

**PERFORMANCE EVALUATION OF GROUND TO
SATELLITE OPTICAL LINK AND STRATEGIES
FOR PERFORMANCE IMPROVEMENT**

by

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Certificate

This is to certify that the thesis entitled “**Performance Evaluation of Ground to Satellite Optical Link and Strategies for Performance Improvement**” being submitted by Ms. Hemani Kaushal (nee Sharma) to the Department of Electrical Engineering, Indian Institute of Technology Delhi is the record of the bonafide research work carried out by her. She has worked under our supervision and guidance during the period July 2007 to May 2012. She has fulfilled all the requirements for submission of the thesis which has reached the requisite standard.

The results contained in the thesis has not been submitted either in part or in full to any other university or institute for the award of any degree or diploma.

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Abstract

The increasing demand for high bandwidth requirements have generated renewed interest in free space optical (FSO) communication links. Also, FSO links are an attractive technology for broadband communications where fiber optic links are not feasible. The transition from conventional radio frequency (RF) band to optical and near infrared band offers the capability to increase the data rate by several orders of magnitude. The other advantages offered by a FSO link are its low mass and less power requirement, immunity to interference and unlicensed spectrum. Most of the advantages are due to the higher frequency of optical signals as compared to RF signals. However, the signal in FSO link suffers due to the adverse effects (viz., absorption, scattering and turbulence) of the atmospheric channel. Out of these three effects, the atmospheric turbulence is a major challenge that may lead to serious degradation in the link performance and make the communication link infeasible.

The work reported in this thesis is concerned with the effect of atmospheric turbulence on the link performance of ground-to-satellite FSO system for coherent (subcarrier BPSK and QPSK) and noncoherent (OOK and M-PPM) schemes. Various strategies to improve the link performance have been investigated. It is seen that link BER performance is affected with change in transmitter beam size, zenith angle and operating wavelength. Therefore, the effect of beam size for coherent and noncoherent modulation schemes has been investigated for various zenith angles and operating wavelengths in weak atmospheric turbulence. To achieve the better propagation of laser beam through turbulent atmosphere, an optimization of transmitter beam size is carried out.

A comparative study of both coherent and noncoherent modulation schemes have been made using two performance metrics i.e., BER and acquisition time. Further, the improvement in the link performance using transmit diversity has been worked out. In the

analysis for transmit diversity, effect of correlation among the transmitting antennae beams has been incorporated. In addition to transmit diversity, error correcting coding techniques i.e., convolutional and LDPC codes are also used to improve the link BER performance. Improvement with these coding schemes in terms of coding gain (in dB) has been evaluated for both the modulation schemes. Finally, for a given requirements, a link power budget has been made for SC-BPSK modulation scheme. The variations of link margin with zenith angle have been studied. It is seen that the link margins decrease continuously with the increase in zenith angles for single transmitter and transmit diversity. However, the decrease in the link margin with zenith angle is relatively less in transmit diversity as compared to single transmitter. Also, transmit diversity provides more gain at higher zenith angles i.e., in adverse conditions. Further, the gain provided by the LDPC code is much more than the gain provided by transmit diversity irrespective of the zenith angle. Usage of LDPC code becomes more advantageous than transmit diversity especially at higher zenith angles and is more effective in improving the link margin for same BER and data rate requirements in weak atmospheric turbulence channel.

Contents

Certificate	i
Acknowledgements	ii
Abstract	iii
List of Figures	ix
List of Tables	xv
List of Symbols	xvii
List of Abbreviations	xxi
1 Introduction to Free Space Optical Communication	1
1.1 Overview of Free Space Optical Communication	1
1.2 Advantages of FSO Communication over Radio Frequency Communication .	3
1.3 Characteristics of Atmospheric Optical Channel	5
1.3.1 Atmospheric Loss	6
1.3.1.1 Absorption and Scattering Loss	6
1.3.1.2 Free Space Loss	9
1.3.1.3 Beam Divergence Loss	9
1.3.1.4 Pointing Loss	10
1.3.2 Atmospheric Turbulence	11
1.3.2.1 Beam Wander Effect	15

