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PULSE GENERATION AND ANALYSIS OF ULTRA WIDE BAND SYSTEM MODEL

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ABSTRACT

This paper gives an introduction to one of the revolutionary technology for wireless communication - Ultra-Wideband (UWB) radio. Ultra-Wideband (UWB) technology is loosely defined as any wireless transmission scheme that occupies a bandwidth of more than 25% of a center frequency, or more than 1.5GHz. Ultra wideband (UWB) technology, useful for both communication and sensing applications, uses the radio spectrum differently than the vast majority of radio communication technologies. UWB signaling has many attributes that make it attractive for a wide range of applications; from ultra-low-power RFID tags and wireless sensors to streaming wireless multimedia and wireless USB at greater than 1Gb /s. This chapter introduces MATLAB simulations of such system have been performed and the performance of such system due to different pulse shaping scheme is compared. Different spectra are produced and their properties are measured. Further study explores possible ways in suppressing the spectrum and means to quantify the spectrum.

INTRODUCTION

Bandwidth inadequacy has always been the bottleneck for the development of wireless communication systems as spectrum is a limited recourse and is becoming more valuable. New technologies aiming to allow new services to use already allocated spectrum to establish the services without causing significant interference to present users leads to the concept of Ultra Wideband (UWB) systems.

Ultra-Wideband (UWB) technology has been around since the 1980s, but it has been mainly used for radar based applications until now because of the wideband nature of the signal that results in very accurate timing information. However, due to recent developments in high-speed switching technology, UWB is becoming more attractive for low-cost consumer communications applications. Although the term *Ultra-Wideband* (UWB) is not very descriptive, it does help to separate this technology from more traditional “narrowband” systems as well as newer “wideband” systems typically referred to in the literature describing the future 3G cellular technology. In this paper, the underlying basic technology of WUB systems is briefly introduced. A simulated system model is then followed, the effect on Power Density Spectrum (PSD) employing data modulation and different pulse position scheme are described and compared.

UWB Technology Basic

As mentioned before, UWB send information through pulses. The pulses are sent one by one, after each other with a given pulse repetition frequency (PRF). The pulses have large bandwidth, which means that the energy of a pulse is spread over a wide frequency band whereas a carrier wave system concentrates the energy on a specific frequency. Comparing these two alternatives, it can be seen that a pulse based system can have a lower average output power per MHz than a carrier wave based system and hence does not disturb the carrier wave under simultaneous operation. The pulses can be created in different ways and have different characteristics. The basic element in UWB radio technology is the use of Gaussian monocycle as shown in figure 1. in both time and frequency

ISSN 1512-1232

domains. The monocycle with a narrow pulse width produces a wide bandwidth signal. The monocycle's width determines the centre frequency and the bandwidth. [1][2][3][4] .

