

Prototype Design of Visible Light Communication System for the Road Safety Application

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Presentation Layout

- Introduction
- Objectives
- Tasks Accomplished
- Tasks To Be Carried Out
- Summary

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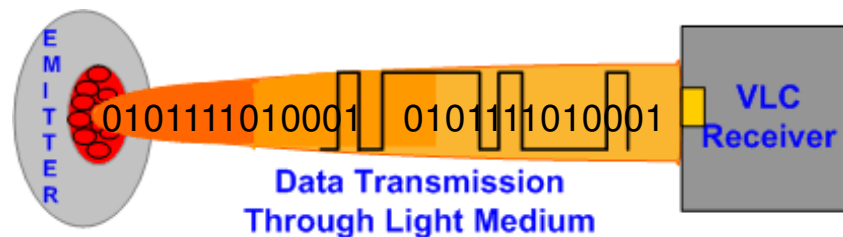


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Prototype Design of Visible Light Communication System for the Road Safety Application

INTRODUCTION: Visible Light Communication (VLC) -

Communication using Visible Spectrum of Light is a new emergent and promising area of research. It has many indoor and outdoor applications.



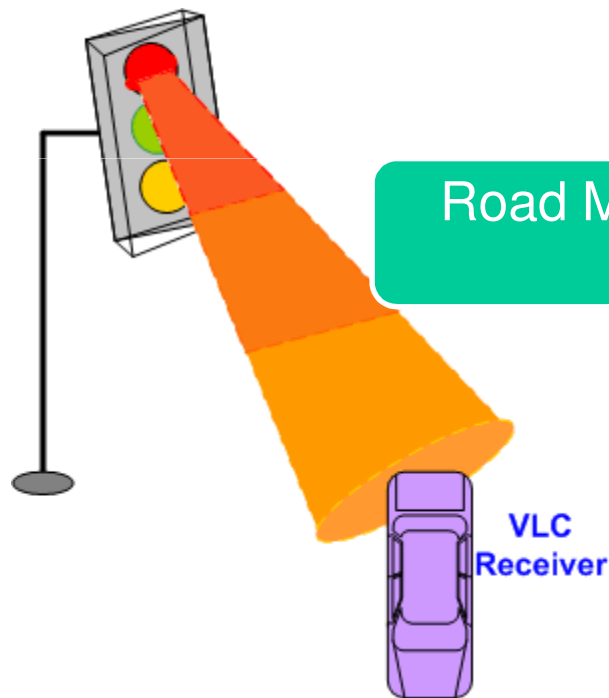
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INTRODUCTIONVLC in Intelligent Transport System (Road Safety)

VLC System in Road Safety Application-

- Uses Light Emitting Diode as Traffic Light.
- Serves as VLC Emitter.



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OBJECTIVES

Overall Objective – To Design a Prototype VLC System suitable for Road Traffic Application.

Major Tasks: (Expected Contributions)

- Conceptual design of VLC system for specified application
- Characterization of LED lights and developing necessary traffic light emitter model.
- Characterization of channel and developing optical channel model
- Developing and designing appropriate modulation and demodulation technique
- Developing noise model
- Characterisation of receiver
- Integration of whole system
- Designing prototype

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ACCOMPLISHED TASKS

- Overall Conceptual Design
- Characterization of LED emitter lights and Development of appropriate Traffic Light Emitter model
- Preliminary Study and Investigation on Modulation and Demodulation Techniques
[Feasibility study of Direct Sequence Spread Spectrum (DSSS) is being carried out. Some preliminary investigation show positive results.]
- Some Studies on Channel Conditions and Possible contributions from various noise sources are also performed.

