



Cairo University

OPTIMUM DESIGN OF MULTIPLE ACCESS POINTS VISIBLE LIGHT COMMUNICATION SYSTEMS

By

Mai Badawi Sayed Ali Kafafy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Electronics and Communications Engineering

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Title of Thesis:

Optimum Design of Multiple Access Points Visible Light Communication Systems

Key Words:

Visible Light Communication; Illumination; System Design, Power Consumption, Multiple Access

Summary:

This thesis answers a number of crucial questions on designing multi-user indoor visible light communication systems with multiple access points. These questions include the effect of the multiple access, illumination conditions, and room occupancy on the performance of visible light communication systems and its power consumption. The thesis formulates and statistically characterizes the power consumed by orthogonal and non-orthogonal multiple access techniques to support multi-users with specific quality of service. It also derives formulas to decide which lamps should support visible light communication in buildings that use their already existing lighting infrastructure. It also provides a methodology to jointly optimize the design of visible light communication alongside illumination. This joint design is suitable for buildings whose lighting is yet to be designed or renovated. All the design depend on information that is readily available to the system designer. The thesis also proposes a resource allocation algorithm to maximize the power efficiency of systems that allow hybrid visible light and radio frequency communications.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the reference section.

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Table of Contents

Disclaimer	i
Acknowledgements	ii
Table of Contents	iii
List of Tables	vi
List of Figures	vii
List of Abbreviations and Symbols	x
Abstract	xiv
1 Introduction	1
1.1 Visible Light Communication	1
1.2 Thesis Contribution	3
1.3 Thesis Organization	5
2 Literature Review	6
2.1 VLC modulation techniques	6
2.1.1 Intensity modulation/ Direct detection	6
2.1.1.1 Single Carrier Modulation	7
2.1.1.2 Multi-Carrier Modulation	8
2.1.2 Color Modulation	9
2.1.3 Intensity and Color Modulation	11
2.1.4 Dimming schemes	12
2.2 VLC multiple access techniques	14
2.2.1 Frequency Division	14
2.2.2 Interleave Division	14
2.2.3 Code Division	15
2.2.4 Spatial Division	15
2.2.5 Wavelength and Color Division	16
2.2.6 Power Division	17
2.3 MIMO Techniques	19
2.4 Interference Mitigation	21
2.5 Designing VLC systems	23
2.6 VLC Experiments and Commercial Products	24
2.6.1 Experimental Rates	25
2.6.2 Commercial Rates	25
2.7 Hybrid VLC/RF systems	25
2.8 Power Efficiency	27

3	System Model	29
3.1	Lamp Model and VLC Channel	29
3.2	Indoor Setup	30
3.2.1	A Two-dimensional Corridor Model	30
3.2.2	A Three-dimensional Room Model	31
3.3	Users Positions	32
3.4	Indoor Illumination Conditions	32
3.5	VLC Performance Metrics	33
4	Minimizing VLC Power Consumption for NOMA and OMA Techniques	35
4.1	Non Orthogonal Multiple Access (NOMA)	35
4.2	Orthogonal Multiple Access (OMA)	36
4.3	Performance Evaluation	36
4.4	Statistical Characterization of VLC Power Consumption	40
4.4.1	System Model	41
4.4.2	PDF of NOMA VLC power consumption	43
4.4.3	PDF of OMA VLC power consumption	44
4.4.4	Simulation Results	45
4.4.4.1	NOMA	45
4.4.4.2	OMA	49
4.5	Summary and Conclusions	51
5	Optimizing the Inter-distance between Transmitter in Multi-VAP Systems	52
5.1	The Average Rate per User	52
5.1.1	Water-filling based Power Allocation Technique (WFPA)	54
5.1.2	Max-Min Rate based Power Allocation Technique (MMRPA)	56
5.2	Numerical results	57
5.3	Summary and Conclusions	63
6	Designing Multi-VAP Systems under Illumination and Communication Constraints	64
6.1	Two-dimensional Narrow Corridors	64
6.1.1	Formulation of the Multi-VAP System Design	65
6.1.2	Effect of Design Parameters on Illumination Constraints	66
6.1.2.1	Illumination Consistency Ratio	67
6.1.2.2	Average Illumination	69
6.1.3	Effect of Design Parameters on Objectives	71
6.1.3.1	Power Consumption	71
6.1.3.2	Achieved Rate per User	72
6.1.4	Optimum Strategy for Multi-VAP System Design	75
6.2	Three-dimensional Rooms	83
6.3	Effect of Illumination and Room Occupancy on Average Rate per User	89
6.4	Summary and Conclusions	93

