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Real Time System Applications in Spread Spectrum Communication: A Literature Review

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Abstract

Spread Spectrum communication system is one of the most important types of the modern telecommunication systems. It involves diverse activities and processes where time restrictions are very important which formulate these systems very complex. To solve the complexity of these systems and to process the involved activities in time, the Real Time System (RTS) concept, with a vital role, came into being. RTS is an information processing system which has to respond to some input stimuli with in finite & specified period of time and to schedule the shared resources among different tasks. This paper examines that how real time system applications are involved in spread spectrum communication.

Keywords: *DSSS, Spread Spectrum, Real Time System*

1. Introduction

Spread spectrum communication is a technique in which the information signal (normally an electrical or EM signal) of a particular narrow bandwidth is consciously spread which results in a wider bandwidth information signal. SS communication uses various forms/techniques such that direct sequence spread spectrum (DS-SS), frequency hopping spread spectrum (FH-SS), time hopping spread spectrum (TH-SS) and hybrid of these. DSSS is the most commonly used form of Spread Spectrum communication in which narrow band information signal is converted into a wider band (spread) signal or spreading of the narrow band signal is achieved by means of its direct multiplication to a high bit rate spreading sequence. The spreading sequence is also some times called Pseudo Random Noise (PN) sequence. DSSS uses short as well as long sequence as the spreading sequences approved by IEEE 802.11 standards. Spread spectrum techniques are used because of several advantages including 1) inherent security of the information signal, 2) low probability of interference and detection *i.e.*, LPI & LDI, 3) highly resistive to noise 4) anti-jamming 5) multiple use of single frequency band [1, 2] and much more.

Real time system is the study of system (hardware, software or even both) that focuses on real time constraints that may or may not be strict, for example in case of computer system, the operational deadlines from an event to the system response. Normally, these time responses are considered in milliseconds, microseconds or sometimes less than that. In more simple words, a system is referred as a real time system if the correctness of the operation of that system totally depends upon its logical correctness as well as the time in which is has to be performed. RTSs can be classified on the basis of their deadlines such that, 1) Hard RTS: where missing of deadline results in total system failure, 2) Soft RTS: where deadlines are important but its missing just results in the degrading of the system performance, 3) Real

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RTS: these are hard real time systems with a very crucial deadline often in micro or even in nanosecond, 4) Firm RTS: these are soft real time systems where the usefulness of response is not significance after missing the deadline.

This study presents that how and where these real time concepts and applications are involved in the field of spread spectrum communication.

2. Literature Review of RTS applications in SS Communication

In this section of the paper I present and discuss few attributes from spread spectrum communication where the real time system (RTS) applications are involve.

2.1. Real Time Discrete Fourier Transform Based SS Communication (RT-DFT-Based)

As discuss earlier that SS communication provides low probability of interference or rejection of narrow band interference to the transmission. This rejection or elimination of interference can be improved significantly by using an algorithm that operates on RT-DFT of the received signal having a quality of adapting the changing interference spectrum promptly and eliminating multiple interferences by looking at short observation time [3]. Author presents the sensitivity loss (due to time windowing) and over excision losses of various algorithms.

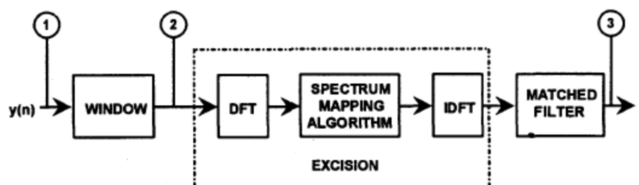

Figure 1. Windowed RT-DFT Architecture

In this study, for the RT-DFT excision losses calculation, a novel approach is discussed based on 4CS window in AWGN as shown in Figure 2.

This study also reveals that windows in conjunction properties are also applicable with non-linear losses of any algorithm for prediction of total system performance in small amount of dB.