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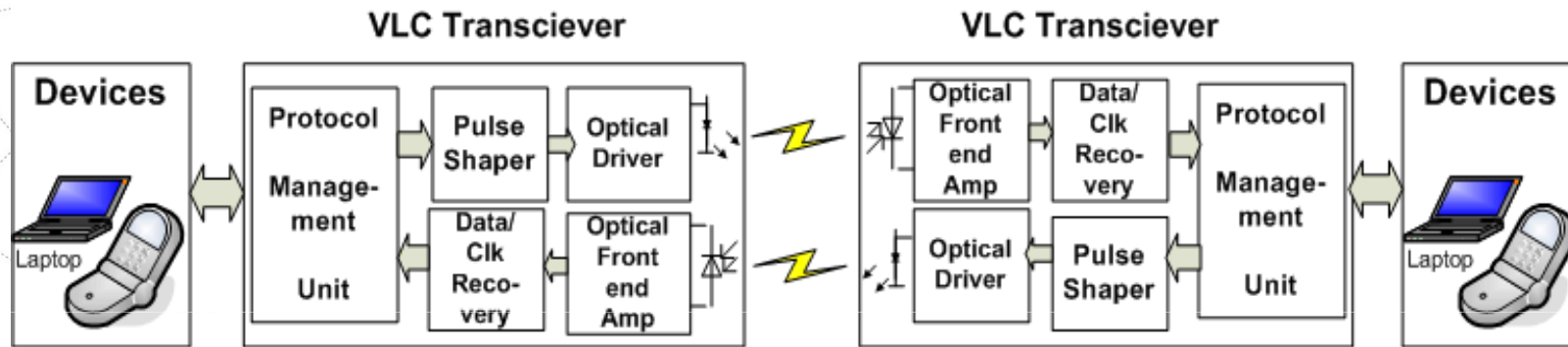


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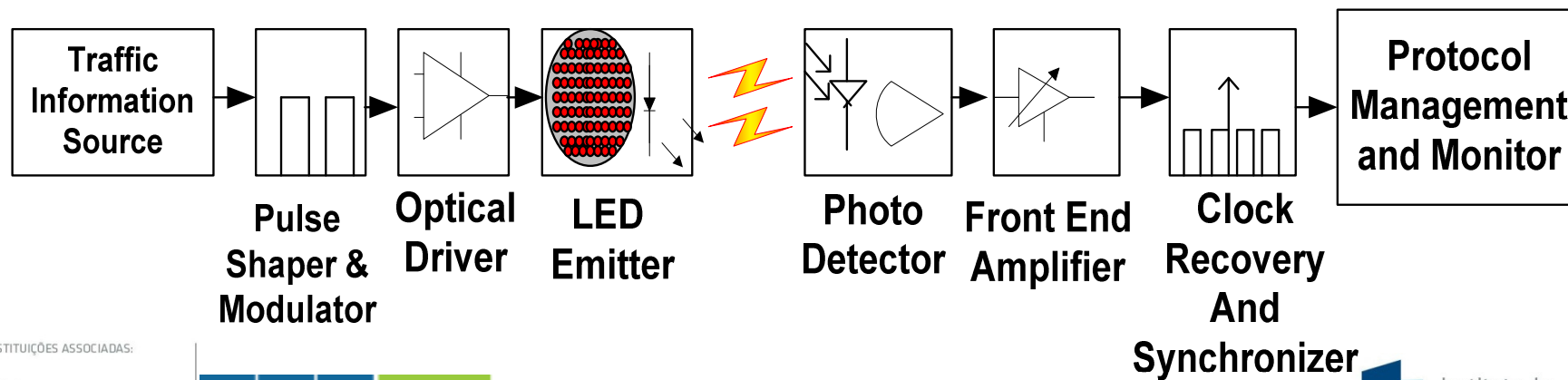


A. Conceptual Design

Block Diagram Representation of Full Duplex Mode VLC System



VLC System For Traffic Information Transmission: Broadcast



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Conceptual Design

However, results on circuit level details are also explored as work progresses

Important Publications:

- (i) “Visible Light Communication Systems Conception and VIDAS”, IETE Technical Review | Vol 25 | Issue 6 | Nov-Dec 2008. (Won the Best Paper Award for 2008-09, IETE – India)
- (ii) “Visible Light for Advanced Driver Assistant Systems”, ConfTele’09, Portugal
- (iii) “Visible Light Communication Systems: A Promising Technology”, Under review for a chapter of IEC Annual book on Communication System 2009 (Already notified for acceptance in 2008 but not published because of some administration change.)

