AUTOMATIC DETECTION FOR COMMON INTERFERENCE SOURCES IN CELLULAR SYSTEMS

By

Ayman Mohamed Hamdy Abd El-Rahman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE IN
Electronics and Communications Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

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Title of Thesis :

Automatic Detection for Common Interference Sources in Cellular Systems

Key Words: Interference, Automatic Detection, GSM, CDMA, Jammer

Summary :

The main objective of this thesis is to enhance interference detection experience for engineers, who are new in the field of measurement, and to reduce time and effort for finding interference sources in cellular systems. This is achieved by suggesting a suitable software using some new techniques based on the results of RF signals only (frequency and level). This suggested software is able to identify the type of the interference source with minimum errors.

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LIST OF ABBREVIATIONS

3G	: Third Generation
CDMA	: Code Division Multiple Access
CEPT	: The Conference of European Posts and Telecommunications Administrations
DL	: Downlink
DSSS	: Direct Sequence Spread Spectrum
EPA	: Edge Partial Average
ETSI	: The European Telecommunications Standard Institute
FDD	: Frequency Division Duplex
FDMA	: Frequency Division Multiple Access
GSM	: Global System for Mobile Communications
ITU	: International Telecommunication Union
LTE	: Long-Term Evolution
NSMS	: National Spectrum Management System
OFDM	: Orthogonal Frequency Division Multiplexing
PAI	: Partial Average Indicator
RF	: Radio Frequency
SFH	: Slow Frequency Hopping
TDMA	: Time Division Multiple Access
TRA	: Telecommunication Regulatory Authority
UL	: Uplink
WCDMA	: Wide CDMA

LIST OF SYMBOLS

A_{avg} : the average resulting trace

$A_{prior\ avg}$: the previous average trace.

A_K : the current trace.

K : the number of the current trace.

D[i] : the decision from the i^{th} method

S : the slope of the curve.

L : the signal level.

F : the frequency value.

$r_{xx}(i)$: the resulting auto correlation at lag i

$x(n+i)$: the received signal shifted by i

N = the number of samples used.

$\bar{x}$ = the average level.

x_i = the level value of the i^{th} sample.

ABSTRACT

Frequency spectrum is a limited as well as precious resource. Spectrum is divided into non-overlapping spectrum bands which are assigned to different services. Therefore, a Telecommunication Regulatory Authority (TRA) was established in each country to manage, control and protects the frequency spectrum.
There are two main departments dealing with frequency spectrum in any TRA:

1. Spectrum Management department.
2. Spectrum Monitoring department.

Spectrum management is that process of managing the frequency spectrum by the administration using the necessary scientific and technical procedures to guarantee the efficient use of frequency spectrum without presence of interference from any service to another.

Spectrum monitoring is the process of monitoring the frequency spectrum bands by the administration to guarantee the use of the frequency spectrum is according to the existing licenses, which is issued by the administration, and solve any interference case that may exist to protect the legal users from illegal ones.

Spectrum monitoring is responsible of detecting, identifying and resolving any interference that may happen due to legal or illegal transmissions.

In Global System for Mobile Communications (GSM) and Third Generation (3G) networks, it is assumed that there is an exclusive use of spectrum by the network operator. One of the main roles of regulatory authorities in different countries is to assure the clearance of interference sources in the assigned bands of different operators. Operators in cellular systems take care of the co-channel interference by reusing the spectrum in geographically distant regions. However, practically, there are interference sources that contributes to the degradation of the quality of service. We focus on two common sources of interference in practical networks: The Code Division Multiple Access (CDMA)2000 interference in the 800 MHz band and interference due to jammers.

In this thesis, we introduce algorithms to automatically detect the existence or non-existence of interference sources in GSM and 3G networks. The algorithms introduced in this thesis were designed to be embedded in spectrum analyzers, and they only depend on the radio frequency (RF) readings (frequency and level) of the GSM and 3G spectrum. These algorithms were tested in practical scenarios using outputs of a commercial spectrum analyzers, Tektronix real time spectrum analyzer. The practical tests show the capability of the algorithms to accurately detect the CDMA and jammers interference sources.

Although the algorithms were tested against CDMA2000 in the 800 MHz band, they can be applied on other CDMA systems like cdmaOne (IS-95), Wideband CDMA (WCDMA) if they operate in the same band.

The main objective of this thesis is to enhance interference detection and to reduce time and effort for finding interference sources. This is achieved by suggesting a suitable software using some new techniques based on the results of RF signals only (frequency and level). This suggested software is able to identify the type of the interference source with minimum errors.