7	Power Efficiency of Multi-VAP Hybrid RF/VLC Systems	94
7.1	Maximization of the system power efficiency	95
7.2	Joint Locally Optimal Bandwidth and Power Allocation Scheme	96
7.2.1	RF/VLC Power Allocation Subproblem	97
7.2.2	RF/VLC Bandwidth Allocation	99
7.2.3	Computational Complexity	101
7.3	Numerical Results	101
7.4	Summary and Conclusions	106
8	Summary and Conclusions	107
	References	109
	List of Publications	125

List of Tables

3.1	Simulation parameters	34
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List of Figures

1.1	Optical wireless communications	2
2.1	Illustration of intensity modulation	7
2.2	Variations of pulse position modulation	8
2.3	color chromaticity diagram	10
2.4	Two sets with metatametrically equivalent points	11
2.5	VLC modulation techniques	12
2.6	Analog and digital dimming	12
2.7	Contour plot of the phase modulation in spatial light modulator	16
2.8	An 18 LED angle diversity transmitter	16
2.9	Orthogonal and non-orthogonal multiple access techniques	17
2.10	VLC multiple access techniques	18
2.11	VLC MIMO Techniques	19
2.12	Techniques for hybrid RF/VLC load balancing	27
3.1	VLC Tx-Rx link	29
3.2	Side view of a 2D corridor	31
3.3	The ceiling of an $L \times L$ room	31
4.1	Lamp locations on the ceiling	37
4.2	Illumination contours in the room (lux)	37
4.3	VAP setup	37
4.4	VLC power consumption Vs R_{min} (at $ U =8$ users)	38
4.5	VLC power consumption Vs $ U $ (at $R_{min} = 10$ Mbps)	39
4.6	Bit error rate	40
4.7	Statstical system model	41
4.8	PDF absolute difference versus number of VAPs $ \tilde{V} $ (at $ U =1$ and $R_{min}=25$ Mbps)	45
4.9	Scaled PDF of VLC power consumption per AP (at $ U =1$ and $R_{min}=25$ Mbps)	46
4.10	PDF absolute difference versus number of users $ U $ ($R_{min}=25$ Mbps at $ \tilde{V} = 30$)	47
4.11	PDF absolute difference versus minimum user rate R_{min} (at $ U =4$ $ \tilde{V} =30$)	47
4.12	Scaled PDFs of VLC power consumption per VAP (at $ \tilde{V} =30$)	48
4.13	PDF absolute difference versus number of users $ U $ ($R_{min}=25$ Mbps at $ \tilde{V} = 30$)	49
4.14	PDF absolute difference versus minimum user rate R_{min} (at $ u =4$ $ \tilde{V} =30$)	49
4.15	Scaled PDFs of VLC power consumption per VAP (at $ \tilde{V} =30$)	50
5.1	Example of an Indoor Setup	53
5.2	Optimal inter-VAP distance for different corridor dimensions (at $\lambda = \frac{2}{3}$ user/m, $F=1$)	58
5.3	Optimal number of VAPs for different corridor dimensions (at $\lambda = \frac{2}{3}$, $F=1$)	59
5.4	Average rate per user (at $L=19$ m, $z=2.3$ m, $F=1$)	60

