



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

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Under the Supervision of
Prof. Dr. **Hebat-Allah M.Mourad**

.....

Professor of
Electronics and communication
Faculty of Engineering, Cairo University

Dr. Omar Ahmed Nasr

Dr. Fadel Fadel Digham

.....

.....

Associate Professor

Doctor

Electronics and communication

National Telecommunication Regulatory

Faculty of Engineering, Cairo University

Authority, Smart Village

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Approved by the
Examining Committee

Prof. Dr. Hebat-Allah M.Mourad (Thesis Main Advisor)

Dr. Omar Ahmed Nasr (Thesis Advisor)

Dr. Fadel Fadel Digham (Thesis Advisor)
National Telecommunication Regulatory Authority, Smart Village

Prof. Dr. Magdi Fikri Mohamed (Internal Examiner)

Prof. Dr. Hesham Mohamed Elbadawy (External Examiner)
National Telecommunication Institute, Naser City

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

2018

Engineer: Ayman Mohamed Hamdy Abd EL-Rahman Soliman
Date of Birth : 15 / 07 / 1982
Nationality : Egyptian
E-mail : Ayman.mohamed.hamdy@gmail.com
Phone. : +201000834438
Address : B9, Street 232 degla , maadi , Cairo
Registration Date : 1 / 10 / 2012
Awarding Date : / / 2018
Degree : Master of Science
Department : Electronics and communications Engineering



Supervisors : Prof Dr. Hebat-Allah M.Mourad
Dr. Omar Ahmed Nasr
Dr. Fadel Fadel Digham
(National Telecommunication Regulatory Authority)

Examiners : Prof. Dr. Hesham Mohamed Elbadawy (External Examiner)
(National Telecommunication Institute)
Prof. Dr. Magdi Fikri Mohamed (Internal Examiner)
Prof Dr. Hebat-Allah M.Mourad (Thesis Main Advisor)
Dr. Omar Ahmed Nasr (Thesis Advisor)
Dr. Fadel Fadel Digham (Thesis Advisor)
(National Telecommunication Regulatory Authority)

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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TABLE OF CONTENTS

ACKNOWLEDGMENTS	i
TABLE OF CONTENTS	ii
LIST OF TABLES	v
LIST OF FIGURES	vi
LIST OF ABBREVIATIONS	ix
LIST OF SYMBOLS	x
ABSTRACT	xi
Chapter 1. Introduction and Background	1
1.1. Introduction.....	1
1.2. Purpose of spectrum monitoring.....	1
1.3. RF Interference	2
1.3.1. Permissible Interference	2
1.3.2. Accepted Interference.....	2
1.3.3. Harmful Interference	2
1.4. Interference Types	2
1.4.1. Co-channel interference.....	3
1.4.2. Adjacent channel	3
1.4.3. Desensitization	3
1.4.4. Intermodulation	3
1.4.5. Spurious emission.....	3
1.5. Cellular Mobile Radio Systems	4
1.6. GSM Cellular Network.....	5
1.6.1. Structure of the GSM Network.....	6
1.6.2. Physical Channels.....	6
1.6.3. RF Spectrum.....	7
1.7. CDMA Network	8
1.7.1. Structure of the CDMA Network	8
1.7.2. Physical Channels.....	9
1.7.3. RF Spectrum.....	9
1.8. Cellular Jammers	10
1.8.1. Jammer Technology	10
1.8.2. Jammer operation	11
1.9. Background.....	12
1.10. Thesis objective.....	13
1.11. Thesis Organization	13

Chapter 2. CDMA interfering with GSM	14
2.1. Problem Description	14
2.2. prerequisite setup	15
2.3. Interference Analysis	15
2.4. Decision Methods	18
2.4.1. Slope of the Curve	18
2.4.2. Auto Correlation	18
2.4.3. Partial Average Indicator (PAI).....	19
2.5. On Field Measuring Procedure	19
2.6. Results.....	21
2.6.1. Slope of the Curve	21
2.6.2. Auto Correlation	22
2.6.3. Partial Average Indicator.....	25
2.7. Lab Experiment.....	28
2.7.1. Slope of Fitting Curve	29
2.7.2. Auto Correlation	29
2.7.3. Partial Average Indicator.....	30
2.8. Analysis Justification	32
2.8.1. Slope of the curve	32
2.8.2. Auto Correlation	34
2.8.3. Partial Average Indicator.....	35
2.9. Conclusion	37
Chapter 3. Jamming interference to Cellular Networks.....	39
3.1. Problem description	39
3.1. prerequisite setup	40
3.2. Interference Analysis	40
3.3. Decision Methods for GSM band	43
3.3.1. Average Level value	43
3.3.2. Number of Crossings	44
3.3.3. Variance.....	44
3.4. Measuring procedure	44
3.5. Results.....	47
3.5.1. Average Level value	47
3.5.1. Number of Crossings	49
3.5.2. Variance.....	52
3.5.3. Analysis Justification.....	53
3.5.4. Conclusion.....	54