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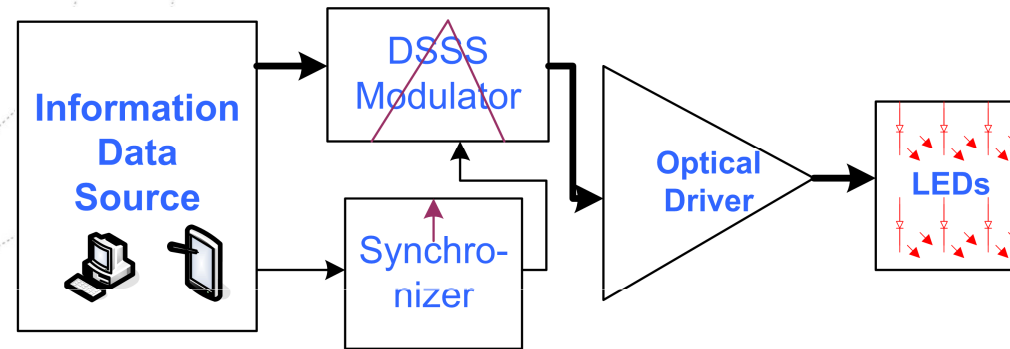


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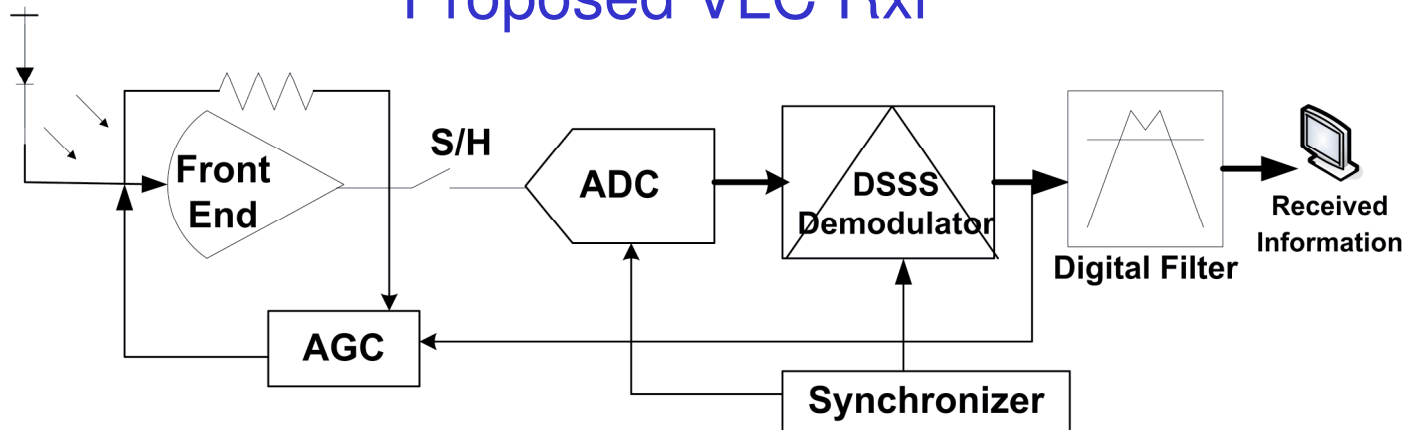
Conceptual Design

