NOVEL PERFORMANCE EVALUATION STUDIES OVER EXTENDED GENERALIZED-K COMPOSITE FADING CHANNELS

By

Husam Rafiq Mahmoud Alhennawi

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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Title of Thesis:

Novel Performance Evaluation Studies over Extended Generalized-K Composite Fading Channels

Key Words:
Extended Generalized-K; Symbol error rate; Cognitive radio; Probability of detection; Fox′s H-function

Summary:

In this thesis, the performance of EGK is studied by offering unified and generic closed-form exact expressions for the symbol error rate of the EGK composite fading channels. In this context, the single as well as the maximal-ratio combining and equal-gain combining receivers are considered over most of the commonly used modulation schemes. Furthermore, a novel general expression for the average probability of detection of energy detection spectrum sensing is derived over the EGK fading. The new expression provides a unified form, which can handle several of the well-known fading environments.

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Dedication

This Master thesis is dedicated to my parents, my brother and my sister who have supported me all the way in my life and my study.

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List of Abbreviations

AAF	Amplify-and-Forward
ABEP	Average Bit Error Probability
AC	Average Capacity
AF	Amount of Fading
AFD	Average Fade Duration
ASEP	Average Symbol Error Probability
ASK	Amplitude Shift Keying
AUP	Average Unified Performance
AWGGN	Additive White Generalized Gaussian Noise
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
CAF	Cyclic Autocorrelation Function
CBFSK	Coherent Binary Frequency Shift Keying
CDF	Cumulative Distribution Function
CFD	Cyclostationary Feature Detection
CR	Cognitive Radio
CSD	Cyclic Spectral Density
CSS	Cooperative Spectrum Sensing
DBPSK	Differentially Binary Phase shift keying
DF	Decode-and-Forward
DPSK	Differentially coherent Phase shift keying
DSA	Dynamic Spectrum Access
ED	Energy detection
EGC	Equal Gain Combining
EGK	Extended Generalized-K
FC	Fusion Center
FCC	Federal Communications Commission
GG	Generalized Gamma
GNM	Generalized Nakagami-m
i.i.d	Independent and identically distributed
i.n.i.d	Independent and non-identically distributed
LOS	Line-Of-Side
MF	Matched Filtering
MGF	Moment Generating Function
MIMO	Multiple-input Multiple-output
MISO	Multiple-input Single-output
MRC	Maximal-Ratio Combining
NCBFSK	Non-Coherent Binary Frequency Shift Keying
NC-FSK	Non-Coherent Frequency Shift Keying

NLOS	Non Line-Of-Side
PAM	Pulse Amplitude Modulation
PDF	Probability Density Function
PSK	Phase Shift Keying
PU	Primary User
QAM	Quadrature Amplitude Modulation
QoS	Quality of Serves
QPSK	Quadrature Phase shift keying
RMSC	Root Mean Square Combining
ROC	Receiver Operating Characteristic
RV	Random Variable
SC	Selective Combining
SDR	Software Defied Radio
SER	Symbol Error Rate
SLC	Square-Law Combining
SLS	Square-Law Selection
SNR	Signal-to-Noise Ratio
SS	Spectrum Sensing
SSC	Switch and Stay Combining
SSK	Space Shift Keying
SU	Secondary User

List of Symbols

A, B and g	The modulation schemes parameters
c	The real constant that lies in the strip of definition of the Mellin-transform
$E[.]$	Expected value
$f^*(s)$	The Mellin transform of function $f(.)$
$f_{\gamma_l}(\gamma_l)$	The PDF of the l i.n.i.d instantaneous SNR, γ_l where $l = 1, \cdots, L$
$f_\gamma(\gamma)$	The PDF of the instantaneous SNR
$f^*_\gamma(\gamma)$	The Mellin transform of $f_\gamma(\gamma)$
$F_\gamma(\gamma)$	The CDF of the instantaneous SNR
$F_{\gamma_l}(\gamma_l)$	The CDF of the l i.n.i.d instantaneous SNR γ_l
$F^*_\gamma(\gamma)$	The Mellin transform of $F_\gamma(\gamma)$
${}_pF_q$	The generalized hypergeometric function
$g^*(z)$	The Mellin transform of $g(\gamma) \equiv -\gamma \frac{d}{d\gamma} P(error\|\gamma)$
$G^{m,n}_{p,q}(.)$	Meiger′s G-Function
$G^{0,n;m_1,n_1;m_2,n_2}_{p,q;p_1,q_1;p_2,q_2}(\gamma_1, \gamma_2)$	Bivariate G-Function
h	Channel gain
$h^*(z)$	The Mellin transform of $h(\gamma) \equiv P(error\|\gamma)$
$h^*(\mathbf{z})$	L-dimensional Mellin-transform of conditional SER
H_0	Primary user absence
H_1	Primary user presence
$H^{m,n}_{p,q}(.)$	Fox′s H-Function
$H^{0,n;m_1,n_1;\cdots;m_r,n_r}_{p,q;p_1,q_1;\cdots;p_r,q_r}(\gamma_1, \cdots, \gamma_r)$	Multivariable H-function
$I_v(.)$	Modified Bessel function of the first kind order
K_G	Generalized-K distribution
L	Number of branches in diversity reception
m	Fading figure(diversity severity/order) of EGK distribution
m_l	Fading figure(diversity severity/order) of l-branch in EGK distribution
m_s	Fading shaping factor of EGK distribution
$m_{s,l}$	Fading shaping factor of l-branch in EGK distribution
$M[.]$	The Mellin transform
$M^{-1}\{.\}$	The inverse Mellin transform
n	The number of collaborative users in CSS scenario
$n(t)$	zero-mean AWGN