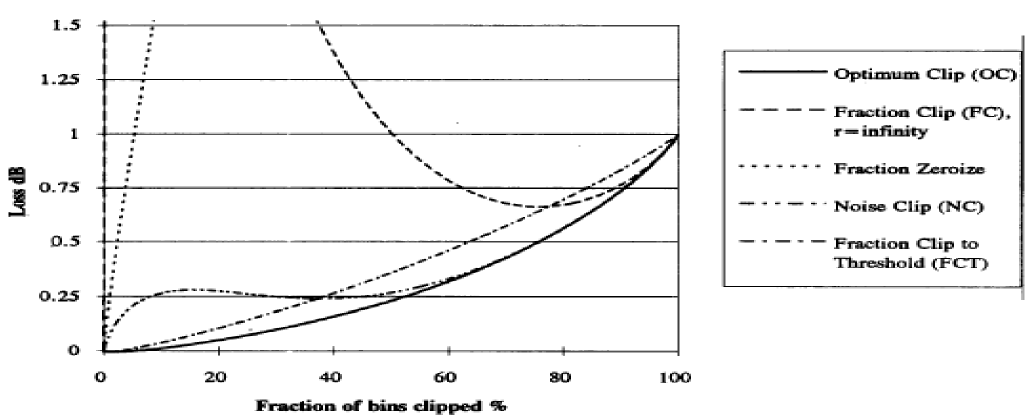

Figure 2. Over-Excision Sensitivity Loss in AWGN

2.2. Real time Multi-user Detection in SS Communication

As its name reveals, Multi-user detection in SS communications must precede a solution to a system of equations to recombine multiple access (MA) interference between two or more users communicating with a shared base station [4].

In this study the author proposed a vector multi-processor architecture that provides the essential computational performance as shown in Figure 3.

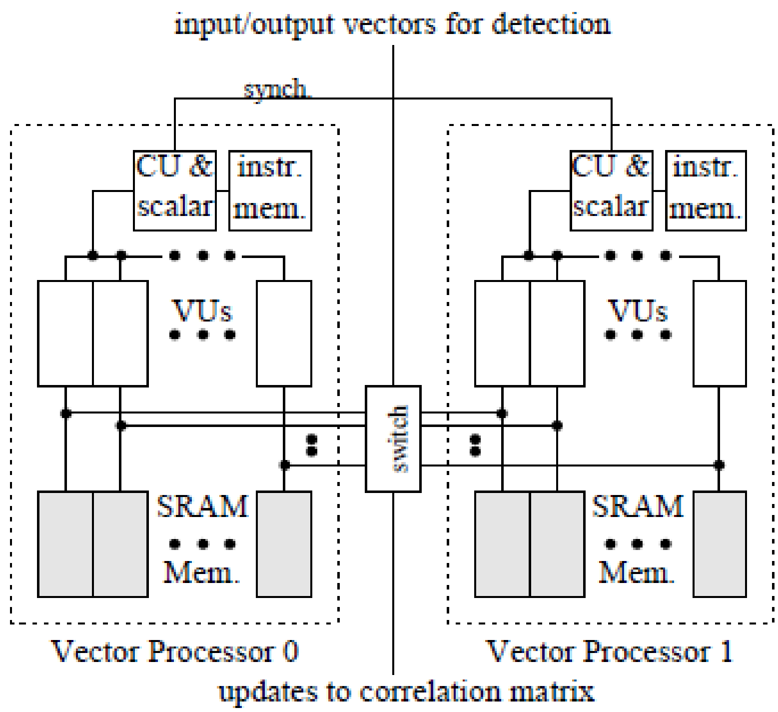

Figure 3. Vector Multi-Processor Architecture for Multi-User Detection

Here in this architecture, two vector processor *i.e.*, vector processor 0 and vector processor 1 are joined and connected with SRAM having parallel pipelining for the multiplication and addition operations and matrix inversion at real time bases for detection of multiple users in SS communication and to accomplish the performance of 100MHz (internal clock).

In this architecture, the pipelining of two or vectors are designed for the efficient execution of loading, multiplication, addition and storing operations so that to avoid the complex logic for commands or instructions that may results in overlapping in pipelining. As this proposed architecture focuses on the specific applications, it reduces the complexity to significant level for the existing superscalar microprocessors.

2.3. Real-Time Automatic Animal Tracking System using SS Communication

In this paper author is presenting an automatic animal tracking system using SS communication similar to a technique of animal tracking using a method like GPS. Using this system hundreds and thousands of animals in a field or even in forest can be tracked simultaneously by means of transmitters (cheaper, lighter in weight, longer life time and more accurate as compared to other automatic positioning labels) [5]. Technical aspects and their results for this tracking system are shown in the corresponding Figures 4, 5, 6 and 7. We can clearly reveal from Figure 4, that the transmitter used is composed of inexpensive components including low power microcontroller, PLL, an amplifier and mixer. This transmitter is based on BPSK that modulate and spread the carrier power directly from 1MHz to 2MHz. similarly Figure 5 shows the output of the above discussed transmitter with modulated and un-modulated carrier. This system was tested in Ithaca, NY using few American Crows while the tags were affixed with them using a backpack style harness as shown in Figure 6.