5.5	Average, minimum, and maximum user rate (at $L=19\text{m}$, $z=2.3\text{m}$, $\lambda = \frac{2}{3}$, $F=1$)	60
5.6	Average rate per user (at $L=19\text{m}$, $z=2.3\text{m}$, $\lambda = \frac{2}{3}$)	61
5.7	Comparison of 2D corridor approximation with 3D corridors (at $L=19\text{m}$, $z=2.3\text{m}$, $\lambda = \frac{2}{3}$, $F=1$)	62
5.8	Average rate per user for different lamp semi-angles at half intensity, $\theta_{\frac{1}{2}}$, (at $L=19\text{m}$, $z=2.3\text{m}$, $\lambda = \frac{2}{3}$, $F=1$)	63
6.1	The interplay between the design parameters and the performance metrics	66
6.2	Minimum $\theta_{\frac{1}{2}}$ required for different illumination consistency ratios	68
6.3	Required number of LEDs per lamp for $IL_{req}=500\text{lx}$	70
6.4	Power consumption (at $IL_{req} = 500\text{lx}$)	72
6.5	The two objectives (at $D = \frac{L}{5}$ and $IL_{req}=500\text{lx}$)	73
6.6	Optimum $\theta_{\frac{1}{2}}$ for communication	75
6.7	The optimum semi-angle choice for $L=19\text{m}$, $D=L/5$, $IL_{req}=500\text{ lx}$	77
6.8	The two objective plane for $ICR_{req}=0.5$ and $IL_{req}=500\text{ lx}$	78
6.9	The two objective plane for $ICR_{req}=0.7$ and $IL_{req}=500\text{ lx}$	79
6.10	Number of LEDs per lamp at different corridor widths (at $IL_{req} = 500\text{ lux}$)	80
6.11	Power consumption at different corridor widths (at $IL_{req} = 500\text{ lux}$)	81
6.12	The two objectives at different corridor widths (at $IL_{req} = 500\text{ lux}$, $D=L/5$)	82
6.13	Minimum to maximum illumination over 80% of the room	84
6.14	Minimum to average illumination over 80% of the room	84
6.15	$IL_{(x,y)}/IL_{avg}$ (at $D = \frac{L}{7}$)	85
6.16	Minimum to average illumination (at $D = \frac{L}{7}\text{m}$)	86
6.17	Total number of LEDs required for different illumination levels (at $D = \frac{L}{7}\text{m}$)	86
6.18	Power consumption (at $IL_{avg}=500\text{ lx}$)	87
6.19	The ARU and total power consumption (at $D = \frac{L}{7}\text{m}$)	87
6.20	ARU	88
6.21	ARU and IL_{min}/IL_{avg} (at $D = \frac{L}{7}\text{m}$, $IL_{avg}=500\text{ lx}$)	88
6.22	Two objectives	89
6.23	Average user rate for different illumination levels	91
6.24	Average user rate and its lower bound Vs user density (at $IL_{avg} = 500\text{ lx}$ and $IL_{min}/IL_{avg} \geq 0.7$)	92
6.25	Percentage of active VAPs Vs the user density	92
7.1	A room with multi-VAPs and an RF AP	94
7.2	Flowchart of joint power and bandwidth allocation	96
7.3	Power efficiency versus the minimum required rate, R_{min} , (at $ U =8$ users)	102
7.4	Power Efficiency versus the number of users, $ U $, (at $R_{min}=10\text{ Mbps}$) . . .	103
7.5	Ratio of VLC to hybrid rate versus the minimum required rate, R_{min} , (at $ U =8$ users)	103
7.6	Ratio of VLC to hybrid rate versus the number of users, $ U $, (at $R_{min}=10\text{ Mbps}$)	104
7.7	VLC system utilization versus the number of users, $ U $, (at $R_{min}=10\text{ Mbps}$)	104
7.8	Power efficiency for different receiver field of view, FoV, (at $R_{min}=5\text{ Mbps}$ and $ U =8$ users)	105

7.9	Ratio of VLC to hybrid rate for different receiver field of view, FoV, (at $R_{min}=5$ Mbps and $ U =8$ users)	105
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List of Abbreviations and Symbols

List of Abbreviations

2D	Two Dimension
3D	Three Dimension
5G	Fifth Generation
ACO-OFDM	Asymmetrically Clipped Optical OFDM
AP	Access Point
ARU	Average Rate
BER	Bit Error Rate
CAP	Carrierless Amplitude and Phase
CDMA	Code Division Multiple Access
CSK	Color Shift Keying
DCO-OFDM	DC biased Optical OFDM
DFT	Discrete Fourier Transform
DMT	Discrete Multi Tone
FDMA	Frequency Division Multiple Access
HCM	Hadamard Coded Modulation
HetNet	Heterogeneous Network
i.i.d	independent and identically distributed
IDFT	Inverse Discrete Fourier Transform
IDMA	Interleave Division Multiple Access
IEEE	Institute of Electrical and Electronics Engineers
IVD	Inter-VAP Distance
IVI	Inter-VAP Interference

LED	Light Emitting Diode
LiFi	Light Fidelity
LoS	Line of Sight
LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
MISO	Multiple Input Single Output
MMRPA	Max-Min Rate based Power Allocation
NOMA	Non Orthogonal Multiple Access
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OMA	Orthogonal Multiple Access
OOK	On Off Keying
PAM	Pulse Amplitude Modulation
PAPR	Peak to Average Power Ratio
PDF	Power Density Function
PM-OFDM	Position Modulating OFDM
PPM	Pulse Position Modulation
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
RF	Radio Frequency
SC-FDMA	Single Carrier FDMA
SDMA	Space Division Multiple Access
SIC	Successive Interference Cancellation
SINR	Signal to Interference and Noise Ratio