1.3.2.2	Scintillation Effect	19
1.3.3	Atmospheric Turbulent Channel Model	21
1.4	Effect of Atmospheric Turbulence on Gaussian Beam	27
1.4.1	Conventional Rytov Approximation	31
1.4.2	Modified Rytov Approximation	34
1.5	Techniques for Turbulence Mitigation	36
1.5.1	Aperture Averaging	37
1.5.2	Spatial Diversity	38
1.5.3	Adaptive Optics	40
1.5.4	Coding	43
1.6	Research Objectives	44
1.7	Outline of the Thesis	46
1.8	Major Contributions	49
2	FSO System Modules and Design Issues	51
2.1	Optical Transmitter	53
2.1.1	Choice of Laser	55
2.1.2	Modulators and Encoders	57
2.1.3	Acquisition, Tracking and Pointing (ATP) System	61
2.2	Optical Receiver	64
2.2.1	Communication Detectors	64
2.2.2	Beacon Detectors	65
2.2.3	Issues in Optical Receiver	65
2.3	Link Design Trade-off	73
2.3.1	Operating Wavelength	75
2.3.2	Aperture Diameter	77
2.3.3	Receiver Optical Bandwidth	78
3	Optimum Beam Size for Different Modulation Schemes	79
3.1	Beam Wander and its Effect on Scintillation Index	80
3.2	Optimum Beam Size for Turbulence Atmosphere	84

3.2.1	Coherent Subcarrier Modulation Schemes	86
3.2.2	Noncoherent Modulation Schemes	89
3.2.3	Optimization Process for Beam Size	95
3.2.4	Choice of Optimum Beam Size for Coherent and Noncoherent Modulation Schemes	100
3.3	Experimental Study on Beam Wander	102
3.3.1	Experimental Setup	102
3.3.1.1	Beam Wander Variance Measurement	103
3.3.1.2	Experimental Results	104
3.4	Observations and Conclusions	106
4	BER Evaluation for Different Modulation Schemes	107
4.1	System Model	108
4.1.1	Transmitter	109
4.1.2	Atmospheric Channel	111
4.1.3	Receiver	111
4.2	BER Evaluation with Spatial Diversity	113
4.2.1	Coherent Subcarrier Modulation Schemes	114
4.2.2	Noncoherent Modulation Schemes	119
4.3	Choice of Appropriate Modulation Scheme and Diversity Level	126
4.4	Observations and Conclusions	130
5	Acquisition Time Evaluation for Different Modulation Schemes	131
5.1	Acquisition Link Configuration	132
5.1.1	Acquisition Uncertainty Area	132
5.1.2	Acquisition Time	134
5.2	Beam Divergence and Power Criteria for Acquisition	136
5.3	Description of Receiver for Acquisition	138
5.4	Acquisition Time Evaluation with Spatial Diversity	140
5.4.1	Coherent Subcarrier Modulation Schemes	141
5.4.2	Noncoherent Modulation Schemes	144

5.5	Modulation Scheme with Minimum Acquisition Time	148
5.6	Observations and Conclusions	152
6	Link Performance Improvement with Different Coding Techniques	153
6.1	Channel Capacity and Various Statistical Models	155
6.1.1	Statistical Model for Direct Detection	156
6.1.1.1	The Poisson Channel Model for Ideal Photodetectors	156
6.1.1.2	The McIntyre-Conradi Model for APDs	156
6.1.1.3	Additive White Gaussian Noise Approximation	158
6.1.2	Channel Coding Gain	159
6.2	Error Correcting Coding Techniques	159
6.2.1	Convolutional Codes	160
6.2.2	Low Density Parity Check Codes	161
6.3	Coding Gain for FSO Channel	163
6.3.1	Coherent Subcarrier Modulation Schemes	163
6.3.2	Noncoherent Modulation Schemes	166
6.4	Choice of Appropriate Coding Scheme	169
6.5	Observations and Conclusions	170
7	Link Feasibility Study	171
7.1	Link Requirements and Basic Parameters	171
7.1.1	Transmitter Parameters	174
7.1.2	Atmospheric Transmission Loss Parameter	176
7.1.3	Receiver Parameters	176
7.1.4	Receiver Power Requirements	177
7.2	Link Power Budget	179
7.3	Observations and Conclusions	182
8	Conclusions	183
8.1	Suggestions for Future Work	187
	Bibliography	188