3.6.	Decision Methods for 3G band	56
3.6.1.	Edges Partial Average	56
3.7.	Measuring procedure	56
3.8.	Results.....	60
3.8.1.	Average Level value.....	60
3.8.2.	Edge Partial Average	61
3.8.3.	Variance.....	63
3.8.4.	Analysis Justification.....	64
3.8.5.	Conclusion.....	65
Chapter 4.	Conclusion and Future work	67
References	68
Appendix A:	Spectrum Analyzer	71
Appendix B:	Matlab source code	73

LIST OF TABLES

Table 1.1 Source of Interfering Signal	4
Table 1.2 GSM UL Bands	7
Table 1.3 CDMA DL Channels	9
Table 1.4 Comparison of Jammer techniques	11
Table 2.1 Slope of Normal GSM UL	22
Table 2.2 Slope of the Interfered GSM UL	22
Table 2.3 Slope of lab experimental Interfering GSM UL	29
Table 2.4 Jammer interfering GSM threshold values	38
Table 3.1 Average Level in dBm for Normal Spectrum	47
Table 3.2 Average Level in dBm for Spectrum with jamming interference	48
Table 3.3 Number of crossing for Normal Spectrum	51
Table 3.4 Number of crossing for Spectrum with jamming interference	51
Table 3.5 Variance for Normal Spectrum	52
Table 3.6 Variance for Spectrum with jamming interference	52
Table 3.7 Jammer interfering GSM threshold values	55
Table 3.7 Average Level in dBm for Normal Spectrum	60
Table 3.8 Average Level in dBm for Spectrum with jamming interference	60
Table 3.9 Normal Edge Partial Average	62
Table 3.10 Jamming Edge Partial Average	63
Table 3.11 Variance for Normal Spectrum	63
Table 3.12 Variance for Spectrum with jamming interference	64
Table 3.14 Jammer interfering GSM threshold values	66
Table A.0.1: Spectrum Analyzer window description	71

LIST OF FIGURES

Figure 1.1 National spectrum management system.....	1
Figure 1.2 Basic cellular system.....	5
Figure 1.3 GSM Network Architecture	6
Figure 1.4 GSM Frame.....	6
Figure 1.5 GSM UL RF Spectrum Without calls	7
Figure 1.6 GSM UL RF Spectrum with two channels	8
Figure 1.7 GSM UL RF Spectrum with three channels	8
Figure 1.8 CDMA Network.....	9
Figure 1.9 CDMA DL Spectrum in 800MHz Band	10
Figure 1.10 CDMA DL Spectrum in 2100MHz Band	10
Figure 2.1 CDMA and GSM Normal Spectrum.....	14
Figure 2.2 CDMA interfering GSM	15
Figure 2.3 GSM UL with Max Hold	16
Figure 2.4 Average Level of the Max Hold GSM UL	16
Figure 2.5 Average Level of Normal GSM UL	17
Figure 2.6 Average Level of interference in GSM UL	17
Figure 2.7 UL with no working Channels	19
Figure 2.8 UL with one working Channel.....	20
Figure 2.9 UL with two working Channels	20
Figure 2.10 UL with three working Channels	20
Figure 2.11 Interfered UL with no call attempt.....	21
Figure 2.12 Interfered UL with call attempts	21
Figure 2.13 Auto Correlation function in a free interfering band (sample 1)	23
Figure 2.14 Auto Correlation function in a free interfering band (sample 2)	23
Figure 2.15 Auto Correlation function in a free interfering band (sample 3)	23
Figure 2.16 Auto Correlation function in an interfered band (sample 1).....	24
Figure 2.17 Auto Correlation function in an interfered band (sample 2).....	24
Figure 2.18 GSM UL band with no interference (sample 1).....	25
Figure 2.19 Partial Average for GSM UL band with no interference (sample 1)	26
Figure 2.20 GSM UL band with no interference (sample 2).....	26
Figure 2.21 Partial Average for GSM UL band with no interference (sample 2)	27
Figure 2.22 GSM UL band with CDMA interference.....	27
Figure 2.23 Partial Average for GSM UL band with CDMA interference	28
Figure 2.24 Lap Experiment to generate CDMA Signal	28
Figure 2.25 Auto correlation function using a CDMA interference lab experiment (sample 1).....	29

