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A Review Multi path & Multiband-OfDM Based Ultra-Wideband MIMO Communication System

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ABSTRACT: We study the performance of Multi channel Transmission over the Multi path & Multiband-OfDM Based Ultra-Wideband MIMO Communication System over multiple-antenna fading channels with linear receivers. We show that, under iterative linear detection and decoding, one can achieve full diversity with a special class of space-time precoders. We then study the outage probability at the output of the linear detector that determines the theoretical performance of coded modulations with such receivers. Finally, symbol and word error rate performances under Monte Carlo simulations are reducing the power consumption and complexity of a multi band orthogonal frequency-division multiplexing (MB-OFDM) ultra wideband (UWB) system by applying ideas from pulsed UWB systems. The approach is quite general and applicable to many other systems. Unlike the MB-OFDM system, the enhancement that we propose uses pulses with duty cycles of less than 1 as the amplitude shaping pulse of orthogonal frequency-division multiplexing (OFDM) modulation. Pulsating OFDM symbols spread the spectrum of the modulated signals in the frequency domain, leading to a spreading gain that is equal to the inverse of the duty cycle of the pulsed sub carriers.

Keywords: Reduce complexity, Power consumption, Multiple-antenna

I. INTRODUCTION

We study the spectral characteristics of pulsed OFDM and the added degrees of diversity that it provides. We show that pulsed-OFDM signals can easily be generated by either up sampling an equivalent OFDM base band signal with a reduced number of carriers or by replacing the digital-to-analog converter (DAC) of a normal MB-OFDM transmitter with a low duty- cycle DAC. We establish that a pulsed-OFDM receiver can fully exploit the added diversity without using Rake receivers. It is shown that, while pulsed OFDM has superior or comparable performance to MB-OFDM in multi path fading channels, it also has intrinsic low-complexity and power consumption advantages compared with MB-OFDM. To establish this fact, we describe an example design for the IEEE 802.15.3a Standard and present full simulation results for the UWB indoor propagation channels provided by the IEEE 802.15.3a Standard activity committee. (UWB) receiver that uses a parallel autocorrelation front-end to separate a transmitted multi channel signal. The front-end calculates samples of the autocorrelation function of the received signal. Despite this nonlinear operation, a linear multiple-input multiple-output (MIMO) model can be found for the relation between the transmitted data symbols and the receiver outputs. According to the MIMO model, the sub channel data can be separated using well-known combiner structures. The nonlinear receiver front-end causes cross terms among the sub channel signals and the noise. It is shown that the MIMO model only holds if certain conditions for the mutual cross correlation of the sub channel signals are met. Violating this condition leads to a considerable number of performance-degrading cross terms. This thesis focuses on an analysis of the influence of the upsurge of wireless communication devices in our lives shows no sign of languor. The growing demand for high quality media and high-speed content delivery drives the pursuit for higher data rates in communication networks. Wireless personal area networks (WPAN's) are used to convey information over relatively short distances of about 10 meters among a relatively few participants. Unlike wireless local area networks (WLANs), WPAN's connections involve little infrastructure close to theoretical limit [2]. Higher code-rates can be achieved easily and hence reduce the complexity, power consumption and cost of the system implemented using codes. Also, UWB technology is used for short and medium range wireless communication networks with various throughputs including very high data rate applications. UWB communication systems use signals with a bandwidth that is larger than 25% of the center frequency or more than 500 MHz. The main issue of spectrum scarcity is overwhelmed by ultra-wideband technology.

