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ON THE OPTIMUM PULSE-POSITION MODULATION INDEX FOR ULTRA-WIDEBAND COMMUNICATION

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Abstract. Pulse-position modulation (PPM) is one of the popular modulations for ultra-wideband (UWB) communications. The modulation index used in a time-hopping PPM scheme plays an important role in the reduction of bit error rate introduced by noise. In this paper, we mathematically show the optimal modulation index that yields the least probability of error based on a given SNR for PPM with different orders of Gaussian monocycle shaping function.

Keywords. Pulse-position modulation, ultra-wideband, time-hopping, modulation index, Gaussian monocycle.

1 Introduction

Ultra-wideband (UWB), recently approved by FCC[1], is an area of communication that has generated curious interests due to its large bandwidth. Its very large bandwidth suggests that it has great capacity for high data rate and resolution of multipath fading [13], [12], [6], [7] – features which are desirable in wireless communication. Some works have taken advantage of this feature of multipath resolution to improve the performance by using RAKE receiver [4]. UWB has also been shown to have a greater resistance to narrowband interference than direct-sequence spread spectrum (DSSS) [15].

A common modulation scheme used in UWB communication is pulse-position modulation (PPM). It has been in use in optical communication where large bandwidth is available. PPM uses a basic pulse such as a first-order Gaussian monocycle to convey information by producing signal whose pulse position is time-shifted within a time-referenced window depending on the transmitted bits [15]. PPM as used in ultra-wideband communication also provides for multi-user access [5], [11] since the bandwidth allotted is large. In this paper, though, we optimize PPM modulation in terms of lowering its bit-error rate (BER) by choosing the optimal modulation index. Ramírez-Mireles has studied this kind of problem in [10] using experimental data with an approximation technique. Here, we use a mathematical formulation of the problem to find the optimal modulation index. We will focus