ISSN 2229-5518

Literature Survey for Performance evaluation of various time hopping ultra-wideband communication system

S.Srimathi, P.Kannan

Abstract— Performance evaluation of time-hopping UWB using various modulation techniques has been proposed. Then the performance improvement is analysed based on the BERs of various existing methods. Recently a new method called TH-BPSK UWB system is proposed which provides a better performance than all other existing systems. The literature survey discusses all the existing techniques of UWB communication.

Index Terms— time hopping, ultra wideband communication, code division multiple access system, spread spectrum, multiuser interference, pulse position modulation, binary phase shift keying.

◆

1 Introduction

In a spread spectrum system, the transmitted signal will occupy extremely larger bandwidth even in the absence of data modulation. In this case ,a signal is transmitted with a bandwidth much larger than the data modulation bandwidth &with reduced power spectral density. The key motivations for using TH-SS impulse radio are the ability to highly resolve multipath and to generate UWB signals with relatively low complexity.

An UWB-TH CDMA system employing a binary pulse position modulation signaling has been introduced. Here a data is transmitted using short pulses with duration less than 1ns. This technique is called impulse radio (IR). The BER performance of TH-PPM in the presence of MUI and AWGN channel based on Gaussian Quadrature Rules is proposed. It is done to improve the performance of multilevel digital signals with ISI.

Several modulation techniques have been proposed for UWB signals such as PPM, PAM, BPSK. But currently TH-PPM & TH-BPSK UWB system are often used . The performance of both the systems are analysed and compared using different pulse parameters.

2 LITERATURE REVIEW

2.1 Ultra wide bandwidth time hopping spread spectrum

Moe Z. Win & Robert A. Scholtz (1) proposed a spread spectrum system for high data rate transmission using ultra wide bandwidth communication. The SS radio system does not use a sinusoidal carrier to raise the signal to a frequency band in which the signal propagate well but instead communicates with a time hopping (TH) baseband signal composed of sub nanosecond pulses. The TH-SS impulse radio is used because of its ability to resolve multipath and to generate UWB signals with relatively low complexity.

A time hopping k^{th} impulse radio transmitter output signal is given by (1)

$$s_{tr}^{(k)}\left(u,t^{(k)}\right)=\sum_{j=-\infty}^{\infty}w_{tr}(t^{(k)}-jT_f-c_j^{(k)}T_c-d_j^{(k)}(u))\quad(1)$$

Where $t^{(k)}$is the transmitter clock time &$w_{tr}^{(t)}$represents the transmitted monocycle waveform.

When N_u transmitters are active in the multiple access system,the received signal at the output of this receiver antenna is modeled as (1)

$$r(u,t)=\sum_{k=1}^{N_u}A_k\left(u,t-\zeta_k(u)\right)+\eta(u,t)\quad(2)$$

Where N_u is the number of active users,A_k & ζ_k are the channel attenuation and delay.

2.2 Multiple access system with coded and uncoded schemes

Amir R. Forouzon, Masoumeh Nasiri Kenari and Jawad A. Salehi (3) proposed an ultra wide bandwidth time hopping spread spectrum code division multiple access system which employs a binary pulse position modulation (PPM) signaling. Here in this system ,a data is transmitted using short pulses with duration less than 1ns. This technique is called impulse radio (IR).In a uncoded scheme, every transmitter sends N_s pulses for each data bit. These pulses are located apart in sequential frames, each with a duration T_f. Here a BPPM is used in which the pulses corresponding to 1 bit are sent δ seconds later than pulses corresponding to bit 0. The transmitter signal of user k is (3)

$$s_{tr}^{(k)}(t)=\sum_j w_{tr}(t-jT_s-C_j^{(k)}-\delta\, d_j^{(k)})\quad(3)$$

Where the index j indicates the frame number, $w_{tr}(t)$ repre-

---

- *Srimathi.S is currently pursuing masters degree program in Communication Systems in Anna University, Chennai, India, PH-9442234688. E-mail: srimathi.shri@gmail.com.*
- *Kannan.P is currently a Professor in PET engineering in Vallioor.*

sents the transmitted pulse & $C_j^{(k)}$ is the dedicated pseudorandom sequence for user k with integer components.