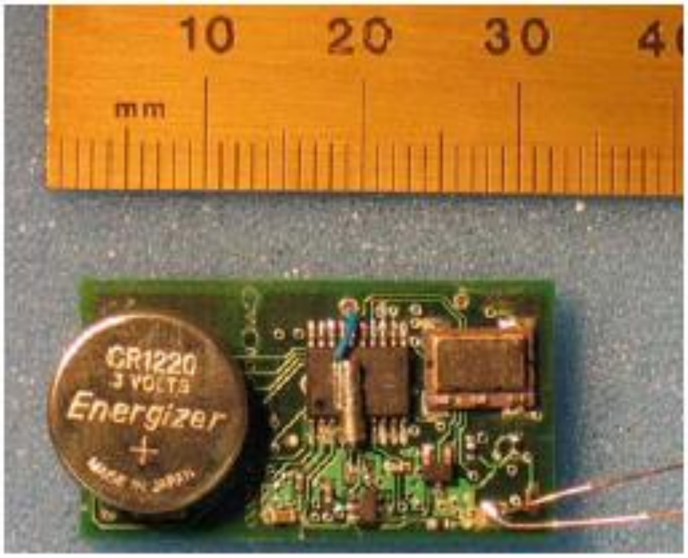

Figure 4. System Transmitter along Battery PLL

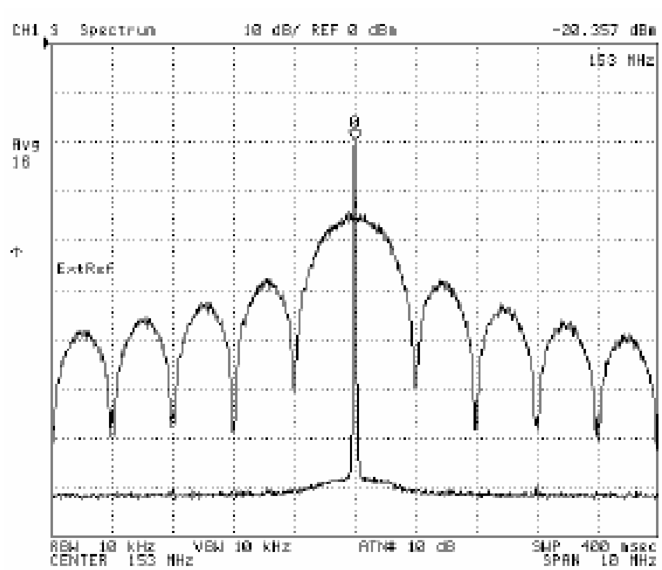

Figure 5. Output of Transmitter with Modulated and Nonmodulated Carrier

Figure 7 shows the track of crow for a five minute long test and it was located using a GPS. After this test and its validation, the author concludes that the conventional tracking systems are not suitable for the huge number of animals and also for the long battery life. These deficiencies can be removed using tracking system based on Spread Spectrum communication. Moreover, the GPS and ARGOS based tags (including transmitters) are too bulky for most of the birds, while the proposed transmitters are much suitable to most of the birds and also can work for long terms.

Figure 6. American Crow having DSSS Transmitter

Figure 7. Track of Crow (WJ)

2.4. Other RTS applications in Spread Spectrum Communication

RTS applications in spread spectrum communications are not limited to the prescribed examples in above subsections. These applications are deeply involve, almost, in each and every unit of spread spectrum communication. Some other applications include: RT processing of digital SS communication signal based on TIC (Time Integrating Correlator) [6], RT realization of non-Gaussian interference used for the short range (robust) wireless optical communication [7], RT-Fourier Analysis of SS communication signal based on SWI (surface wave implemented) chirp z transformation [8], and Quick re-sampling Denoising of SS communication signal for RT wireless location [9].

3. Conclusion

In this study I have demonstrated that spread spectrum communication has wide range of real-time applications. Above prescribed and discussed examples of real-time application in spread spectrum communication are few of them. A standard systematic literature review can be organized on real time applications in SS communication which is superior form of the literature review. This study concludes that each and every section of SS communication system is actually a real time application.

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