UWB communication systems have advantages, including robustness to multi path interference and inherent support for location-aware networking and multi user access [3-4]. UWB communications transmit in a way that doesn't interfere largely with other more traditional narrowband and continuous carrier wave uses in the same frequency band. OFDM technique and its variations are widely used in several narrow-band systems. Pulsed-OFDM is a major UWB system that uses OFDM modulation in the UWB spectrum. The pulsation of the OFDM signal spreads its spectrum and provides a processing gain that is equal to the inverse of the duty cycle (less than 1) of the pulsed sub-carriers [1]. A pulsed- OFDM signal can easily be generated by up-sampling the output of an module in a normal OFDM system. Also, a low-complexity receiver is achieved for the pulsed-OFDM system that exploits the spreading gain provided by the pulsation to enhance the performance of the system in multi path fading channels [1]. In this paper MULTIPLE-ANTENNA techniques have been shown to provide high transmission rates over fading channels [1] and help in increasing the diversity order of signals over slow fading channels [2]. For un-coded systems, *i.e.* systems not employing error correction coding, achieving maximum diversity requires the use of space-time codes together with maximum likelihood (ML) receivers [3]. For coded systems, a posteriori probability detectors are required to recover maximum diversity at the receiver end [4-6]. In both cases, the complexity at the detector increases exponentially with the number of transmit antennas. On the other hand, linear receivers for un coded transmission over multiple-antenna quasi-static fading channels have been extensively studied [7-11], and the achieved diversity orders are far from being optimal even with full-rate space-time precoders [12-13]. With orthogonal space-time codes, linear receivers can achieve full diversity at the cost of low rate transmission [14]. In this work, we show that by concatenating coded modulations with full-rate space-time precoders, an iterative receiver can recover maximum diversity with a soft-input soft output (SISO) linear detector [15]. We then study the outage probability [14] of such receivers that provide an information theoretic lower bound on the performance and thus give insight MIMO system

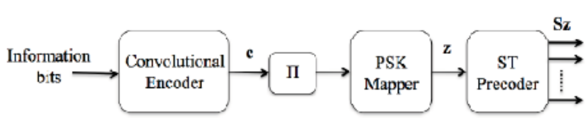


Fig. 1. ST-BICM encoder.

II.SYSTEM MODEL AND NOTATIONS

We consider a system transmitting via a space-time bit interleaved coded modulation [15] over a quasi-static frequency non-selective MIMO fading channel with transmit and receive antennas, *i.e.* a codeword undergoes one temporal channel realization. The channel model is written bit-interleaved coded modulations that achieve maximum diversity over a multiple-antenna channel with iterative linear receivers. We show that, assuming interference is totally removed between modulated symbols, the linear detector attains maximum diversity using a space-time rotation. Moreover, we show that, under specific properties of the space-time rotation, the channel decoder is capable of removing the interference between the transmitted symbols. The outage probability of these receivers is then studied in order to provide an information-theoretic bound on the performance. We finally show symbol and word error rate performances under Monte Carlo simulations. **U**LTRAWIDEBAND (UWB) communication systems use signals with a bandwidth that is larger than 25% of the center frequency or more than 500 MHz. UWB communication systems offer several potential advantages, including robustness to multi path interference and inherent support for location aware networking and multi-user access [1], [2]. UWB is the underlying technology behind several emerging military sensor and communication networks.

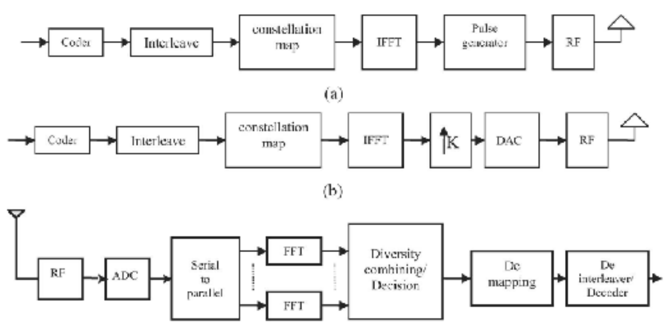
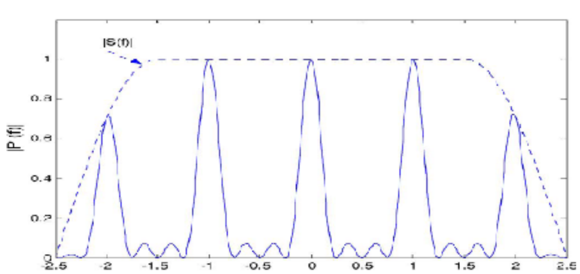


Fig. 2. Pulsed-OFDM transceiver structure.

