

On the Impact of Channel and Channel Quality Estimation on Adaptive Modulation

by

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Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Electrical Engineering

Keywords: Adaptive Modulation, Channel Quality Estimation, Long term SNR estimation, Short term SNR estimation, Pilot Symbol Assisted Modulation, Channel Estimation, Rayleigh Fading, Quadrature Amplitude Modulation

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*December 2002
Blacksburg, VA*

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(Abstract)

The rapid growth in wireless communications has given rise to an increasing demand for channel capacity using limited bandwidth. Wireless channels vary over time due to fading and changing interference conditions. Typical wireless systems are designed by choosing a modulation scheme to meet worst case conditions and thus rely on power control to adapt to changing channel conditions. Adaptive modulation, however, exploits these channel variations to improve the spectral efficiency of wireless communications by intelligently changing the modulation scheme based on channel conditions. Necessarily, among the modulation schemes used are spectrally efficient modulation schemes such as quadrature amplitude modulation (QAM) techniques.

QAM yields the high spectral efficiency due to its use of amplitude as well as phase modulation and therefore is an effective technique for achieving high channel capacity. The main drawbacks of QAM modulation are its reduced energy efficiency (as compared to standard QPSK) and its sensitivity to channel amplitude variations. Adaptive modulation attempts to address the first drawback by using more energy efficient schemes in low SNR conditions are reserving the use of QAM for high SNR conditions. The second drawback leads to a requirement of high quality channel estimation. Many researchers have studied pilot symbol assisted modulation for compensating the effects of fading at the receiver. A main contribution of this thesis is the investigation of different channel estimation techniques (along with the effect of pilot symbol spacing and Doppler spread) on the performance of adaptive modulation.

Another important parameter affecting adaptive modulation is the signal-to-noise ratio. In order to adapt modulation efficiently, it is essential to have accurate knowledge of the channel signal-to-noise ratio. The performance of adaptive modulation depends directly on how well the channel SNR is estimated. The more accurate the estimation of the

channel SNR is, the better the choice of modulation scheme becomes, and the better the ability to exploit the variations in the wireless channel is. The second main contribution of this thesis is the investigation of the impact of SNR estimation techniques on the performance and spectral efficiency of adaptive modulation. Further, we investigate the impact of various channel conditions on SNR estimation and the resulting impact on the performance of adaptive modulation. Finally, we investigate long term SNR estimation, its use in adaptive modulation and present a comparison between the two approaches.

ACKNOWLEDGEMENTS

I am very thankful to my advisor Dr. R.M.Buehrer without whose support this thesis would not have been possible. His invaluable advice has helped me to reach this important milestone of my life. He has been a mentor in guiding me through my graduate career. It has been a great honor for me to work under his guidance. I also would like to use this opportunity to thank Dr. Jacobs and Dr. Woerner to serve as my committee members. Their help and guidance are deeply appreciated.

I thank my parents Dr. Ashok K. Jain and Mrs. Sarita Jain, and my brother Gaurav, for loving me and encouraging me throughout my life. Many thanks to my colleagues at the MPRG who have contributed greatly to my learning over the course of these two years and for their generosity in sharing their knowledge. I wish to thank Vikash Srivastava for his love and support. Finally, I want to express my gratitude to God whose blessings made this effort fruitful.

TABLE OF CONTENTS

I INTRODUCTION

1.1 Motivation.....	1
1.2 Significance of this thesis	2
1.3 Overview of thesis	2

2 EQUALIZATION TECHNIQUES FOR QAM

2.1 Introduction.....	4
2.2 Fundamentals of Pilot Symbol Assisted Modulation	4
2.3 Wireless channel model	7
2.3.1 Rayleigh fading phenomenon	7
2.3.2 Jakes model for Rayleigh fading.....	10
2.4 Transmitter and receiver model	11
2.5 Gaussian interpolation	13
2.6 Wiener interpolation.....	14
2.7 FFT interpolation	16
2.7.1 Edge effects due to FFT interpolation.....	17
2.8 Simulation results and discussion.....	19
2.8.1 Effect of interpolation order on the Gaussian interpolator.....	19
2.8.2 Effect of the Doppler spread	23
2.8.3 Effect of pilot symbol spacing	24
2.8.4. Effect of the pilot SNR	27
2.8.5. Comparison of channel estimators	27
2.8.6 Analysis of the effect of channel estimation error on <i>M</i> -QAM BER performance in Rayleigh fading	31
2.8.6.1 Amplitude estimation error only.....	32
2.8.6.2 Amplitude and phase estimation error	34

