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Ultra Wideband Using Multiple Access Modulation Scheme System Improvement in Multipath Channel

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Abstract - *Ultra-Wideband (UWB) technology is a wireless transmission scheme having a bandwidth of more than 25% of a center frequency, or more than 1.5GHz. It uses very narrow band pulses of nano-seconds duration to provide very high data rate communications. The pulses in the UWB spread the energy of the signal over a large frequency range and it is extremely important to meet the requirements of ultra wideband emission mask requirements to get improved performance in the multipath environment. This paper focuses on improvement in the performance of ultra wideband multiple access modulation scheme system using improved optimal Gaussian derivative pulses in the UWB multipath channel.*

Key Words: *UWB, PPM, PPM-TH, PAM, PAM-DS, FCC.*

1.INTRODUCTION

UWB history is generally started after 1960 with the development of Linear Time Invariant System description via impulse stimuli. Through the late 1980's, UWB technology was referred to as baseband, carrier-free or impulse technology. By that time, development of techniques using this technology had been under development for nearly 30 years.
During the late 2000 the UWB research focused more on communication methodology and commercial short-range wireless applications such as wireless Local Area network (LAN) and home entertainment.

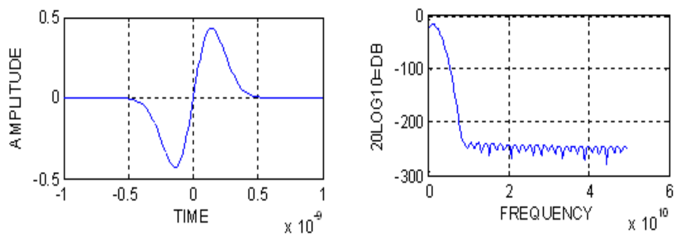
UWB systems vary widely in their projected capabilities; this technology can have peak speeds of over 480 Mbps at a range of 10 meters with spatial capacity of approximately 1000 Kbps/m^2 .Ultra wideband (UWB) technology, useful for both communication and remote sensing applications. It uses 1/1000 of the power required for equivalent conventional transmission methods and because of their low average transmission power; UWB communications systems have an inherent immunity to detection.

The Gaussian pulse is defined as

$$p(t) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(t-\mu)^2}{2\sigma^2}} \quad -\infty < t < \infty \quad (1)$$

Where σ is the standard deviation of the Gaussian pulse, and μ is the location in time for the midpoint of the Gaussian pulse in seconds [4].
Also with mean at zero

$$p(t) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(t)^2}{2\sigma^2}} \quad -\infty < t < \infty \quad (2)$$



Time domain Frequency domain

Fig.-1: Gaussian derivative Pulse in time and Frequency Spectrum

In order to have better performance in multipath channel environment it is required to use Gaussian pulse derivatives that matches the emission mask requirements[3] [4].

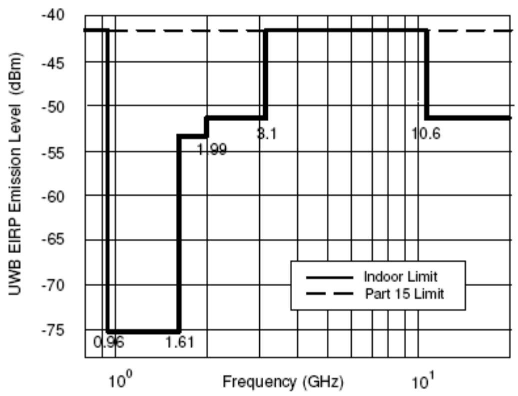
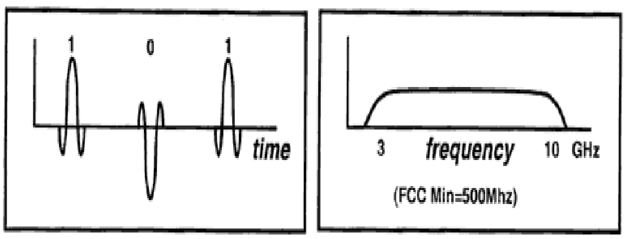


Fig.-2: UWB Emission Mask

2. MODULATION

UWB can directly modulate impulse pulses of nano-seconds duration that results in a waveform that occupies several GHz of bandwidth [6].



Time domain Frequency domain

Fig-3: UWB Pulse Modulation.

UWB signals are obtained by either applying the Pulse Position (PPM), Pulse Amplitude (PAM), Bi-Phase modulation etc.

3. UWB MULTIPLE ACCESS SYSTEM MODEL

In this paper we will consider the Pulse Position Modulation Time Hopping (PPM-TH) and Pulse Amplitude Modulation Direct sequence (PAM-DS) multiple access modulation techniques. [8].
The binary information contained in the bits sent to coder for repetition. The modulation technique used here is the pulse position modulation and Pulse amplitude modulation using antipodal amplitude pulses. However, fine time resolution is necessary in UWB system to modulate pulses which are in sub nanosecond range. This time dither time shift is introduced with the help of pseudo random (PN) codes.
The time shift is generated by PPM the modulator.