A. OFDM Ultra-Wideband Systems

In the MB-OFDM scheme of [5-6], the whole available UWB spectrum is divided into several sub bands with smaller bandwidth. In each sub band, a normal OFDM symbol is transmitted, and then, the system switches to another sub band. Quadrature phase-shift keying (QPSK) modulation is used for OFDM.

The transmitted signal in this is the number of sub carriers in each OFDM symbol, and p(t) is a low-pass pulse with duration Tp. [16]. The QPSK symbol that is transmitted in the rth time slot and over the kth sub carrier is denoted by br k. The sub carrier spacing is denoted by f0 and is equal to 1/Tp. Sequence c(r) controls frequency hopping between sub bands. To spread the spectrum of the transmitted signal, the pulsed-OFDM system modulates the OFDM signal with a regular train of pulses with low duty cycle. Specifically, an MB-pulsed-OFDM signal can be presented with a similar formula as the MB-OFDM signal In the preceding equation, s(t) is a mono pulse with duration Ts, and T is the pulse separation time, which is larger than Ts. The number of mono pulses is denoted by N and is the same as the number of sub carriers for the OFDM modulation. This number will be chosen, such that the total bandwidth of the pulsed-OFDM signal becomes equal to that of the nonplused-OFDM signal. Note that the MB-pulsed-OFDM system does not change the multi band structure of the MB-OFDM system. The change is in the transmitted signal within a sub band. The pulsed OFDM can simply be generated by replacing the DAC in an OFDM transmitter with a pulse train generator. The generator produces amplitude-modulated pulses with duty cycles of less than 1. If the inverse of the duty cycle is integer, the same signal can also be generated by up sampling the digital base band OFDM modulated signal before sending it to a conventional DAC. The up sampling is done by inserting K − 1 zeroes between samples of the signal. The resulting pulsed- OFDM signal is then a pulse train with a duty cycle of 1/K. Since this kind of pulsed-OFDM system can easily be implemented with a simple change in a normal OFDM transmitter, we shall retain it in the remainder of this paper. We also refer to parameter K as the processing gain of the pulsed-OFDM system. Both transmitter structures Pulsed-OFDM Signal Spectrum The spectrum of the pulsed-OFDM signal is easily derived from the impulse response s(t) of the DAC or, equivalently, from pulse train p(t). Specifically, following [9, p. 208], we have



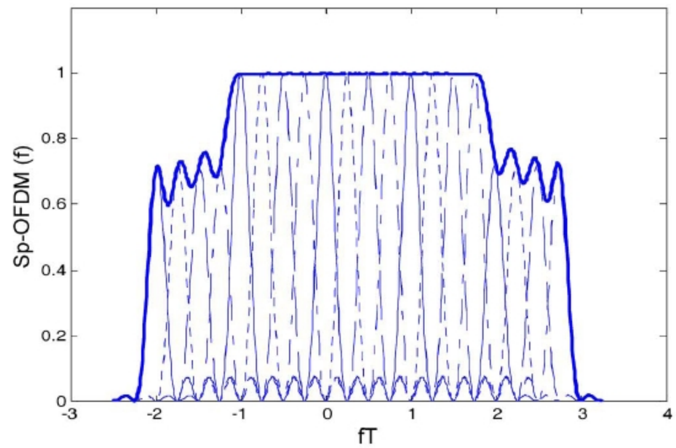


Fig. 3. (a) Spectrum of a pulse train with N = 4 pulses per train and a duty cycle of 1/4. (b) Spectrum of the corresponding pulsed-OFDM signal.