2.9 Chapter summary.....	36
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3 INTRODUCTION TO ADAPTIVE MODULATION

3.1 Introduction.....	37
3.2 Motivation.....	37
3.3 Adaptive Modulation.....	40
3.4 Discussion and results.....	46
3.4.1 Ideal performance.....	46
3.4.2 Effect of feedback delay.....	50
3.4.3 Effect of Doppler frequency.....	52
3.4.4 Impact of channel equalization.....	54
3.5 Chapter summary.....	58

4 ANALYSIS OF CHANNEL QUALITY (SNR) ESTIMATION ON ADAPTIVE MODULATION

4.1 Introduction.....	59
4.2 Channel Quality estimation.....	60
4.3 Impact of short term SNR estimation on adaptive modulation.....	65
4.4 Impact of SNR estimation on adaptive modulation with FFT estimation	71
4.5 Impact of symbol decisions on the improved short term SNR estimation	73
4.6 Analysis of long term SNR estimation	74
4.7 Simulation results and discussion	81
4.7.1 Effect of feedback delays	81
4.7.2 Effect of Doppler frequency	83
4.7.3 Effect of equalization techniques	85
4.8 Chapter summary	86

5 CONCLUSIONS AND FUTURE WORK

5.1 Conclusions88

5.2 Future work88

BIBLIOGRAPHY90

VITA92

LIST OF FIGURES

Figure 2.1 Frame format for PSAM.....	5
Figure 2.2 Signal constellations of QAM indicating possible pilot symbol.....	6
Figure 2.3 A typical Rayleigh fading envelope as a function of time.....	9
Figure 2.4 Rayleigh probability density function (pdf).....	9
Figure 2.5 Fading power spectrum density.....	9
Figure 2.6 Temporal correlation of the fading waveform.....	9
Figure 2.7 Model for a component radio wave incident on the mobile.....	10
Figure 2.8 Configuration of the transmitter and receiver.....	12
Figure 2.9 Fading distortion compensator.....	14
Figure 2.10 General FFT algorithm.....	17
Figure 2.11 Frame structure to reduce edging effect.....	18
Figure 2.12 (a) BER performance with and without the edge effect for 16-QAM and Doppler frequency = 50Hz.....	18
Figure 2.12 (b) BER performance with and without the edge effect for 64-QAM and Doppler frequency = 50Hz.....	18
Figure 2.12 (c) Illustration of the edge effects in the channel envelope.....	19
Figure 2.12 (d) Shows enlarged portion of the edge effects in the channel envelope of Figure 2.9 (c).....	19
Figure 2.13(a) The estimated fading envelope as traced by the zeroth order interpolation	22
Figure 2.13(b) The estimated fading envelope as traced by the first order interpolation.	22
Figure 2.13 (c) The estimated fading envelope as traced by the second order interpolation.....	22
Figure 2.13 BER performance of 16-QAM using different interpolation orders for Gaussian interpolator at Doppler 50Hz and BER target of 0.1%.....	22
Figure 2.14 (a) Impact of Doppler spread on FFT interpolation for 16-QAM.....	23
Figure 2.14 (b) Impact of Doppler spread on Wiener interpolation for 16-QAM.....	23
Figure 2.15 Effect of Doppler frequency on 16-QAM performance.....	24
Figure 2.16 (a) Fading envelope for Doppler frequency of 120 Hz.....	25
Figure 2.16 (b) Fading envelope for Doppler frequency of 130 Hz.....	25

Figure 2.16 (c) Signal constellation for 16-QAM at Doppler frequency of 120 Hz.....	25
Figure 2.16 (d) Signal constellation for 16-QAM at Doppler frequency of 130 Hz.....	25
Figure 2.16 (e) BER performance of 16-QAM with Doppler of 120 Hz and 130 Hz....	26
Figure 2.17 BER vs. Pilot symbol spacing for 16QAM.....	26
Figure 2.18 (a) Signal constellation of 64 QAM using Wiener interpolation.....	28
Figure 2.18 (b) Signal constellation of 64 QAM using FFT interpolation.....	28
Figure 2.19 Comparison of Mean squared error.....	29
Figure 2.20(a) Spectral plot of the channel using Gaussian interpolation.....	30
Figure 2.20(b) Spectral plot of the channel using Wiener interpolation.....	30
Figure 2.20(c) Spectral plot of the channel using FFT interpolation.....	30
Figure 2.21 Simulated and Analytical Performance of 16-QAM with only amplitude error.....	33
Figure 2.22 Simulated and Analytical Performance of 16-QAM with amplitude and phase error.....	36
Figure 3.1 Spectral efficiency of constant and variable power.....	39
Figure 3.2 Basic flow diagram of adaptive modulation.....	41
Figure 3.3 Theoretical BER performance in AWGN.....	44
Figure 3.4 Theoretical BER performance of adaptive modulation for BER target of 10 %.....	44
Figure 3.5 Theoretical BER performance of adaptive modulation for BER target of 1 %.....	44
Figure 3.6 Theoretical BER performance of adaptive modulation for BER target of 0.1%.....	45
Figure 3.7 Theoretical spectral efficiency of adaptive modulation for all the three BER targets.....	45
Figure 3.8(a) BER performance of adaptive modulation with perfect channel at BER = 10%.....	47
Figure 3.8(b) Spectral Efficiency of adaptive modulation with perfect channel at BER=10%.....	47
Figure 3.9(a) BER performance of adaptive modulation with perfect channel at BER = 1%.....	47

