Chapter 1

Introduction

1.1 Introduction

In mid-1950's, Spread-Spectrum (SS) systems were applied to military antijaming tactical communication, to guidance systems, to experimental antimultpath systems, and to other applications [9]. Nowadays, they have been applied to commercial applications such as wireless LAN, satellite systems, and especially mobile phone systems.

A good meaning of the SS systems is given by Picholtz, Schilling and Milstein [22] which stated that "SS is a means of transmission in which the signal occupies a bandwidth in excess of the minimum necessary to send the information. The bandspread is accomplished by means of a code which is independent of the data, and a synchronized reception with the code at the receiver is used for despreading and subsequent data recovery."

Advantages of SS systems are: selective addressing capability, code division multiplexing, low-density output, inherent message privacy/security, high-resolution range measurement, and interference rejection. However, there are disadvantages, but they are often outweighed by the advantages. Two prime disadvantages are [11]

1) they employ more bandwidth

2) they are more complex in that they must include PN sequence generator, correlators, PN synchronization loop or other subsystems.

The basic types of SS modulations are "Direct-Sequence"(DS) modulation, "Frequency-Hopping" (FH) modulation, and "Time-Hopping" (TH) modulation. The focus of this thesis is on DS modulation because it has many benefits and it is often used in commercial applications. More details of FH and TH can be found in [23] [27].

The DS/SS is the simplest method of SS systems; it can be accomplished as follows. First, the data signal modulates a carrier, using binary phase-shift keying (BPSK), for example. Then, the modulated signal modulates a very-wide-band signal, which is a Pseudo-Noise (PN) signal. Consequently, the bandwidth has been spread.

One of the major functions of a spread-spectrum system receiver is to generate a local pseudo-noise (PN) signal which is in synchronism with the incoming PN signal. PN synchronization is traditionally achieved in the two steps: coarse synchronization (called acquisition) and fine tuning (called tracking). Acquisition

schemes may be coherent or noncoherent, depending on whether the receiver knows the carrier phase or not. Generally, the receiver generates a local PN signal and verifies whether or not it aligns with the incoming PN signal to within a specified range (normally within T_c, where T_c is the chip duration) by inspecting the correlation result of the locally generated and the incoming PN signals. If alignment is detected, the tracking circuit is initiated. Otherwise, the local PN signal updates its phase, and the process continues.

The objective of this thesis is to design and improve the PN acquisition to obtain better performance. We address the acquisition time and implementation of the proposed PN acquisition system.

1.2 Outline of Thesis

The contents of the thesis are organized as follows. In Chapter 2, we summarize the history of the PN acquisition, which can be classified into 3 groups: research which develops the conventional schemes, research which proposes new acquisition schemes, and research which analyzes or models the PN acquisition process.

In Chapter 3, we present a closed-loop noncoherent PN acquisition scheme, which is modified from the coherent scheme of Salih and Tantaratana [26]. The proposed scheme uses the same auxiliary signal as [26] to control the search direction. Expressions for the probabilities of detection and false alarm of the proposed scheme are obtained. Computer simulation is used to present the performance of the proposed noncoherent scheme.

In Chapter 4, we propose a closed-loop coherent PN acquisition scheme which uses a new auxiliary signal. We described the detail of the new auxiliary signal and the proposed coherent scheme. Probabilities of detection and false alarm are evaluated. The performance of the proposed scheme is evaluated by computer simulation.

Finally, Chapter 5 summarizes the result and suggests some topics for further research.