$$S_{\text{POFDM}}(f) = \sum_{n=0}^{N-1} \left| P\left(f - \frac{n}{NT}\right) \right|^2$$

where P(f) is the Fourier transform of p(t), which, by taking Fourier transform from both sides of (2), is given by

$$|P(f)|^2 = |S(f)|^2 \frac{\sin^2(\pi N fT)}{\sin^2(\pi fT)}.$$

the spectrum of a pulse train with rectangular mono pulses, where the number of pulses is equal to N = 4, the duty cycle is 1/4, and the spectrum of the corresponding pulsed-OFDM signal has N = 4 sub carriers. Equations (3) and (4) show that the bandwidth of a pulsed-OFDM signal with a symbol rate of 1/T and a processing gain of K is approximately equal to (K + 1)/T . The actual shape of the spectrum within this bandwidth depends on the impulse response of the DAC, and design optimization can be performed to make it as flat as possible. An alternate approach in calculating the spectrum of the pulsed-OFDM signal gives us more insight about the spreading properties of pulsed OFDM. As noted before, the pulsed- OFDM signal is generated by up sampling a normal OFDM signal by a factor of K, and it is well known that the up sampling process spreads the frequency of the signal over a band that is K times larger than the original by repeating the original signal spectrum in the frequency domain [7]. Therefore, we can compute the spectrum of the pulsed-OFDM signal.

B. Fundamentals of UWB Technology

Ultra wide bandwidth (UWB) transmission systems have gained significant interest in the scientific, commercial and military sectors over the last decade. A 2002 ruling by the US Federal Communications Commission (FCC) allows for coexistence of UWB systems with traditional and protected radio [13] services, and enables the potential use of UWB transmission without allocated spectrum. Wide bandwidth provides fine delay resolution, robustness against fading, and superior obstacle penetration, making UWB technology a viable candidate for reliable communications and accurate positioning in challenging environments, such as urban canyons and forests. UWB transmission systems potentially allow low-cost production and reuse of already populated spectra; and hence they are currently under consideration for communications and localization in a wide variety of applications. With its low probability of detection and anti-jam capabilities, UWB also has applications in military [11] and homeland security operations. UWB, or Ultra-Wide Band technology offers many advantages, especially in terms of very high data transmission rates which are well beyond those possible with currently deployed technologies such as 802.11a, b, g, WiMax and the like. As such UWB, ultra wideband technology is gaining considerable acceptance and being proposed for use in a number of areas. Already Bluetooth, Wireless USB and others are developing solutions, and in these areas alone its use should be colossal. As the name implies UWB, ultra wide band technology, is a form of transmission that occupies a very wide bandwidth. Typically this will be many Gigahertzes, and it is this aspect that enables it to carry data rates of Gigabits [12] per second. The fact that UWB transmissions have such a wide bandwidth means that they will cross the boundaries of many of the currently licensed carrier based transmissions. As such one of the fears is that UWB transmission may cause interference. However the very high bandwidth used also allows the power spectral density to be very low, and the power limits on UWB are being strictly limited by the regulatory bodies. In many instances they are lower than the spurious emissions from electronic apparatus that has been certified. In view of this it is anticipated that they will cause no noticeable interference to other carrier based licensed users. Nevertheless regulatory bodies are moving forward cautiously so that users who already have spectrum allocations are not affected.

III. CONCLUSION

Pulsed-OFDM is a combination of the benefits of MIMO codes and pulsed-OFDM, utilizing the ultra-wideband spectrum to efficiently achieve a comparable performance under different code rates and has achieved a bit-error-rate nearly 10-5. The system provides frequency spreading and diversity in multi path fading channels. By replacing the convolution encoder and puncture in the Pulsed-OFDM system and using MIMO encoder, we designed a system for the WPAN utilizing the UWB channel conditions with reduced complexity, reduced power consumption. Since, QPSK is used, the maximum achievable SNR is 6dB to 8dB. To enhance SNR up to 16dB for different code rates, amplitude-phase shift keying (APSK) could be used Also, data rates of more than 1Gbps could be achieved using MIMO.

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