Figure 3.9(b) Spectral Efficiency of adaptive modulation with perfect channel at BER=1%.....	47
Figure 3.10(a) BER performance of adaptive modulation with perfect channel at BER=0.1%.....	47
Figure 3.10(b) Spectral Efficiency of adaptive modulation with perfect channel at BER=0.1%.....	47
Figure 3.11 A segment of the variations in the fading channel at BER = 1% and 30dB...49	
Figure 3.11 (a) BER performance of adaptive modulation in the presence of frame delays.....	50
Figure 3.11 (b) Spectral efficiency of adaptive modulation in the presence of frame delays.....	50
Figure 3.12 (a) BER performance of adaptive modulation in the presence of frame delays.....	51
Figure 3.12 (b) Spectral efficiency of adaptive modulation in the presence of frame delays.....	51
Figure 3.13 (a) BER performance of adaptive modulation with different Doppler frequency.....	53
Figure 3.13 (b) Spectral efficiency of adaptive modulation with different Doppler frequency.....	53
Figure 3.14 (a) BER performance of adaptive modulation with different Doppler frequency.....	53
Figure 3.14 (b) Spectral efficiency of adaptive modulation with different Doppler frequency.....	53
Figure 3.15(a) BER performance for the adaptive modulation with the Gaussian interpolator at BER = 0.1%.....	56
Figure 3.15(b) Spectral efficiency of the adaptive modulation with the Gaussian interpolator at BER = 0.1%.....	56
Figure 3.15(c) BER performance for the adaptive modulation with the Gaussian interpolator at BER =1%.....	56
Figure 3.15(d) Spectral efficiency of the adaptive modulation with the Gaussian interpolator at BER =1%.....	56

Figure 3.15(e) BER performance for the adaptive modulation with the Gaussian interpolator at BER =10%.....	57
Figure 3.15(f) Spectral efficiency of the adaptive modulation with the Gaussian interpolator at BER =10%.....	57
Figure 3.16 (a) BER performance of adaptive modulation with feedback delay for FFT interpolation at BER target = 0.1%.....	57
Figure 3.16 (b) Spectral efficiency of adaptive modulation with feedback delay for FFT interpolation at BER target = 0.1%.....	57
Figure 4.1 Performance of Static and Adaptive Modulation with Perfect and Estimated SNR ($N = 32$).....	63
Figure 4.2 (a) BER performance of Adaptive Modulation with short term SNR estimation at Doppler 5Hz with and without the perfect knowledge of channel SNR.....	67
Figure 4.2 (b) Spectral efficiency of Adaptive Modulation with short term SNR estimation at Doppler 5Hz with and without the perfect knowledge of channel SNR.....	67
Figure 4.3 (a) BER performance of Adaptive Modulation with short term SNR estimation at different Dopplers of at a BER target of 0.1%.....	68
Figure 4.3 (b) Spectral efficiency of Adaptive Modulation with short term SNR estimation at different Dopplers at a BER target of 0.1%.....	68
Figure 4.4 (a) BER performance for the short term SNR estimation at low Doppler of 5Hz at BER target of 0.1%.....	70
Figure 4.4 (b) Spectral efficiency for the short term SNR estimation at low Doppler of 5Hz.....	70
Figure 4.5 (a) Estimated vs. True SNR performance for the short term SNR estimation at Doppler 50Hz.....	70
Figure 4.5 (b) Estimated vs. True SNR performance for the Improved short term SNR estimation at Doppler 50Hz.....	70
Figure 4.6 (a) BER performance for the short term SNR estimation at Doppler 50Hz...	71
Figure 4.6 (b) Spectral efficiency for the short term SNR estimation at Doppler 50Hz..	71
Figure 4.7 (a) BER performance for the short term SNR estimation at Doppler 5Hz	72
Figure 4.7 (b) Spectral efficiency at Doppler 5Hz.....	72
Figure 4.7 (c) BER performance for the short term SNR estimation at Doppler 50Hz...	72

