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THEORETICAL CONCEPTS AND MATLAB MODELLING OF VLC BASED MIMO SYSTEMS

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Introduction
Highly efficient and long lasting LED lights are replacing standard incandescent and fluorescent lighting technologies. Solid-state LEDs have wide frequency bandwidths enabling them to be switched at very high frequencies. Combining the lighting and switching capabilities of the LED enables a dual functional system, where the primary function is room illumination, and the secondary is to act as an optical transmitter as part of a visible light communication (VLC) system. VLC systems present enormous potential for applications in computer networking, control systems and audio/video streaming.

Aims
- Develop MATLAB based computer models to simulate an indoor, short-range 4x4 MIMO VLC system
- Use LED as optical transmitters in a VLC system
- Generate a block diagram of a 4x4 MIMO VLC unidirectional system model

Research Topics
- Lambertian emissions: line-of-sight (LOS)
- Characterization of LEDs and photodiodes (PD)
- Intensity modulation (IM) schemes; DIPPM, digital offset PPM, NRZ-OOK, duo binary PPM
- Error correction coding techniques: maximum likelihood sequence estimation (MLSE) and Reed–Solomon (RS)
- Channel estimation: channel matrix (H)
- Analogue circuits: PD transimpedance amplifiers (TIA), Matching filters (MF) and channel equalization, LED driver transconductance amplifiers (TCA)

Results
- Generated a block diagram of a 4x4 MIMO VLC unidirectional system model (Figure 1)
- Coded and tested MATLAB models to simulate a single LED and 2x2 LED array’s Lambertian radiant intensity (Figure 2)
- Developed a theoretical strategy for modelling the transmitter, channel, receiver, and MIMO channel estimation (Figure 3)

Conclusions
- Successfully generated a block diagram of a 4x4 MIMO VLC unidirectional system model
- Successfully simulated Lambertian intensity of a single LED and 2x2 LED array within a 3D space using MATLAB, also simulated the path time delays from Tx to Rx
- Work continues to develop MATLAB models

Figure 1 Block diagram of a 4x4 MIMO VLC unidirectional system model

Figure 2 MATLAB simulation: Lambertian intensity (Ro)
2x2 LED array within a 3D space 8m x 8m x 2m

Figure 3 4x4 MIMO Channel Matrix/ H Matrix