Block Level Representation of VLC Transmitter and Receiver –

Proposed
VLC Txr



Proposed VLC Rxr

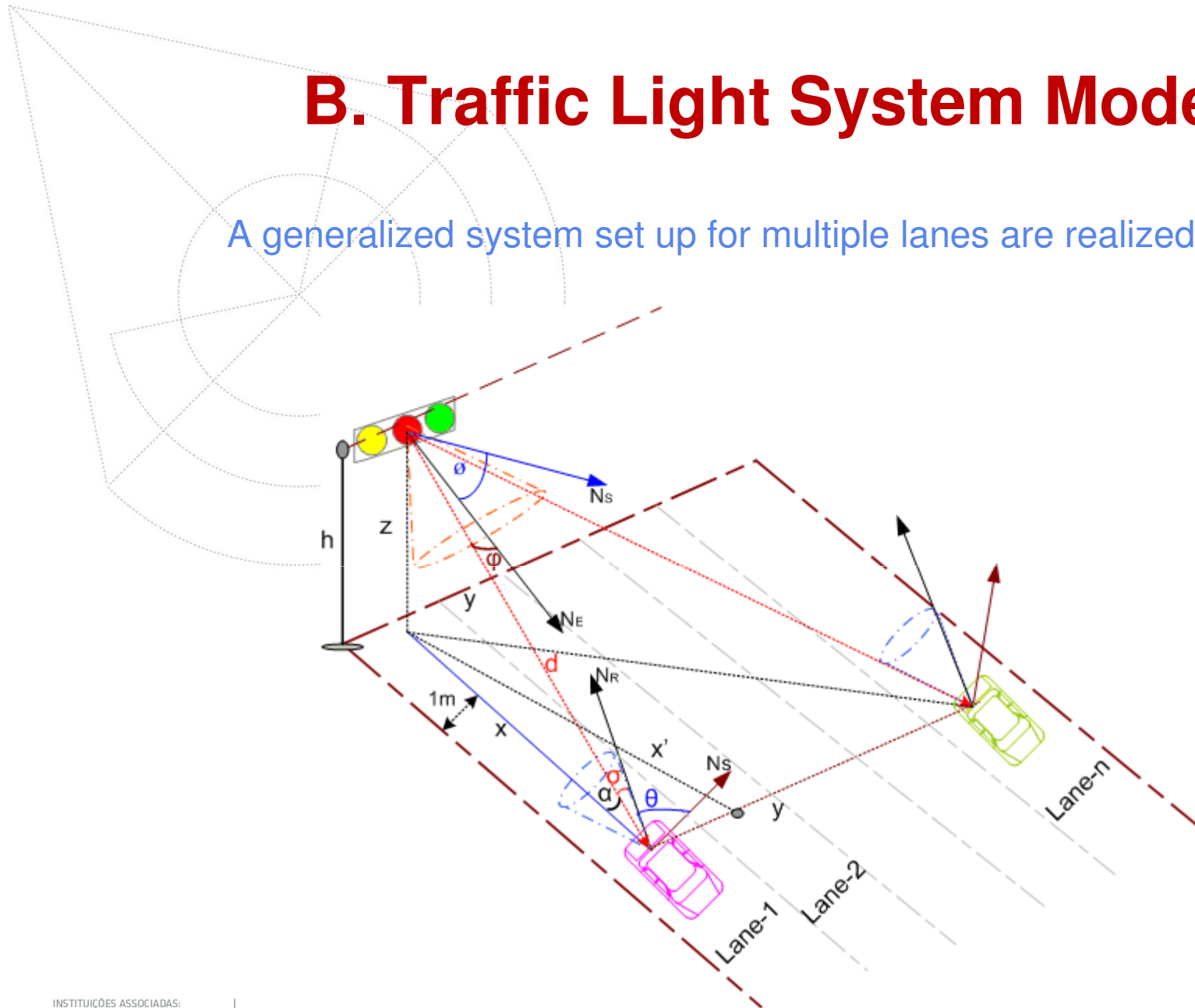


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B. Traffic Light System Model

A generalized system set up for multiple lanes are realized as shown:



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Traffic Light System Model

Important Design Parameters -

Table -1
Design Parameters for Traffic Light System Set UP

Parameters	Meaning/definition and value
h	Height of Traffic Light
z	Height of traffic light from the receiver (h – 1)m
Lane Width	3.5 m
x	Horizontal distance (m) from traffic light to the vehicle in lane 1
y'	Distance (m) from the base of traffic light to the receiver on vehicle in different lane
d	Direct distance (m) from emitter to the detector on lane 1
d'	Direct distance (m) from emitter to the detector on lane 2
$\theta_{1/2}$	Half power semi-angle of emitter (degree)
θ	Orientation of Emitter (degree)
φ	Angle of irradiation (degree)
θ	Orientation of Receiver (degree)
σ	Angle of incidence (degree)
	Width of the vehicle (1.8m)