Figure 4.7 (d) Spectral efficiency at Doppler 50Hz.....	72
Figure 4.8 (a) BER performance for the short term SNR estimation at Doppler 50Hz....	74
Figure 4.8 (b) Spectral efficiency for the short term SNR estimation at Doppler 50Hz..	74
Figure 4.9(a) Theoretical BER performance of different modulation schemes in Rayleigh fading.....	77
Figure 4.9(b) Theoretical BER performance of adaptive modulation with perfect long term SNR estimation for BER target of 0.1 %.....	77
Figure 4.9(c) Theoretical BER performance of adaptive modulation with perfect long term SNR estimation for BER target of 1 %.....	77
Figure 4.9(d) Theoretical BER performance of adaptive modulation with perfect long term SNR estimation for BER target 10 %.....	77
Figure 4.9(e) Spectral efficiency of adaptive modulation with perfect long term SNR estimation for all BER targets.....	77
Figure 4.10 (a) BER performance of conventional Long term SNR estimation for BER target of 1 %.....	78
Figure 4.10 (b) Spectral Efficiency of conventional Long term SNR estimation for BER target of 1 %.....	78
Figure 4.11 (a) Conventional Long term SNR estimation at $F_d = 10\text{Hz}$ for BER target of 1 %.....	79
Figure 4.11 (b) Improved Long term SNR estimation at $F_d = 10\text{Hz}$ for BER target of 1 %.....	79
Figure 4.11 (c) Conventional Long term SNR estimation at $F_d = 50\text{Hz}$ for BER target of 1 %.....	79
Figure 4.11 (d) Improved Long term SNR estimation at $F_d = 50\text{Hz}$ for BER target of 1 %.....	79
Figure 4.12 (a) BER performance of long term SNR estimation at BER target 1% with Doppler = 50Hz.....	80
Figure 4.12 (b) Spectral efficiency of long term SNR estimation at BER target 1 % with Doppler = 50Hz.....	80
Figure 4.13 (a) BER performance of long term adaptive modulation at Doppler = 10Hz	82
Figure 4.13 (b) Spectral efficiency of long term adaptive modulation.....	82

Figure 4.13 (c) BER performance of long term adaptive modulation.....	82
Figure 4.13 (d) Spectral efficiency of long term adaptive modulation.....	82
Figure 4.14 (a) BER performance of adaptive modulation with different Doppler frequency.....	84
Figure 4.14 (b) Spectral efficiency of adaptive modulation with different Doppler frequency.....	84
Figure 4.15 (a) BER curve for the adaptive modulation with Doppler =10Hz.....	85
Figure 4.15 (b) Spectral efficiency of the adaptive modulation with Doppler = 10Hz....	85
Figure 4.16 (a) BER performance of Improved Long Term Adaptive Modulation.....	86
Figure 4.16 (b) Spectral efficiency of Improved Long Term Adaptive Modulation.....	86
Figure 4.16 (c) BER performance of Improved Short Term Adaptive Modulation.....	87
Figure 4.16 (d) Spectral efficiency of Improved Short Term Adaptive Modulation.....	87

LIST OF TABLES

Table 2.1 Pilot symbols used in different modulation schemes.....	6
Table 2.2 Specifications for Gaussian interpolation.....	20
Table 2.3 Specifications used for the simulation results of Figures 2.18.....	28
Table 2.4 Specifications used for the simulation results of Figures 2.19.....	29
Table 2.5 summarizes the parameters that are used in the Equation 2.24.....	31
Table 2.6 Coefficients in the BER of 16QAM	32
Table 2.7 Gives the values of r and ρ for 16-QAM.....	33
Table 2.8 Coefficients in the BER Calculation of 16-QAM with amplitude and phase error.....	35
Table 3.1 Summary of Switching Levels.....	42
Table 3.2 Specifications used for the simulation results of Figures 3.8-3.10.....	48
Table 3.3 Frequency of Occurrence for different modulation schemes at 30dB average SNR.....	49
Table 3.4 Specifications used for the simulation results of Figures 3.13-3.14.....	52
Table 3.5 Specifications used for the simulation results of Figures 3.15.....	54
Table 3.6 Specifications used for the simulation results of Figures 3.16.....	55
Table 4.1 Summarizes the conditions on the estimated SNR.....	65
Table 4.2 Specifications used for the simulation results of Figures 4.2.....	66
Table 4.3 Relationship between Frame Rate and Doppler rate for Simulations in Figure 4.3	68
Table 4.4 Summary of Switching Levels.....	76
Table 4.5 Specifications used for the simulation results of Figures 4.13	81
Table 4.6 Specifications used for the simulation results of Figures 4.14.....	84