UNIVERSITY OF TECHNOLOGY SYDNEY
Faculty of Engineering and Information Technology

MODELLING AND SIMULATION OF HANDOVER IN LIGHT FIDELITY (LI-FI) NETWORK

by

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A Thesis Submitted
in Partial Fulfillment of the
Requirements for the Degree

Master of Engineering (Research)

Sydney, Australia

12/2020

Certificate of Original Authorship

I, Hieu Danh HUYNH declare that this thesis, is submitted in fulfilment of the requirements for the award of Master of Engineering (Research), in the School of Electrical and Data Engineering, Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institutions.

This research is supported by the Australian Government Research Training Program.

Production Note:

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Date: 12/12/2020

Acknowledgements

I would like to express my special gratitude to my principal supervisor, A/Prof. Dr. Kumbesan SANDRASEGARAN, for the patience, generous support and immense knowledge he afforded me throughout this study.

A special thanks to my parents who were always supporting and encouraging me with their best wishes.

I would also like to thank to Department of Education and Training for giving me financial support in form of a Research Training Program Scholarship (RTPS) scholarship.

Hieu Danh HUYNH

Sydney, Australia, 2020.

List of Publications

The content of this thesis is based on the following papers that have been published or accepted to peer-reviewed conferences.

Conference Papers

C-1. H. D. Huynh, K. Sandrasegaran and S. C. Lam 2018, ‘Modelling and Simulation of Handover in Light Fidelity (Li-Fi) Network’, *TENCON 2018 - 2018 IEEE Region 10 Conference*, pp. 1307-12.

C-2. H. D. Huynh and K. S. Sandrasegaran 2019, ‘Coverage Performance of Light Fidelity (Li-Fi) Network’, *2019* 25^{th} *Asia-Pacific Conference on Communications (APCC)*, pp. 361-66.

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Abbreviation

ADC	Analogue to Digital Converter
ADR	Angle Diversity Receiver
AF	Amplify-and-Forward
AP	Access Point
APS	Access Point Selection
BS	Base Station
CCI	Co-Channel Interference
CCU	Central Controller Unit
CSI	Channel State Information
DAC	Digital to Analogue Converter
DF	Decode-and-Forward
DD	Direct Detection
EGC	Equal Gain Combining
FL	Fuzzy Logic
FOV	Field of View
FR	Frequency Reuse
FSO	Free-Space Optical
IB	In-Band
IM	Intensity Modulation
IR	Infrared
IrDA	Infrared Data Association
JOA	Joint Optimization Algorithm

LAC	Light Fidelity Attocell
LB	Load Balancing
LD	Laser Diode
LED	Light Emitting Diode
Li-Fi	Light Fidelity
LOS	Line of Sight
MAC	Medium Access Control
MIMO	Multiple-Input Multiple-Output
MRC	Maximum Ratio Combining
OBS	Optical Base Station
OPC	Optimum Combining
OWC	Optical Wireless Communications
PD	Photodiode
PDF	Probability Density Function
PF	Proportional Fairness
PPP	Poisson Point Process
QoS	Quality of Service
RF	Radio Frequency
RGB	Red, Green and Blue
SBC	Select Best Combining
SD	Standard Deviation
SDMA	Space-division Multiple Access
SIR	Signal to Interference Ratio
SINR	Signal to Interference plus Noise Ratio
SNR	Signal to Noise Ratio
SOA	Separate Optimization Algorithm
SSL	Solid State Lighting

SSS	Signal Strength Strategy
TDMA	Time Division Multiple Access
UE	User Equipment
VL	Visible Light
VLC	Visible Light Communication
Wi-Fi	Wireless Fidelity

Nomenclature and Notation

Notation	Definition
A	the effective photodetector area
d	the Euclidean distance between AP_i and UE
g	the receiver's optical concentrator gain - gain used to concentrate the received signal of the photodiode detector
$H_{LOS}(0)$	LOS channel gain
$I(0)$	the Lambertian irradiance at the centre of the beam in W/m^2
m	the refractive index
n	order of Lambertian irradiance
n_{rx}	the normal vectors of the receiver plane
n_{tx}	the normal vectors of the transmitter plane
N	the number of users
N_i	users are served by each AP
N^{AP}	the number of AP
R_0	Lambertian radiant intensity - the angular distribution of the radiation intensity pattern
$r_{q,j}$	the rate of j^{th} user when being served by q^{th} AP
$r_1^T, r_2^T, ..., r_Q^T$	rate vectors
T	timeslot T
α	the receiver orientation along the z-axis
β	the receiver orientation along the x-axis

γ	the receiver orientation along the y-axis
ϕ	function angle of irradiance - angle between the transmitter - receiver distance and the vertical axis (from the transmitter)
$\phi_{1/2}$	the half power angle
φ	angle of incidence - angle between the transmitter - receiver distance and the vertical axis (from the receiver)
φ_c	the field of view of the photodiode receiver
$\|\| \|\|$	the Euclidean norm operators
$\|R\|_\infty$	the maximum absolute row sum of the matrix R
"."	the inner product

ABSTRACT

MODELLING AND SIMULATION OF HANDOVER IN LIGHT FIDELITY (LI-FI) NETWORK

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With the demand for faster and secure communication technologies to make our lives better, innovative technologies like Li-Fi (Light Fidelity) are becoming increasingly popular. Li-Fi utilizes Light Emitting Diodes (LEDs) for accomplishing data transmission. This research concentrates around handover algorithms and performance evaluation of a Li-Fi network. Accordingly, the work is outlined in two parts.

Firstly, this research work evaluates the performance of handover algorithms in Li-Fi network. Two handover algorithms are investigated namely, the closest-AP-based algorithm (AP: Access Point) and maximum-channel-gain-based algorithm. Monte Carlo simulations using MATLAB tools are conducted to evaluate handover algorithms and show the impact of User Equipment (UE)'s rotation and movement on handover performance.

Secondly, this research evaluates the performance of a Li-Fi network with multiple beams LEDs on moving UEs. The network performance is investigated in the case of the maximum channel gain. The simulated results show that when the beam angle is 30^o, the Li-Fi system has the best performance in terms of channel gain (hence throughput) by considering its mean and standard deviation (SD) values.