Delay-Locked Loop (DLL) in Ultra-Wideband (UWB) Pulse Position Modulation (PPM) System

Weihua Zhang*, Hanbing Shen*

Zhiquan Bai*, Kyung Sup Kwak*

*UWB Wireless Communications Research Center (INHA UWB-ITRC), Inha University

Tel: +82-32-864-8935, Fax: +82-32-876-7349

E-mail: zhweihua2000@hotmail.com, shen_ice@hotmail.com

sdzqbai@hotmail.com, kskwak@inha.ac.kr

Abstract

Recently Ultra-wideband (UWB) radio has been paid large attention because it transmits data using sub-nanosecond baseband pulses with very low duty cycle. It has been a promising candidate for short-range communications and it is also been adopted in relative distance measurement for a long time. However, due to the short duration of the impulse signal, very precise synchronization control is vital for the whole system. Early-late delay-locked loop (DLL) has been proposed in some papers to achieve frame synchronization. In this paper, an improved early-late DLL is introduced to the UWB system with time hopping /spread spectrum (TH/SS). Instead of using only two central correlator branches in the DLL as the conventional systems, more correlator branches with different delay parameters and different weight parameters are adopted. Lower tracking jitter and higher mean time to lose lock (MTLL) than the conventional systems can be achieved from proposed ones. Performance of several different combinations of correlator parameters are evaluated in this paper and some of them perform superior to that of the conventional DLLs.

I. Introduction

Recently, Ultra-wide band (UWB) radio systems are considered as an excellent candidate for next-generation short-distance, low power consumption, and high data rate wireless indoor communications [1], [2]. Specifically, as a communication or measurement system, UWB is allowed to operate in the frequency range from 3.1 to 10.6 GHz, and occupy a very wide bandwidth of at least 500 MHz with an effective isotropic radiated power (EIRP) level of less than -41.3 dBm, as seen in FCC spectral mask for UWB system announced by Federal communications Commission (FCC) on 14 February and released in April, 2002 [3]. According to FCC's reports, the bandwidth of UWB is quite large and it can offer such a kind of ability to transfer high data rate up to several hundruds Megabits. The short pulse waves with large bandwidth also make it possible to measure the relative distance between the UWB terminals accurately.

As the narrow time duration of the pulse waveforms, tracking timing error, which is the timing shift from the correct one to achieved one by DLL, will make the degradation of system performance enlarged. Some papers have researched the performance of DLL in UWB-IR systems and some new DLL schemes are proposed to achieve better performance. The well-known delay locked loop (DLL) [4], [5] can be used in UWB direct sequence / spread spectrum (DS/SS) system. While, for a time hopping / spread spectrum (TH/SS) system, a novel DLL is developed [6], [7] and the performance is evaluated [8]. An adaptive DLL algorithm for UWB-IR transmission in multipath scenarios is proposed [9]. Otherwise, the performance of a conventional DLL in the UWB distance measurement system is evaluated [10].

This research was supported by university IT Research Center Project (INHA UWB-ITRC), Korea.

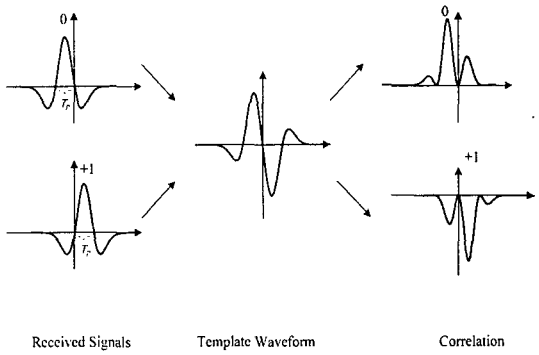

Fig. 1. Demodulation Scheme of TH PPM UWB

In this paper, an improved DLL design method will be proposed to achieve a better performance in UWB-IR system, espicially in TH/SS system. New correlator branches with different delay parameters and different weight parameters will be applied. The analysis and simulation results certify that proposed DLLs with carefully-choosen parameters superior to the conventional ones.

The remainder of this paper is organized as follows. Section II describes the conventional UWB-IR (TH/SS) system model and the DLL in UWB TH/SS systems. In Section III, conventional DLL and proposed one are analyzed and compared by their discriminator characteristics. Conventional DLLs and proposed ones with different parameters will be analysed and compared in Section IV, where both the simulation results of tracking jitter viarance and mean time to lose lock are considered. Some concluding remarkd and future works is given in Section V.