Figure 2.26 Auto correlation function using a CDMA interference lab experiment (sample 2).....	29
Figure 2.27 Auto correlation function using a CDMA interference lab experiment (sample 3).....	30
Figure 2.28 GSM UL band with a CDMA interference lab experiment (sample 1).....	30
Figure 2.29 Partial average for a CDMA interference lab experiment (sample 1)	31
Figure 2.30 GSM UL band with a CDMA interference lab experiment (sample 2).....	31
Figure 2.31 Partial Average for a CDMA interference lab experiment (sample 2)	32
Figure 2.32 GSM UL band with a CDMA interference lab experiment (sample 3).....	32
Figure 2.33 Partial Average for a CDMA interference lab experiment (sample 3)	32
Figure 2.34 GSM UL band with an unknown signal interference	33
Figure 2.35 SOC result of the GSM UL band with an unknown signal interference.....	33
Figure 2.36 AC result of the GSM UL band with an unknown signal interference.....	33
Figure 2.37 PA result of the GSM UL band with an unknown signal interference	34
Figure 2.38 GSM UL band with an unknown signal interference	34
Figure 2.39 AC result of the GSM UL band with an unknown signal interference.....	35
Figure 2.40 SOC result of the GSM UL band with an unknown signal interference.....	35
Figure 2.41 PA result of the GSM UL band with an unknown signal interference	35
Figure 2.42 GSM UL band with CDMA interference.....	36
Figure 2.43 PA result of the GSM UL band with CDMA interference	36
Figure 2.44 SOC result of the GSM UL band with CDMA interference.....	36
Figure 2.45 AC result of the GSM UL band with CDMA interference	37
Figure 2.46 Flow chart of the decision algorithm	38
Figure 3.1 Full Band in Normal Case.....	39
Figure 3.2 Full band with jamming signals	40
Figure 3.3 CDMA DL network without jamming.....	41
Figure 3.4 CDMA DL network with jamming	41
Figure 3.5 GSM DL network without jamming	42
Figure 3.6 GSM DL network with jamming	42
Figure 3.7 3G DL network without jamming	43
Figure 3.8 3G DL network with jamming	43
Figure 3.9 GSM DL band (instantaneous spectrum).....	44
Figure 3.10 GSM DL band (average spectrum)	45
Figure 3.11 GSM DL with jamming signal received at 5m from the jammer	45
Figure 3.12 GSM DL with jamming signal received at 10m from the jammer	46
Figure 3.13 GSM DL with jamming signal received at 20m from the jammer	46
Figure 3.14 GSM DL with jamming signal received at 30m from the jammer	46

Figure 3.15 GSM DL with jamming signal received at 40m from the jammer	47
Figure 3.16 Average Level for instantaneous 25MHz	48
Figure 3.17 Average Level for average 15MHz.....	48
Figure 3.18 Average Level for instantaneous 15MHz	48
Figure 3.19 Average Level for average 12.5M	48
Figure 3.20 normal spectrum harmony around average level	49
Figure 3.21 instantaneous jamming signal without deep fading	50
Figure 3.22 instantaneous jamming signal with deep fading	50
Figure 3.23 average jamming signal	50
Figure 3.24 Flow chart of the decision algorithm	55
Figure 3.25 Two Carrier 3G DL.....	57
Figure 3.26 Three Carrier 3G DL.....	57
Figure 3.27 3G DL with jamming signal received at 5m from the jammer	58
Figure 3.28 3G DL with jamming signal received at 10m from the jammer	58
Figure 3.29 3G DL with jamming signal received at 20m from the jammer	58
Figure 3.30 3G DL with jamming signal received at 30m from the jammer	59
Figure 3.31 3G DL with jamming signal received at 40m from the jammer	59
Figure 3.32 Average Spectrum of three-Carrier 3G DL.....	60
Figure 3.33 Edges in a normal instantaneous 3G spectrum	62
Figure 3.34 Edges in a normal average 3G spectrum.....	62
Figure 3.35 Flow chart of the decision algorithm	66

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
$A_{\text{prior avg}}$: 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.