A Simple Modified M-ary TH-PPM Ultra Wideband Communication system

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Abstract

A modified M-ary time hopping pulse position modulation (TH-PPM) ultra wideband communication system is proposed in this paper. The system performance over additive white Gaussian noise (AWGN) channel is evaluated in the condition of perfect time synchronization and correlation receiver. In this system, the modified M-ary modulation is obtained by combining signal partitioning with the pulse position modulation. Three signal partitioning, Ungerboeck Partitioning (UP), Block Partitioning (BP) and Mixed *Partitioning (MP), are investigated in this work. The modified scheme can make no increment in system* complexity compared to the conventional M-ary time hopping pulse position modulation. To some extent, it can improve the system performance. The computer simulation and analysis shows that the modified M-ary TH-PPM system outperforms the conventional M-ary TH-PPM system.

Keywords? Ungerboeck Partitioning (UP), Block Partitioning (BP) and Mixed Partitioning (MP), Ultra wideband (UWB).

I. Introduction

Ultra Wideband communication system, proposed in [1] [2], has attracted considerable interests recently in indoor high rate communications. In UWB system, data bit is transmitted using sub-nanosecond baseband pulses without the need for mixers, and the occupied frequency band is about several gigahertzes. UWB technology can achieve high throughput and is robust to co-channel interference and narrowband jammers and has a greater ability in realizing spectrum sharing. High capacity can be achieved with much lower transmission power levels. UWB technology also has promising features to improve the multipath resolvability.

The High data rate and the high transmission quality are the two key requirements for the modern wireless communication systems. In this paper, without changing the pulse shape and the transmission bandwidth, an M-ary modulation method based on the mapping strategies of the pulse position modulation is proposed, whose transmission bit rate is improved by a factor *log2M* compared to the traditional TH-PPM UWB system [2].

The organization of this paper is as follows. In Section II, an overview of the M-ary TH-PPM UWB system model is provided and the performance analysis is given in detail over AWGN channel. Section III presents our proposed modified M-ary TH-PPM UWB system. Section IV describes *the simulation results obtained and interpretations. Finally,* conclusions are presented in Section V.

II. DS UWB System Description

In [3], the conventional M-ary TH Pulse Position Modulation (TH-PPM) UWB communication systems is proposed over AWGN channel. The performance analysis of the M-ary TH-PPM UWB system is presented in this section. The transmitter of M-ary TH-PPM UWB system is shown in Fig.1. Assume in the single use case that each user has a unique pseudorandom time hopping code sequence $\{c_k\}$, which has the period N_p and the value located in the range $0 \le c_k \le N_h$. A typical transmitted signal of the desired user can be expressed as

$$s_{tr}(t)=\sum_{k=0}^{\infty} w_{tr}(t-kT_f-c_kT_c-\delta^k_{d_{\lfloor k/N_s \rfloor}}), \qquad (1)$$

where $w_{tr}(t)$ is the transmitted monocycle waveform, seen in [1], $\{d_j\}$ is the binary information bit, N_s is the pulse repetition time. The time-hopping sequence $\{c_k\}$ has the characteristics with cardinality N_c and periodicity N_p. T_c is the time shift of the time hopping chip and the time shift corresponding to the data modulation is $\delta^k_{d_{\lfloor k/N_s \rfloor}} \in \{\tau_1,\tau_2,...,\tau_M\}$. The data sequence $\{d_m\}$ carrying the information is an M-ary symbol stream with $1 \le d_m \le M$.

The transmitted signal can be further written as

$$s_{tr}(t)=\sum_{m=0}^{\infty} S_{d_m}\left(t-mN_sT_f-P_m(t)\right)=\sum_{m=0}^{\infty} v_{m,d_m}(t) \quad , \qquad (2)$$

where $S_i(t)=\sum_{k=0}^{N_s-1} w_{tr}\left(t-kT_f-\delta_i^k\right)$ and

$$P_m(t)=\sum_{k=mN_s}^{(m+1)N_s-1} T_c c_k p\left(t-kT_f\right), \qquad (3)$$

with $p(t)=\begin{cases}1, & \text{if } 0 \le t \le T_f \\ 0, & \text{otherwise}\end{cases}$.

An ideal channel and antenna system is known to modify the shape of the transmitted monocycle $w_{tr}(t)$ to $w_{rec}(t)$ at the output of the receiver antenna. For the purpose of analysis, we have assumed that the true transformed pulse shape $w_{rec}(t)$ is known at the receiver.

The normalized pulse correlation function is written as: