

NON COHERENT METHOD OF ULTRA-WIDEBAND

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Abstract- This paper summarize the current non-coherent ultra-wideband system. The energy detection PPM system, PAM system, Gaussian FSK system, pulse width modulation system. Among these system, Gaussian FSK system has the best performance than the other systems. However, it s implementation needs high-order pulse generators. Pulse width modulation system does not need so high-order derivative pulse generator, but it s performance is worse than Gaussian FSK system.

Keywords – Ultra-Wideband Communications; Energy detection ; Non-coherent;

I. INTRODUCTION

Ultra-wideband Communication (UWB) technology is a promising technology for many applications, such as short-distance and high-speed wireless internet, covert communications, ground penetrating radar, through-wall image, and localization [1]. UWB signals convey information by transmitting short pulses. The modulation can be achieved by changing the amplitude and position of the pulses. The popular method includes Pulse Position Modulation (PPM) and Pulse Amplitude Modulation (PAM) and Pulse Width Modulation (PWM) and pulse Derivative Modulation. The receiver can use coherent or non-coherent method to recover the signals.

The coherent method can achieve the better performance than non-coherent system. However, it needs accurate synchronization. Due to the difficulty to achieve the accurate synchronization error, the actual performance of coherent method is worse than non-coherent method.

This paper will introduce several non-coherent UWB systems in the following.

II. THE MODULATION OF PPM

The modulation of PPM can be achieved as [2]

$$s(t)_{PPM} = \sum_j \sqrt{E_p} p(t - jT_f - \delta b_j) \quad (1)$$

Where δ is called the modulation index, and the pulse position shift is determined by δb_j . When δ is 0, no position shift of the pulse occurs. When δ is 1, the pulse is shifted to another position. So the modulation is achieved by changing the pulse position.

The receiver of the PPM system can use coherent or non-coherent methods. The coherent method uses Rake receiver to recover the signal. In Rake receiver, every finger performs a correlation operation using a local template to correlate the received signals. The energy is summed over multiple fingers. The Rake receiver has better performance than non-

coherent method, but it needs very accurate time to align the template signal with the received signal. It is not easy to achieve this alignment in UWB system due to ultra-short pulse period.

The non-coherent receiver of PPM can use energy detection receiver. The energy detection system passes the signal through a filter, and then a square operation. The signal energy is collected over the first and the second frame period, respectively. And then the energy is compared to determine the transmitted bit is 0 or 1. The performance of energy detection PPM system is suboptimal to coherent receiver, but it does not accurate synchronization to align the local template signal with the receiver signal. So it reduces the complexity.

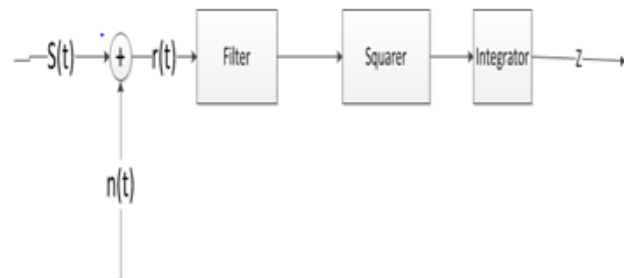


Figure 1. the receiver structure of the PPM system

III. THE MODULATION OF PAM

The pulse amplitude modulation (PAM) system is as [3]

$$S(t)_{GFSK} = \sum_j \sqrt{E_p} b_j P(t - jT_f) \quad (2)$$

Where b_j denote different amplitude. Bit 0 and 1 will use different amplitude to adjust the pulse. For no-coherent UWB system, the transmitted pulse amplitude can be 1 and 0. When data 1 is transmitted, a pulse is sent. When data is 0, no pulse is sent. The receiver structure is similar to Figure1. The

Publication History

Manuscript Received : 1 March 2014
 Manuscript Accepted : 18 March 2014
 Revision Received : 25 March 2014
 Manuscript Published : 30 April 2014

receiver compares the energy to a threshold. When it is greater than a threshold, the transmitted bit is 1. Otherwise, it is 0.

IV. GAUSSIAN FSK MODULATION

In [4], a new energy detection UWB system based on detect the different-order derivative of the Gaussian pulse is proposed. This new modulation is called Gaussian FSK modulation. This new system achieves modulation by using different-order derivative of the Gaussian pulse. The spectra of these pulses are separated entirely in frequency domain. So at the receiver side, it uses two filters with different passband frequency to separate the signal. This system does not suffer from the synchronization error and cross-modulation interference as PPM, so it achieves great performance improvement.

$$S(t)_{GFSK} = \sum_j \sqrt{E_p} (b_j P_1(t - jT_f) + (1 - b_j) P_2(t - jT_f)) \tag{3}$$

Where b_j is the transmitted bit. If it is 1, pulse $P_1(t)$ is transmitted. Otherwise, $P_2(t)$ is transmitted.

The receiver of this system has two energy detection branches. Every branch only can pass the signal energy of one pulse, either $P_1(t)$ or $P_2(t)$. The implementation of Gaussian FSK system needs high-order pulse generators. Currently, there are already many methods to provide high-order pulse generator.

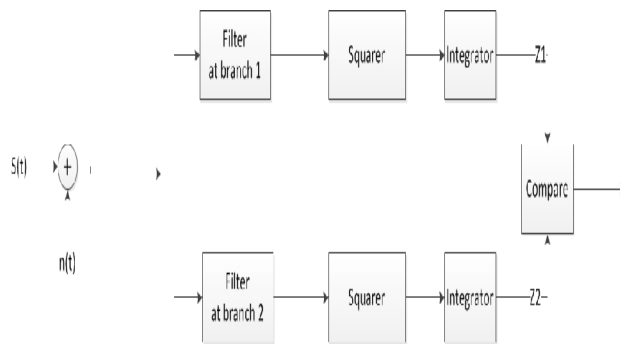


Figure 2 . The receiver structure of Gaussian FSK system

V. PULSE WIDTH MODULATION

The pulse width modulation transmit bit 0 or 1 by using pulse with different width [5]. The modulation is as

$$S_{PWM}(t) = \sum_j \sqrt{E_p} p_{b_j}(t - jT_f) \tag{4}$$

Where p_{b_j} denote the pulse with different width. When different bit b_j is transmitted, the pulse will be different. The spectra of the wide pulse is half of the narrow pulse. So the receiver can use the similar structure as Figure 2. The passband frequencies of the two filters will pass half of the

spectra of the narrow pulse. Because the spectrum of the wide pulse falls on the left half of the narrow pulse. So it can be separate.

The pulse width modulation system also can achieve better performance than the PPM system. When compared to energy detection Gaussian FSK system, it does not need so high-order pulse generator. Its performance is worse than energy detection Gaussian FSK system.

VI. CONCLUSION

The non-coherent UWB system is more and more popular due to its simple structure. Currently, there are four non-coherent UWB systems, energy detection PPM UWB system, energy detection PAM UWB system, energy detection Gaussian FSK UWB system, energy detection pulse width modulation system. Among these system, energy detection Gaussian FSK system has the best performance. The implementation of Gaussian FSK system needs high-order pulse generators. The energy detection pulse width modulation does not need so high-order pulse generator as Gaussian FSK system, but its performance is worse than Gaussian FSK system. Energy detection PPM UWB system suffers from synchronization errors and cross-modulation interference, so its performance is worse than Gaussian FSK and pulse width modulation systems.

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