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LOW-COMPLEXITY DATA-AIDED TIMING ACQUISITION FOR TIME HOPPING UWB IMPULSE RADIOS

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Abstract. Timing acquisition is critical to enabling the potential of ultra-wideband impulse radios in high-speed, short-range indoor wireless networking. To this end, optimum data-aided timing offset estimators are derived in this paper based on the maximum likelihood (ML) criterion. A generalized likelihood ratio test (GLRT) is employed to detect an ultra-wideband waveform propagating through dense multipath, as well as to estimate the associated timing and channel parameters in closed form. In a data-aided mode, the GLRT boils down to amplitude estimation, where the impact of time hopping (TH) is captured by channel-dependent amplitudes of frame-rate correlator output samples and estimated via conditional ML formulation. The desired timing information can then be recovered from the amplitude fluctuation pattern in the presence of TH. The proposed algorithms only employ digital samples collected at a low *frame rate*, thus reducing considerably the implementation complexity and acquisition time.

Keywords. ultra wideband communications, timing recovery, data-aided acquisition, maximum likelihood estimation, generalized likelihood ratio test

1 Introduction

Ultra Wideband (UWB) communications have attracted increasing interest for commercial use with the release of the UWB spectral masks by US Federal Communication Commission (FCC) in 2002. Conveying information over repeated ultra-short (nanosecond scale) pulses with low transmission power density [1], UWB impulse-like radio comes with many beneficial features: ability to exploit the large diversity gain inherent in highly frequency-selective dense-multipath indoor propagation environments, potential for very high data rates and large user capacity offered by the enormous bandwidth, and noise-like interference to other systems operating on the same band.

However, the unique features of UWB signaling also impose a challenging task of timing offset (TO) estimation, whose accuracy and complexity directly affect the synchronization speed and overall system performance. In a baseband-based UWB impulse radio, every information-bearing symbol is repeatedly transmitted over a large number of frames with one pulse per frame, in order to provide adequate symbol energy while maintaining low