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A WAVELET PACKET TRANSFORM-BASED APPROACH FOR INTERFERENCE MEASUREMENT IN SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEMS

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Abstract − The paper mainly concerns interference measurement in spread spectrum, wireless communication systems. A new digital signal-processing method is proposed, which proves non intrusive and independent of the specific system considered. Thanks to the nice properties of the wavelet packet transform, the method is capable of extracting the occurred interference from the spread spectrum signal, thus ensuring accurate interference magnitude and frequency estimates also in critical conditions: interference level much smaller than that characterizing the spread spectrum signal, and interference spectral content very close to the carrier centre frequency of the considered system.

Keywords: *Interference measurement*, *RF measurement*, *Spread spectrum systems*, *Wireless systems, Wavelet packet transform*.

1. INTRODUCTION

Spread spectrum systems have encountered the favour of wireless communication engineers and researchers for a long time [1],[2]. They are nowadays playing a fundamental role in most third-generation (3G) telecommunication proposals [3]. The reason of this success relies essentially on superior operation in multipath environments, better flexibility in the allocation of channels, and increased capacity in bursty or fading channels with respect to conventional narrowband systems.

Although spread spectrum systems have the inherent interference suppression capability, in the strong, non-stationary and sometimes hostile electromagnetic environment, receiver operation may be very disturbed by the presence of interferers, which are often an unavoidable problem [4],[5]. The interference, both intentional, as in military communications, and non-intentional, as in a spectral overlay system [4], can regularly reach such an intensity as to make the processing gain of the system insufficient for the extraction of the desired information from the received spread spectrum signal [6]. Thus, with the aim of pursuing maximum system performance, accurate interference measurements can prove very helpful for a reliable characterization of communication channels, and, consequently, for a proper optimisation of receiver design.

This kind of measurement is not an easy task. In most spread spectrum systems, in fact, streams of data are encoded on a single carrier using a pseudo-random code, with a resulting high and variable crest factor (ratio of peak power to average power) and a power spectrum exhibiting white-noise-like features [7],[8].

Referring to the scientific literature, neither methods nor techniques, expressly devoted to interference measurement, seem to be described; the only solutions of interest are those forming the input section of a variety of receivers, optimised for interference excision [6],[9]-[11]. These solutions, always based on a digital signal-processing approach and often mandated to a preliminary estimation of the interference and a subsequent subtraction of it from the received signal, differ from one another in the domain (time [9], frequency [10], or time-frequency [6],[11]) they operate. Those involving a two-dimensional (time-frequency) domain have recently captured a great deal of interest due to their inherent capability of ensuring good performance also in the presence of non-stationary interference, thus overcoming a relevant limitation of all solutions based on a one-dimensional (time or frequency) approach. Nowadays, in fact, most interferers, including communications signals, radars or jammers, and even impulsive noise bursts, are in some way characterized by a localized time-frequency content [6],[11].

Moreover, at the best of the author's knowledge, few apparatuses, expressly devoted to interference measurement in spread spectrum systems, seem to be available on the market. Some of them, however, need to disable traffic on the channel to be measured, with a consequent inefficiency for final users (intrusive measurement) [12],[13]. Others of them need to demodulate the RF signal in order to apply suitable error vector magnitude (EVM)-based measurement procedures, thus becoming wholly dependent on the specific spread spectrum system considered [14].

The paper proposes a digital signal-processing method for interference measurement in spread spectrum, wireless communication systems. By combining the use of the wavelet packet transform (WPT), one of the most promising time-frequency approaches for interference mitigation [15], and coherent structure extraction (CSE) algorithm [16], the method (i) proves totally independent of the specific spread spectrum system considered, (ii) allows non intrusive measurements, and (iii) assures satisfying accuracy for different types and levels of interference.

The results of many laboratory tests, carried out on spread spectrum signals affected by different types of interferers, carrier wave interference, chirp carrier wave