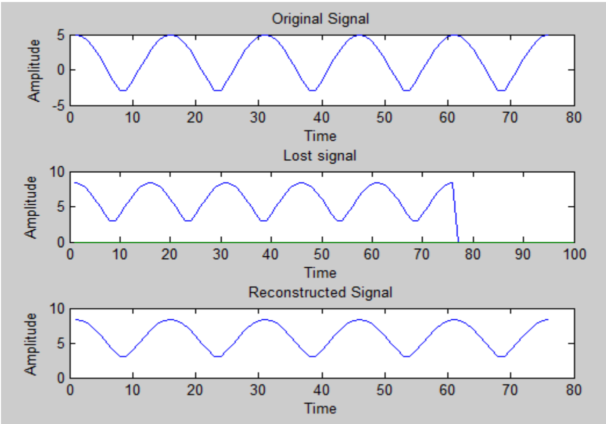

Fig. 6: Improving the signal strength by switching process

In Figure 6 the first graph shows the input signal received by the satellite at location1 and the preceding second graph shows the signal which gets affected by rain which leads to loss of signal, the third graph shows the signal which takes from the nearest unaffected location by rain and hence improves the signal from lost signal

4. Conclusion

Completing analysis about Gain diversity by taking different parameters like distance, frequency, angle of elevation, attenuation, statistics about the minimum requirements for site diversity by plotting different graphs with certain specifications. We have shown that frequencies above 20GHz the site diversity performance decreases and also it undergoes path impairments. Also we have improved the strength of the signal by switching the location without any kind of losses and resultant corresponding signal is reconstructed by comparing the nearest location which is not affected by rain drops among all the different fade mitigation techniques, site diversity technique is considered as one of better technique in analysis of rainfall attenuation.

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