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

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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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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List of Abbreviations and Symbols

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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	Carierless 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