Dedication

This work is dedicated with great thanks to my parents, my brothers and sister …
To my relatives …
To everyone taught me a letter …
To my friends and colleagues …
And I thank all my professor at the Sudan University and Al Jazeera University

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No words can describe how grateful and indebted I am to my parents: my compassionate mother Sumaia ; throughout my life you are always near, A tender smile to guide my way, you are the sunshine to light my day & my mentor father, my way Mohamed, of whom I am a living will: may your happiness fulfill, your goodness, as is just and right, deeds are seeds upon the night as wind and wonder have their way, delivering the destined light. And sister: Razaz ; her novel sense of humor and social networking guidelines made life smooth and enjoyable and brothers Ahmed and Omer with his sense of aesthetic and creative thinking with willingness to challenge the conventional; have added new dimensions to my life. Their love and care are the motivation for all my achievements, and they will forever be. I am deeply thankful to my aunts & uncles and all my family.

,,, Many thanks to all,,,

ABSTRACT

The next generation of wireless communications high data rate and link with high reliability became main factors in measuring the performance of system. Therefore massive Multiple Input Multiple Output systems (massive MIMO) will be promising technology for fifth generation wireless communication to cover the increasing number of users and various wireless applications with acceptable data rate and link with high reliability. Multi User Interference (MUI) is main problem in performance of massive MIMO system. This thesis focus on Multi User Interference(MUI), which is interference results from other user in same cell which has one of the major impact factor in decreasing performance (achievable data rate) of cellular communication system when more users access to the wireless link. The specific goal is to eliminate or mitigate the effect of multi user interference to enhance system performance by increasing number of base station antennas and applying linear pre-coding techniques. This research presents the study and compare the performance analysis of two linear pre-coding techniques which are Matched Filter (MF) and Zero Forcing (ZF) for downlink massive multiple input multiple output System over perfect channel depending on vector normalization and matrix normalization methods when number of base station antennas from 1 to 300 and from 1 to 600, number of user from 1 to 200 and downlink transmitting power 0 dB and -10 dB. Simulations results show that using linear pre-coding techniques and increasing number of base station antennas enhance system performance. When number of base station antenna 600 the achievable sum rate improvements for ZF and MF (433.7451 bit/sec//Hz, 433.2624 bit/sec/Hz) at high power and (86.5119 bit/sec/Hz 86.3519 bit/sec/Hz) at low power respectively. The results indicate that vector normalization and matrix normalization for ZF gives better performances at high downlink transmission power (0 dB) while at low power MF has better performance in vector normalization and ZF has better performance in matrix .

المستخلص

للجيل القادم من الاتصالات اللاسلكية معدل البيانات العالي وقناة ذات موثوقية عالية أصبحا عاملين رئيسين في قياس أداء النظام. وبالتالي نظام متعددة الإدخال متعددة المخرجات الهائلة سوف يكون تكنولوجيا واعدة للجيل الخامس للاتصالات اللاسلكية لتغطية العدد المتزايد للمستخدمين و التطبيقات اللاسلكية المتعددة بمعدل بيانات مقبول و موثوقية عالية. التداخل متعدد المستخدمين من المشاكل الرئيسية في أداء نظام متعددة الإدخال متعددة المخرجات الهائلة. وهذه الرسالة تركز علي التداخل متعدد المستخدمين والذي هو التداخل ألناتج من مستخدم آخر في نفس الخلية والذي لديه عامل تأثير كبير في خفض الأداء (معدل البيانات المتحقق) في نظام الاتصالات الخلوية عند وصول المزيد من المستخدمين إلى قناة لاسلكية. الهدف المحدد هو إزالة أو تخفيف تأثير التداخل متعدد المستخدمين لتحسين أداء النظام عن طريق زيادة عدد هوائيات المحطة الأساسية وتطبيق تقنيات الترميز المبدئي الخطي. هذا البحث يقدم دراسة ومقارنة تحليل الأداء لاثنين من تقنيات الترميز المبدئي الخطي والتي هي الفلتر المطابق والتصفير ألقسري للوصلة الهابطة لنظام متعددة الإدخال متعددة المخرجات الهائلة عبر قناة مثالية اعتمادا علي طريقتي توحيد المتجه وتوحيد المصفوفة عند تكون هوائيات المحطة الأساسية من 1 إلي 300 ومن 1 إلي 600 وعدد المستخدمين من 1 إلي 200 عند قدرة الوصلة الهابطة 0dB و -10dB. أظهرت نتائج المحاكاة أن استخدام تقنيتي الترميز المبدئي الخطي وزيادة عدد هوائيات المحطة الأساسية تحسن أداء النظام. وعندما كانت عدد الهوائيات في المحطة الأساسية 600 كان التحسين في معدل البيانات المتحقق لتقنية التصفير ألقسري والفلتر المطابق (433.7451 بت/ث/هيرتز و 433.2624 بت/ث/هيرتز عند الطاقة العالية و 86.5119 بت/ث/هيرتز و 86.3519 بت/ث/هيرتز عند الطاقة المنخفضة علي التوالي . وتشير النتائج إلي أن توحيد المتجه وتوحيد المصفوفة للتصفير ألقسري تعطي أفضل أداء عندما تكون قدرة الوصلة الهابطة عالية (0dB) بينما في القوة المنخفضة فلتر المطابقة لديه أداء أفضل في توحيد المتجه والتصفير القسري لديه أداء أفضل في توحيد المصفوفة.

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List of Abbreviations

4G	Fourth Generations
5G	Fifth Generations
BD	Block Diagonalization
BS	Base Station
CMA	Constant Modulus
CSI	Channel State Information
ESPARs	Electronically steerable passive array radiators
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
GSM	Global System for Mobile
LTE	Long Term Evolution
MAC	Media Access Control
MF	Matched Filter
MIMO	Multiple Input Multiple Output
MISO	Multiple Input Single Output
ML	Maximum Likelihood
MMSE	Minimum Mean Square Error
RF	Radio Frequency
RRHs	Remote Radio Heads
MRT	Maximum Ratio Transmission
MSINR	Maximum Signal to Interference and Noise Ratio
MSNR	Maximum Signal to Noise Ratio
MTs	Mobile Terminals
MUI	Multi User Interference
MU-MIMO	Multi User- Multiple Input Multiple Output
SD	Spatial Diversity
SDMA	Space Division Multiple Access
SIMO	Single Input Multiple Output
SISO	Single Input Single Output
SM	Spatial Multiplicity
SNR	Signal to Noise Ratio
SU-MIMO	Single User- Multiple Input Multiple Output
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
ZF	Zero Forcing

List Of Symbols

M	Number of Antennas
H	Channel Matrix
h_k^T	Channel Vector
y_k	Received Signal
R	Channel Capacity
R_k	Achievable sum rate per user
$R_{MF_{vec}}$	The achievable sum rate for matched filter by using vector normalization
$R_{MF_{mat}}$	The achievable sum rate for matched filter by using matrix normalization
$R_{ZF_{vec}}$	The achievable sum rate for zero forcing by using vector normalization
$R_{ZF_{mat}}$	The achievable sum rate for zero forcing by using matrix normalization
R_{sum}^{MF}	A achievable sum rate with Matched Filter
R_{sum}^{ZF}	Achievable sum rate with Zero Forcing
R_{sum}	Achievable sum rate
K	Number of Users
P_d	Transmit power in a downlink
n_k	White Gaussian noise vector
W	Pre-coding matrix
w_k	Column vector of transmit and receive
SNR	Signal to noise ratio
S_k	Transmit symbol
H^*	Conjugate transpose of channel matrix