Traffic Light System Model

Analysis Results for Line-of-sight (LOS) case for the given two lanes road based on Lambertian Model from a single LED light source are presented and published in:

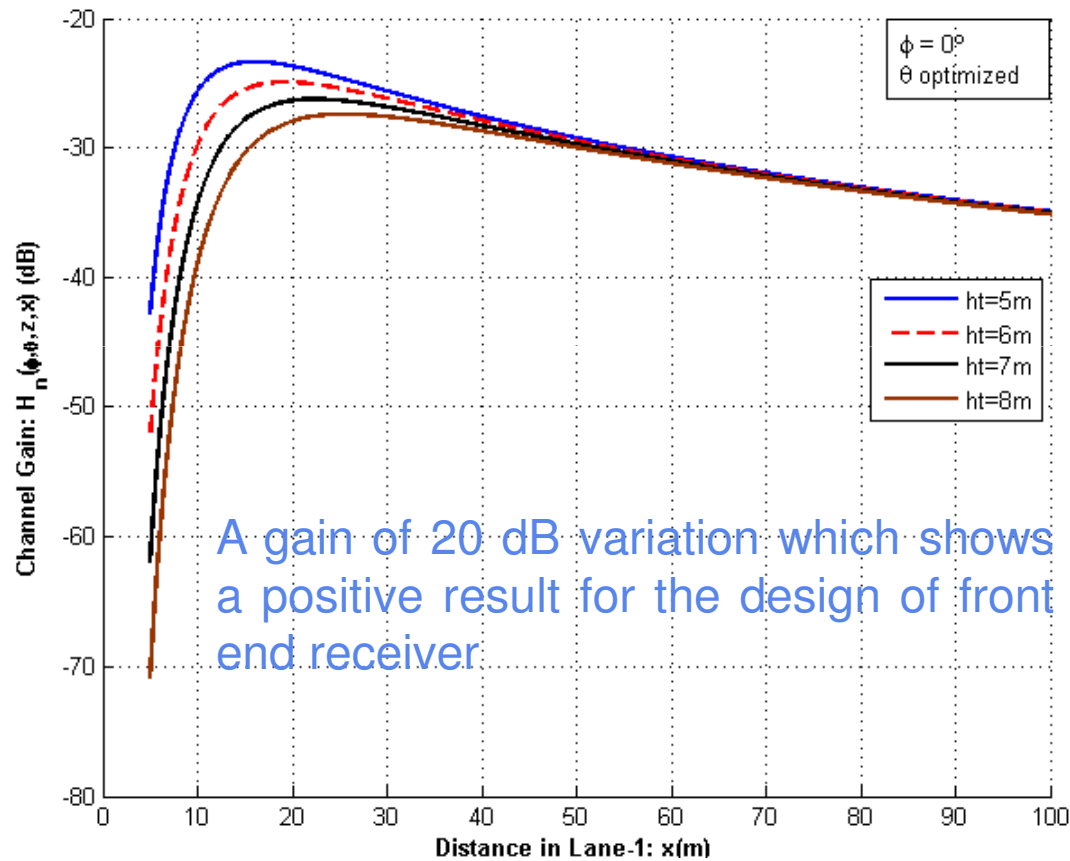
$$Hn(\phi, \theta, x, h) = \frac{(m+1)}{2\pi} \left(\frac{\cos^m\left(\frac{\pi}{2} - \tan^{-1}(x/h) - \phi\right) \cos\left(\tan^{-1}(x/h) - \theta\right)}{h^2 + x^2} \right)$$

Publication:

- (i) "Design and Analysis of the Basic Parameters for Traffic Information Transmission Using VLC", Proceeding of IEEE Int. Conf. WirelessVitae 09, May 2009, Denmark.

