AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics and Communications Engineering Department

Performance Evaluation of Spread Spectrum System in Noise Environment Using Higher-Order Statistics

A Thesis
Submitted in partial fulfillment of the requirements of the degree of
Master of Science in Electrical Engineering

Submitted by
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B.Sc. of Electrical Engineering
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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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List of Publications

1. M. Gouda, A. El-Hennawy, and A. Ezzat, "Detection of Gold Codes Using Higher-Order Statistics," in Informatics and Computational Intelligence (ICI), 2011 First International Conference on, 2011, pp. 361-364.

2. M. Gouda, A. El-Hennawy and A. Ezzat, "Triple Correlation Gold Code Channelized Receiver," IJETAE, vol. 3, no. 8, pp. 60-65, 2013.

ABSTRACT

Spread spectrum communication and navigation systems employ a wideband code to spread the message signal over the communication channel. The estimation of the spreading code and information sequence is of great importance in the security of spread spectrum system, which remains a hot research problem in the wireless communication. There are different types of spreading codes depending on the application. This study discusses the higher-order statistics (HOS) specified in terms of triple correlation (TC) of spreading codes. For the maximal-length sequence, each code has a specific unique triple correlation function pattern of peaks which can be used to detect the original message signal. The Gold code constitutes of a pair of m-sequences, each of them having its own triple correlation peaks, so, also TC can be used in detection of complete or truncated Gold code as demonstrated by simulations.

Conventional receivers are generally ineffective in detecting direct-sequence spread spectrum (DSSS) signals if the spreading sequences are unavailable. A higher-order statistics based efficient receivers for the detection of Gold code spread spectrum signal in the presence of noise is proposed. These receivers take advantage of the TC and use it for code self-synchronization. We study two types of Gold code TC receivers; one-stage receiver which is used with divisible by three code length and two-stage receiver which can be used with any code length. A comparison between the performances of both receivers in Additive White Gaussian Noise (AWGN) channel is performed using Matlab simulations to prove the efficiency of the suggested receivers' structure.

Also, a TC Gold code channelized receiver has been developed and analyzed. The effect of changing the number of channels on the

performance of triple correlation TC receiver in AWGN channel is performed to prove the immunity of the receiver against noise.

The output from the proposed receivers depends on the used threshold. Two threshold techniques were investigated. The fixed and adaptive threshold techniques were tested. The adaptive threshold is more effective in decreasing the noise influence in Gold code detection but works only for offline computation.

CONTENTS

List of Abbreviations

ACF	Autocorrelation Function
AT	Adaptive Threshold
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
C/A	Coarse Acquisition Code
CDMA	Code Division Multiple Access
DFT	Discrete Fourier Transform
DSSS	Direct Sequence Spread Spectrum
FDM	Frequency Division Multiplexing
FFT	Fast Fourier Transform
FHSS	Frequency Hopping Spread Spectrum
FSK	Frequency Shift Keying
GF	Galois Field
GPS	Global Positioning System
HOM	Higher-Order Moment
HOS	Higher-Order Statistics
IFFT	Inverse Fourier Transform
IS-95	Interim Standard 95
ISI	Intersymbol Interference
ISM band	Industrial, Scientific and Medical (ISM) band
LFSR	Linear Feedback Shift Register
LS	Left Shift
MC-CDMA	Multi Carrier CDMA
M-Sequence	Maximum length sequence