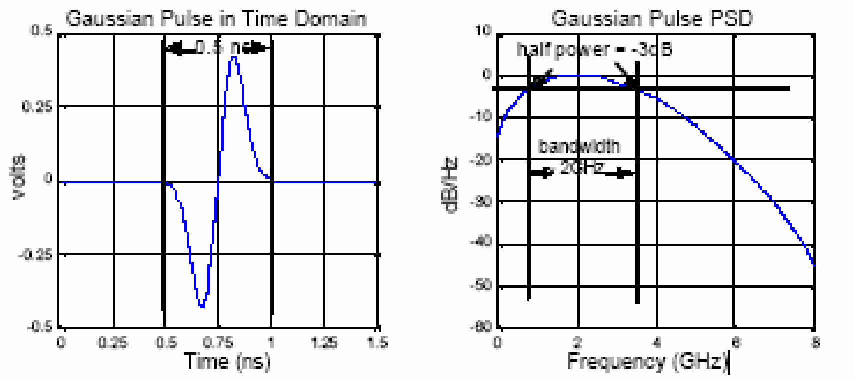


Figure 1: 2GHz centre frequency Gaussian Monocycle in time and frequency domains

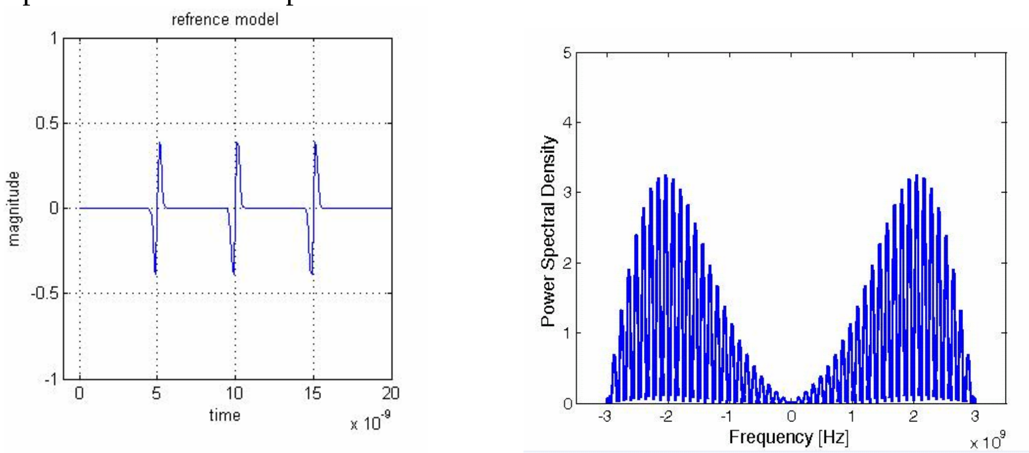
UWB System Model

As described earlier that UWB signals may be generated by a great variety of methods and the most popular pulse shape for UWB communication system is the Gaussian pulse or a derivative of the Gaussian pulse due to mathematical convenience and ease of generation. So my present work starts with generating the UWB signal by using the Gaussian pulse .The Gaussian pulse is defined as

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

UWB System Model construction

After generating a UWB signal an UWB mathematical model basing on Gaussian pulse train in time and frequency domain with MATLAB using Fast Fourier Transform (FFT) were made Figure 1.1(a) and 1.1 (b), with the following specifications For the Gaussian monocycle, the pulse duration is 0.5 ns and the centre frequency is 2GHz with the half power bandwidth approximately 2GHz. Hence, the centre frequency is the reciprocal of the monocycle's duration and the sampling frequency is 10GHz. [5][6] and then the effect on the spectrum by changing the pulse duration and/or repetition rate of each pulse were examined.



(a) **(b)**

Figure 1.1(a): UWB Reference model in time domain and 1.1 (b): UWB Reference model in frequency domain

Increasing the pulse rate

ISSN 1512-1232

The effect of increasing the pulse rate on the Spectrum is analysed. In this the pulse rate is doubled than the reference model constructed.

Increased Pulse Width

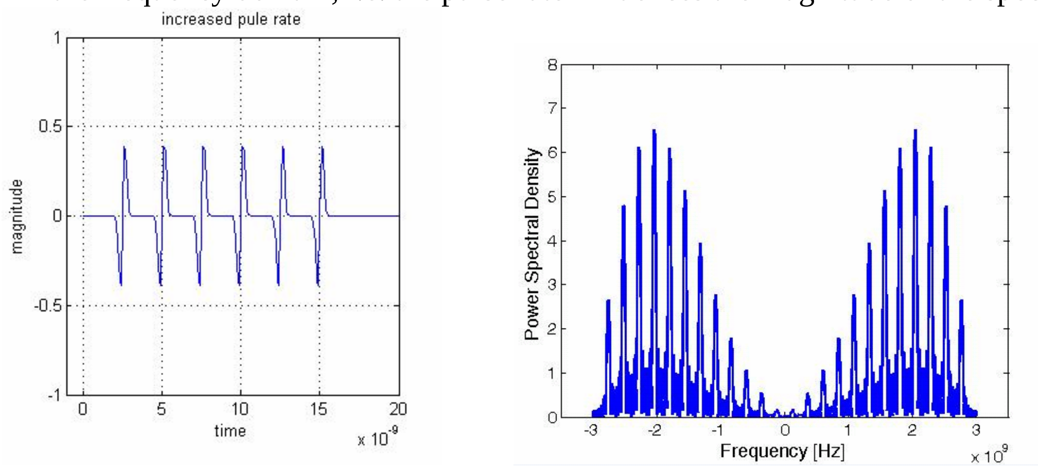
The effect of increasing the pulse width of System Model on the Spectrum is analysed. In this the pulse width is doubled than the reference model constructed.

A random pulse-to-pulse interval

The effect of taking the pulse at random intervals of time of System Model on the Spectrum is analysed.