Important Results

DC Channel Gain (dB) Variation Over Distance(m) for different Heights of Traffic Light in road lane -1:

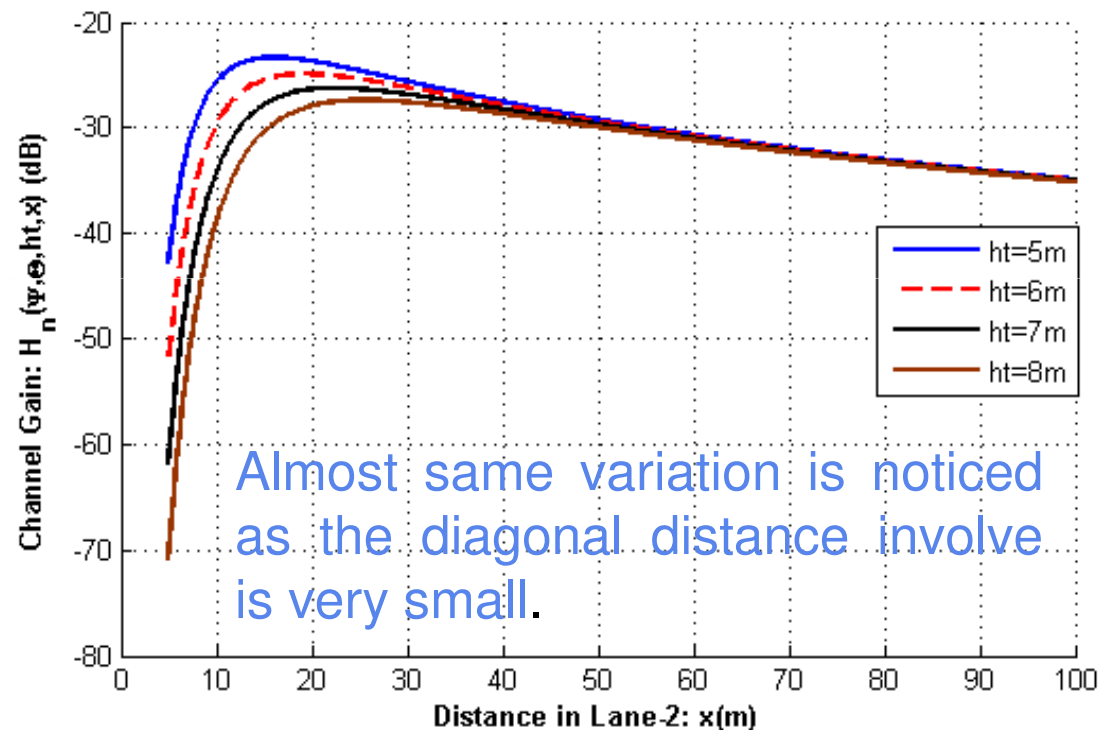


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Important Results

DC Channel Gain (dB) Variation Over Distance(m) for different Heights of Traffic Light in road lane -2:



More results are available in publication listed above.