The transmitted signal is transmitted through a free space propagation channel with AWGN to the receiver. The received signal of the k^{th} user at the receiver antenna output is (3)

$$S_{rec}^{(k)}(t) = \sum_j W_{rec}(t - jT_f - C_j^{(k)}T_c - d_j^{(k)}) \quad (4)$$

Where $W_{rec}(t)$ is the received pulse with duration T_w. The total received signal is (3)

$$r(t)=\sum_{k=1}^{N_u} A_k\, S_{rec}^{(t)}(t-\zeta_k) + \eta(t) \quad (5)$$

where $N_u$is the no of active users A_k & ζ_k are the channel attenuation delay.

In a coded sheme , a simplified repetition block code with rate $1/N_s$ is used. This repetition code is not a good code. So a near optimal code is used instead of the above code. It provides better system performance.

2.3 TH-PPM UWB system in the presence of multiuser interference

G.Durisi and S.Benedetto (2) proposed a time hopping combined pulse position modulation for UWB systems. A Gaussian Quadratue Rules (GQR) are used to the BER performance of TH-PPM in the presence of MUI and AWGN channel.

The information bit is transmitted using N_s consecutive pulses leading to a (N_s , 1) repetition code. These informations are transmitted through an ideal free space propagation, AWGN channel and then the received signal is given by (2)

$$y(t)=s^l(t-\zeta 1) + \sum_{k=2}^{N_u} s^k(t-\zeta_k) + \eta(t) \quad (6)$$

where ζ_k for k=1,…..$N_u$is the delay associated to each user & $\eta(t)$ is a white Gaussian noise process with two sided power spectral density $N_0/2$.

2.4 Performance evaluation of TH-PPM & TH-BPSK UWB systems

Bo Hu and Norman C.Beaulieu compare the performance analysis of the TH-BPSK UWB systems. Here first the performance analysis of the TH-PPM UWB system with multiple access interference (MAI) is considered. An information bit $d_i^{(k)}\mathcal{E}\{0,1\}$ is used in this modulation scheme, no additional time shift modulates the pulse p(t) when the data is 1. The template waveform v(t) is of the form (4)

$$V(t)=p(t)-p(t-\delta) \quad (7)$$

The correlation of the template v(t) with a time shifted pulse is (4)

$$R(x)=\int_{-\infty}^{\infty} p(t-x)\, v(t)\, dt \quad (8)$$

The interfering signal is given by (4)

The waveform used in TH-BPSK sytem is the pulse p(t). The decision stastistic γ_{BPSK} is then given by (4)

$$\gamma_{BPSK} = S_{BPSK} + I_{BPSK} + \eta_{BPSK} \quad (9)$$

Where η_{BPSK} is a Gaussian noise with zero mean and variance $\sigma_{\eta_{BPSK}}^2 = N_0 N_s^2/(2E_b)$

$$S_{BPSK} = d_0^{(1)} A_1\, N_s \quad (10)$$

I_{BPSK} is the total MAI in the TH-BPSK UWB system which is given by. (4)

$$I_{BPSK} = \sum_{k=2}^{N_u} A_k [\sum_{j=0}^{\gamma_k - 1} d_0^{(k)} R(\theta_j^{(k)}) + \sum_{j=\gamma_k}^{N_s-1} d_1^{(k)} R(\theta_j^{(k)})] \quad (11)$$

Where $\theta_j^{(k)} = \propto_k + \theta_j^{(k)} T_c$.

2.5 Soft limiting receiver

Norman C. Beaulieu and Bo Hu [5] proposed a soft limiting receiver structure for detecting a time-hopping ultra wide-bandwidth signal in the presence of multiple-access interference (MAI). The receiver has a nonlinear limiter for suppressing the MAI. This soft limiting receiver provides better performance than the correlation receiver. The gain of this receiver varies from around 10db at small values of signal to interference ratio (SIR) to 0db as the SIR becomes infinitely large.

A second receiver structure has an adaptive soft limiter. The performance of this adaptive threshold soft-limiting receiver with optimized threshold always meets or exceeds both that of conventional matched filter receiver and that of the soft limiting receiver with fixed threshold.