The signal at the output is represented as

$$s(t) = \sum_{j=-\infty}^{+\infty} p(t - jT_s - c_jT_c - a_j\varepsilon) \quad (3)$$

$a\,j\varepsilon$ = time shift

Where in PAM-DS the signal at the output is represented as

$$s(t) = \sum_{j=-\infty}^{+\infty} a_j\, p(t - jT_S) \quad (4)$$

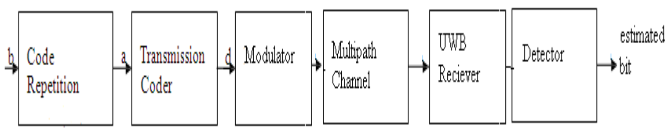


Fig-4: UWB Multiple Access System

IEEE 802.15.3a UWB multipath channel model is used in which the multipath components arrive at the receiver in groups, called clusters, with Poisson distribution. The path (ray) within each cluster also arrives with Poisson distribution [7]. The channel impulse response is given by:

$$h(t) = X \sum_{l-1}^{L} \sum_{n-1}^{M} \alpha_{nl}\, \delta(t - T_l - \tau_{nl}) \quad (5)$$

Where L is number of clusters, M is number of paths within a cluster, α_{nl} is the multipath gain of the nth path corresponding to l th cluster. T_l is delay of l th cluster and τ_{nl} is the time delay of nth ray of the l th cluster [5] [6].

UWB uses a rake receiver that consists of a correlator that converts the received signal into decision variables and detector then makes a decision on which signal is transmitted based on the decision variable.

4. SIMULATION RESULTS

The above described model is created using MATLAB software using binary PPM Time Hopping multiple access modulation scheme. The results are obtained for Gaussian standard fifth order derivative pulse and optimal Gaussian derivative pulse for the same with parameters like average transmitted power=-30dBm, sampling frequency=50e9s, pulse repetition period =5e-9s, pulse duration =0.5e-9s and PPM time shift = 0.5e-9s.

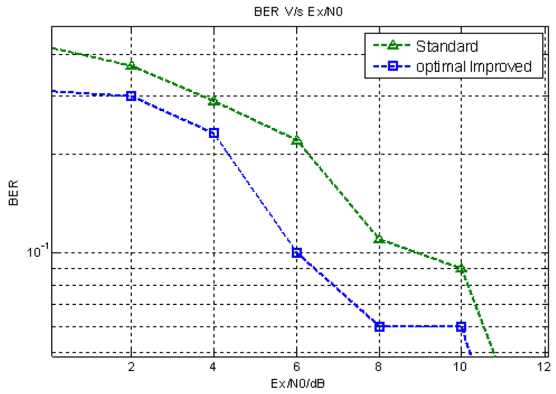


Fig-5: Simulation improved results for Gaussian fifth derivative pulse

Further the model is also created using binary Pulse Amplitude Modulation Direct sequence multiple access modulation scheme again using the same above mentioned parameters and the results are obtained for Gaussian fifth order optimal Gaussian derivative pulse and plotted along with the above obtained results of Pulse Position Modulation Time Hopping multiple access modulation scheme .

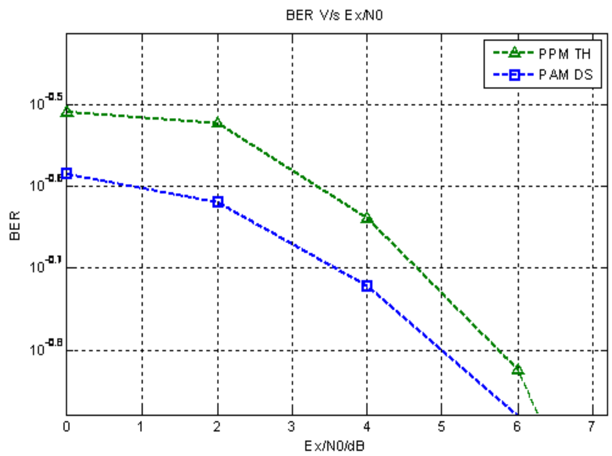


Fig.-6: Simulation results for improved performance of PAM Direct sequence system

5. CONCLUSION

The basics of UWB modulation and multiple access modulation techniques are explained in the paper and the simulation results obtained for the Gaussian derivative optimal pulse shown by blue dash-square line gives the improved performance in terms of the bit error rate for the ultra wideband multiple access modulation system over standard gaussian derivative pulse shown by green dash-triangle line in the multipath channel environment of ultra wideband. Also the results obtained for UWB system model using Pulse Amplitude Modulation Direct sequence multiple access modulation scheme shows improvement over the case of Pulse Position Modulation Time Hopping multiple access modulation scheme.

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