Contents

No		Page
	Chapter one (Introduction)	
1.1	Preface	1
1.2	Problem statement	3
1.3	Objectives	4
1.4	Methodology	4
	Chapter two (MIMO Techniques)	
2.1	Physical Interpretation of MIMO Transmissions	
2. 1. 1	Introduction:	6
2.2	Multiple-Input Multiple-Output Communication:	6
2.3	Free Space Aspects	9
2.4	Multiple-Input Multiple-Output Channel Modeling:	11
2.5	A Geometrically Based Stochastic MIMO Channel Model	
2.5.1	Continuous-Time Channel Model	12
2.5.2	Discrete-Time Channel Model	17
2.5.3	Quasi-Static Discrete-Time Channel Model	21
	Chapter three (OFDM Techniques)	
3.1	Orthogonal Frequency Division Multiplexing (OFDM)	
3.1.1	Background:	25
3.1.2	Principle:	26
3.1.3	Multipath Distortion:	30
3.2	Main Advantages of OFDM:	32
3.3	OFDM Transceiver:	33
	Chapter Four (Theoretical Models)	
4.1	fading models	36
4.1.1	Large Scale Fading	36
4.1.2	Small-Scale Fading	37
4.2	Modeling of OFDM Guard Band:	39
4.3	DFT-Based Channel Estimation	40
4.4	Channel Capacity of Random MIMO Channels	40
4.5	Multi-User MIMO	41
4.6	MIMO OFDM System	42
4.7	Modeling of MIMO OFDM system using simulink	45
4.7.1	random data source:	47
4.7.2	FEC Modulator Bank model	48
4.7.3	IFFT input packing Model	49

Space Time Diversity encoder Model	50
OFDM Transmitter Model	50
Digital pre-distortion & Nonlinear amplifier model	51
MIMO Channel Model	51
OFDM Receiver model	52
Space-Time Diversity Combiner Model	52
Channel Estimation & Space-Time Block combining model	53
Data carrier Model	53
Demodulator & FEC Bank model	54
SNR Estimator Model	54
Chapter Five (Results and Discussion)	
fading models:	57
Large Scale Fading:	57
Small-Scale Fading	58
OFDM Guard Band Modeling results	59
DFT-Based Channel Estimation	60
Channel Capacity of Random MIMO Channels	61
BER performance of two channel in Multi-User MIMO	63
Result of simulink model of MIMO OFDM system:	64
System Parameters and assumptions	64
Batch mode Simulation	66
The parameter of system	66
Graphical Simulation results	67
Chapter Six (Conclusion & Recommendations)	
Conclusion	71
Recommendations and future work	72
References	73
Appendixes	
	OFDM Transmitter Model Digital pre-distortion & Nonlinear amplifier model MIMO Channel Model OFDM Receiver model Space-Time Diversity Combiner Model Channel Estimation & Space-Time Block combining model Data carrier Model Demodulator & FEC Bank model SNR Estimator Model Chapter Five (Results and Discussion) fading models: Large Scale Fading: Small-Scale Fading OFDM Guard Band Modeling results DFT-Based Channel Estimation Channel Capacity of Random MIMO Channels BER performance of two channel in Multi-User MIMO Result of simulink model of MIMO OFDM system: System Parameters and assumptions Batch mode Simulation The parameter of system Graphical Simulation results Chapter Six (Conclusion & Recommendations) Conclusion Recommendations and future work References

List of Figures

No	Figure Name	Page
2 - 1	A schematic representation of a MIMO communication system	7
2 - 2	Antenna set-up	10
2 - 3	A MIMO System Operating In A Scattering Environment	12
2 - 4	flow graph of the link between the p-th TX and q-th RX antenna.	18
2 - 5	Tapped delay line channel model for time-variant channels	20
2 - 6	MIMO signal model represented by a tapped delay line	22
3 - 1	Basic structure of a multi-carrier system	25
3 - 2	Schematic representation of an equivalent baseband OFDM system	27
D D	Normalized squared absolute version of the frequency response of	20
3 - 3	an OFDM symbol	29
3 - 4	The principle of windowing	31
3 – 5	OFDM symbol with cyclic prefix	32
3 – 6	Block diagram of an OFDM transceiver	34
4 - 1	Free Path Losses classification	36
4 – 2	OFDM Guard Band	39
4 – 3	DFT Based channel estimation	40
4 - 4	Multi-user MIMO communication systems	41
4 – 5	Schematic representation of a MIMO OFDM transmitter	43
4 - 6	Schematic representation of a MIMO OFDM receiver	44
4 - 7	general simulink blockset of MIMO OFDM System	46
4 - 8	Random data source parameter	47
4 – 9	FEC Modulator Bank	48
4 - 10	IFFT input packing	49
4 - 11	Space Time Diversity incoder	50
4 - 12	OFDM Transmitter	50
4 - 13	Digital pre-destortion & Nonlinear amplifier	51
4 – 14	MIMO Channel model	51

4 – 15	OFDM Reciever	52
4 – 16	Space-Time Diversity Combiner	52
4 - 17	Channel Estimation & Space-Time Block combining	53
4 – 18	Data carrier	53
4 – 19	Demodulator & FEC Bank	54
4 - 20	SNR Estimator	54
5 - 1	Free Path Losses depend of distance	57
5 - 2	Log-distance path losses according to n path loss exponent	58
5 – 3	Rayleigh and Rician fading model simulation	58
5 - 4	the effect of ISI as the length of a guard interval (CP, CS,	59
	or ZP) varies	
5 - 5	Simulation of DFT Based channel estimation	60
5 - 6	Channel Capacity of Random MIMO Channels Simulation	61
5 - 7	Ergodic_Capacity Vs SNR Simulation	62
5 - 8	Multi-user MIMO simulation	63
5 - 9	Block Parameters	64
5 -	Consentelation diagram	65
10		
5 -	Antonna 1 chastrum	C.E.
11	Antenna 1 spectrum	65
5 –		
12	BER Estimator Display	65
5 -		
	BER Vs SNR in MIMO OFDM System	67
13 5 -		
	Throughput variation According SNR in MIMO OFDM System	68
14	DED a data a Assaultas CND and EED to MINAC OFDM	
5 –	BER variation According SNR and FER in MIMO OFDM	69
15	System	0.5

List of Tables

No	Table Name	Page
4 - 1	pass losses exponent	37
4 - 2	Power delay profile	38
4 - 3	Specific modulation and RS-CC codes	55