The key findings from the simulated results are:-

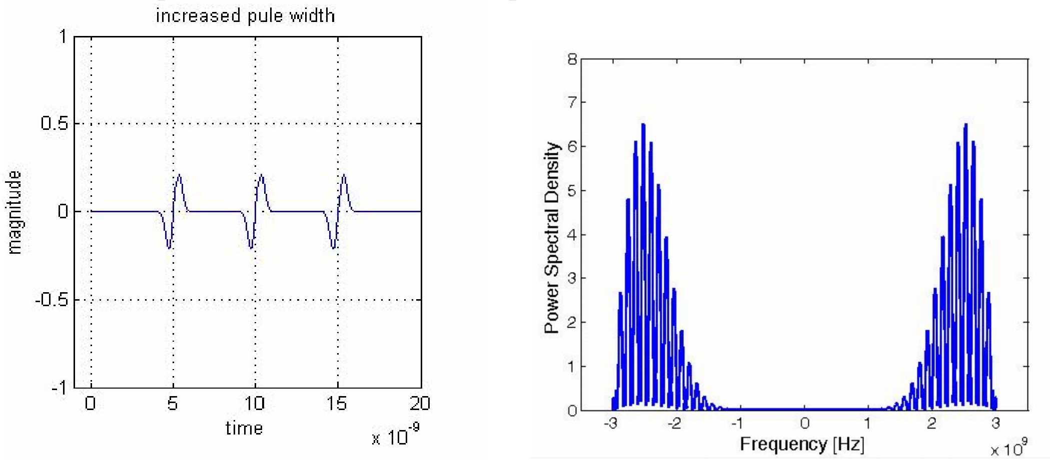
1. Figure 1.2(a) and (b): Increasing the pulse rate in the time domain increases the magnitude in the frequency domain, i.e. the pulse rate influences the magnitude of the spectrum.



(a) **(b)**

Figure 1.2(a): Increased pulse rate in time domain and 1.2 (b): Increased pulse rate in frequency domain

2. Figure 1.3(a) and (b): The lower the pulse duration in the time domain, the wider spectral width, i.e. the pulse duration determines spectral width.



(a) **(b)**

Figure 1.3(a): Increased pulse width in time domain and 1.3 (b): Increased pulse width in frequency domain

3. Figure 1.4(a) and (b): A random pulse-to-pulse interval produces a much lower peak magnitude spectrum than a regular pulse-to-pulse interval since the frequency components are unevenly spread over the spectrum; the additions of magnitude at the same are less

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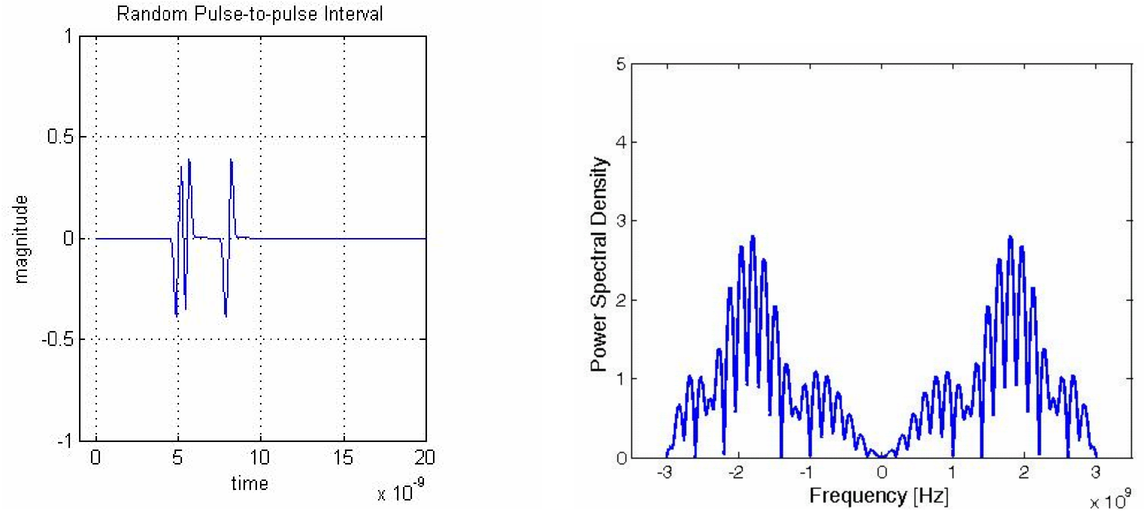
effective. Therefore Pulse-to-pulse interval controls the separation of the spectral components.



(a) (b)

Figure 1.4(a): Random pulse interval pulse in time domain and 1.4 (b): frequency domain

4. It was found that halving pulse rate halves the spectrum's magnitude; therefore alternating the pulse rate had a greater effect on the spectrum since. But lower pulse rate simply means less input power in transmitting less number of pulses, therefore lowering the pulse rate is not an efficient way in flattening the spectrum.

Conclusion

In this UWB technology basic is introduced and the effect of system performance by employing different pulse positioning schemes has been discussed. The ultra-wide band provided by the narrow monocycle implies a large modulation bandwidth and a high data transmission, together with low PSD, UWB radio system is well suited for wireless application. The ultra-low PSD generated by random pulses makes the signal appears as "white noise" in the "noise floor" to other radio frequency devices and therefore the already crowded spectrum can be re-utilised.

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