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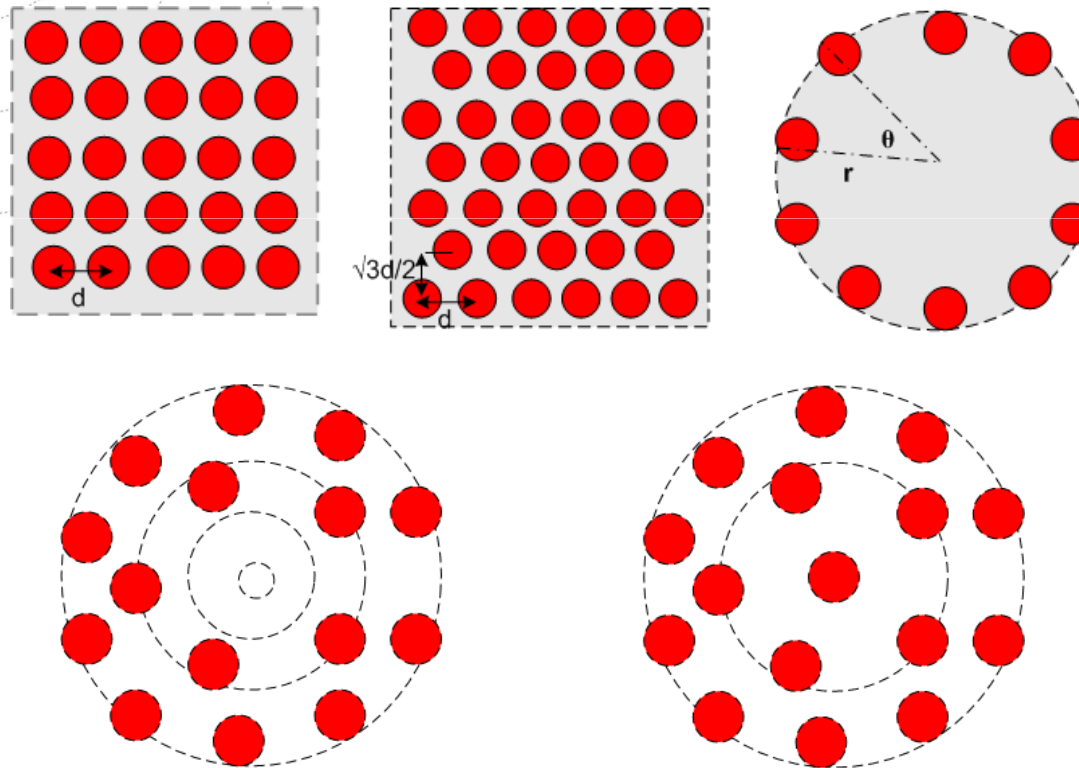


C. Multiple LED Emitter Source

Multiple Configurations have been investigated.

Co-centric circular ring is expected to outperform others.

Final result for the model is near completion.



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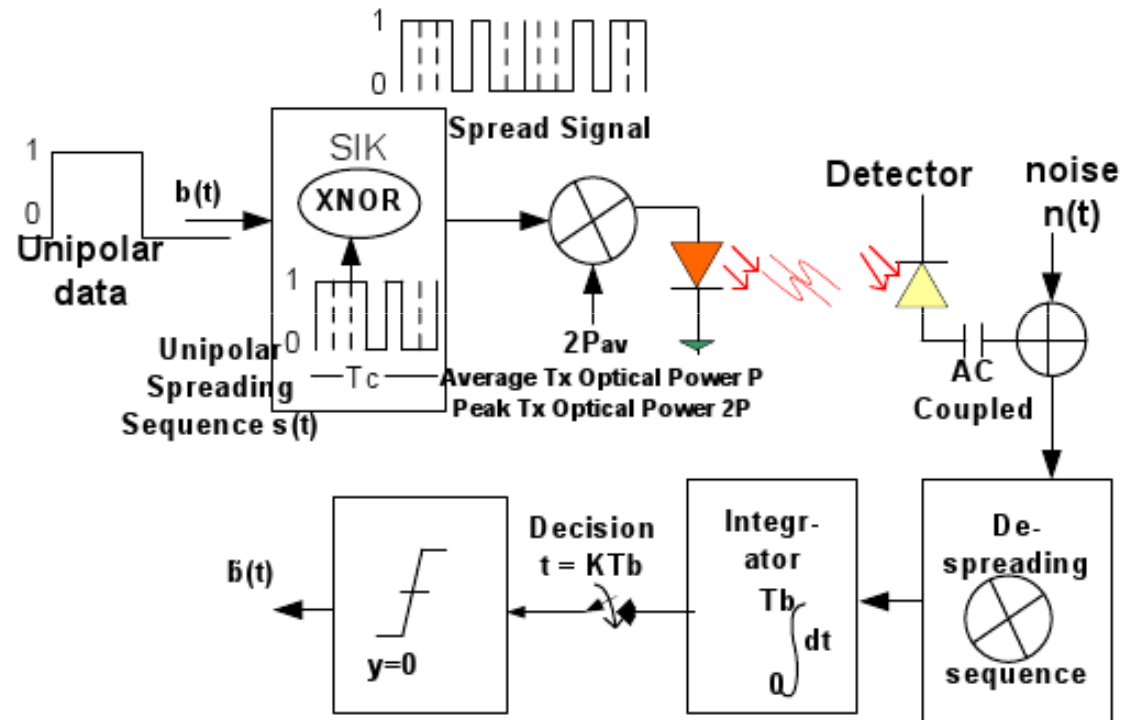