2.6 SNR and SIR Estimation

Yunfei Chen, Norman C. Beaulieu and Hau Shao (6) proposed the estimation of signal to noise ratio (SNR) and signal to interference ratio (SIR) for multiuser time hopping binary phase shift keying using the moment based method. The soft limiting receiver requires the knowledge of SNR & SIR in order to choose the optimum thresholds for detection. Therefore the SNR & SIR for TH-UWB IR systems are estimated with multiple users. These estimators can estimate the SNR , when there is no MAI or the SIR , when the noise is negligible. The estimators are examined in terms of the normalized root mean squared error (NRMSE),(7) defined as the square root of the sample mean squared error divided by the true value. The SNR & SIR estimators have NRMSEs of less than 0.2 in most cases.

3 Conclusion

In this paper, a brief literature survey for performance evaluation of various TH-UWB systems is discussed elaborately .TH spread spectrum , TH-spread spectrum coded & uncoded schemes, TH-PPM & TH-BPSK UWB systems are compared. Among this TH-BPSK UWB system provides better performance than other modulation schemes. The simulation results of performance between TH-BPSK and TH-PPM UWB systems are shown in fig.1.

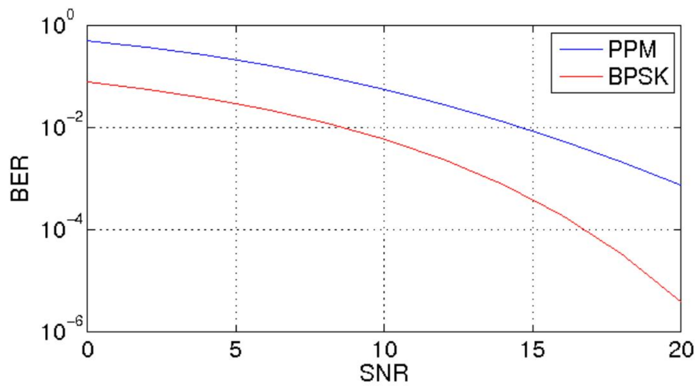

Fig.1. Comparison performance between TH-BPSK and TH-PPM UWB system models with our analytical approach.

Acknowledgment

Apart from the efforts of me, the success of my depends largely on the encouragement and guidelines of many others. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this work. I would like to extend my sincere thanks to all of them. I owe a sincere prayer to the GOD for his kind blessings and giving me full support to do this work. I wish to take this opportunity to express our gratitude to all, who helped me directly or indirectly to complete this paper.

REFERENCES

[1] M.Z. Win and R.A.Scholtz, "ultrawide bandwidth spread spectrum impulse radio for wireless multiple- access communications" IEEE Trans. Commun..,vol.48,pp.679-691,Apr .2000

[2] G.Durisiand S.Benedetto,"Performance evaluation of TH-PPM UWB systems in the presence of multiuser interference," IEEE Commun., Lett., vol.7,pp.224-226,May 2003.

[3] A.R. Forouzan, M.Nasiri-Kenari, and J.A. Salehi, " Performance analysis of time hopping spread-spectrum multiple-access systems; uncoded and coded schemes," IEEE Trans. Wireless Commun., vol.1, pp.671-681 Oct .2002.

[4] B.Hu and N.C. Beaulieu, " Accurate evaluation of multiple access performance in TH-PPM and TH-BPSK UWB systems," IEEE Trans. Commun., vol.52, no. 10, pp.1758-1766,Oct.2004.

[5] N.C.Beaulieu and B.Hu,"soft- limiting receiver structure for time-hopping UWB in multiple access interference ," IEEE Ninth International Symp. Spread Spectrum Techniques Appl.,2006.

[6] Y.Chen, N.Beaulieu and H.S.hao,"SNR and SIR estimation for multiuser UWB IR systems with TH-BPSK," IEEE Signal Process. Lett., vol.17 no.5, May 2010.

[7] Y.Chen and N.C.Beaulieu , "SNR estimation methods for UWB systems," IEEE Trans. Wireless commun.,vol.6, pp.3836-3845,Oct.2007.