D. Modulation and Demodulation

- Unlike other conventional communication systems, VLC will need a robust Modulation and Demodulation scheme.
- Mainly because of many sources of interference (noise) such as ambient, fluorescent light, day light, lights from other vehicles and so on.
- In addition, different atmospheric conditions will have significant effect on the VLC performance.
- Initial investigation on various conventional modulation techniques such as On-Off-Keying direct detection (OOK), M-Level Pulse Position Modulation (L-PPM) suitable for IR (infrared), Sub-Carrier Phase Shift Keying (SC-PSK), Direct Sequence Spread Spectrum (DSSS) *suggest the use of DSSS Sequence Inverse Keying (SIK).*

Modulation and Demodulation

Direct Sequence Spread Spectrum Sequence Inverse Keying for VLC



Some of the results are available on report

TASKS AHEAD

- Modulation and Demodulation Study and Implementation
- Development of Noise Model after Experimental Measurements
- Integration of systems
- Prototype Design and Testing

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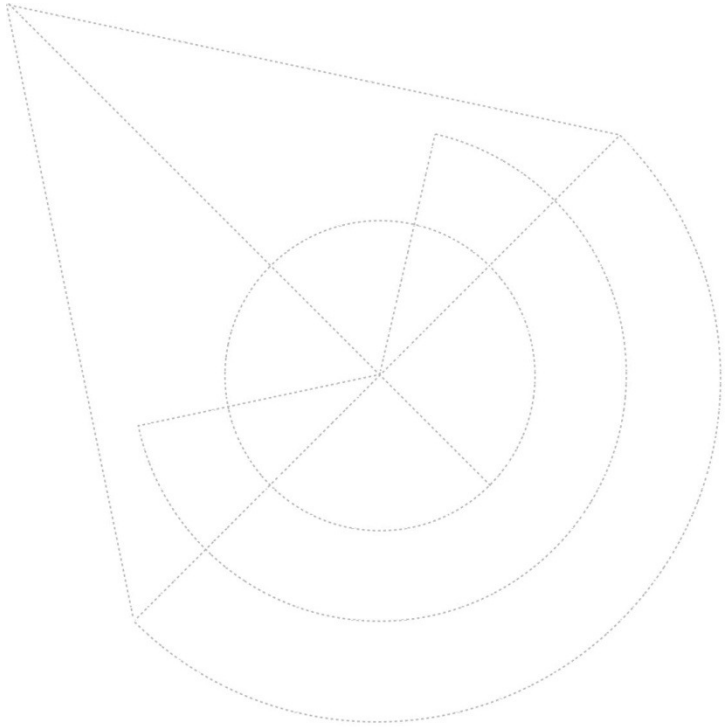
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Summary

- The advancement in LEDs (considered to be the next generation of lighting system) has enhanced the research interest in unlicensed, unharmed visible spectrum of light ($\lambda=400\text{nm} - 700\text{nm}$).
- The VLC systems exploit the inherent characteristics of high rate switching for data communication without interruption to the primary use of LEDs for lighting.
- It is envisioned to be used in a wide range of indoor and outdoor applications using different topologies.
- However, it is challenging and requires many complex models beginning from emitter, channel, noise and so on.
- In this presentation we have discussed important contributions and investigation performed towards achieving prototype design and work in progress with tasks remaining.
- With full devotion, our potential and support from supervisors the design is expected to be available towards the end of coming year.



Thank You !

Questions ?

Acknowledgement

The FCT Grant and FCT Project VIDAS (VIsible light communication for advance Driver Assistant Systems)

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