

Article

Simulation of an Indoor Visible Light Communication System Using Optisystem

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Abstract: Visible light communication (VLC) is an emerging research area in wireless communication. The system works the same way as optical fiber-based communication systems. However, the VLC system uses free space as its transmission medium. The invention of the light-emitting diode (LED) significantly updated the technologies used in modern communication systems. In VLC, the LED acts as a transmitter and sends data in the form of light when the receiver is in the line of sight (LOS) condition. The VLC system sends data by blinking the light at high speed, which is challenging to identify by human eyes. The detector receives the flashlight at high speed and decodes the transmitted data. One significant advantage of the VLC system over other communication systems is that it is easy to implement using an LED and a photodiode or phototransistor. The system is economical, compact, inexpensive, small, low power, prevents radio interference, and eliminates the need for broadcast rights and buried cables. In this paper, we investigate the performance of an indoor VLC system using Optisystem simulation software. We simulated an indoor VLC system using LOS and non-line-of-sight (NLOS) propagation models. Our simulation analyzes the LOS propagation model by considering the direct path with a single LED as a transmitter. The NLOS propagation model-based VLC system analyzes two scenarios by considering single and dual LEDs as its transmitter. The effect of incident and irradiance angles in an LOS propagation model and an eye diagram of LOS/NLOS models are investigated to identify the signal distortion. We also analyzed the impact of the field of view (FOV) of an NLOS propagation model using a single LED as a transmitter and estimated the bitrate (R_b). Our theoretical results show that the system simulated in this paper achieved bitrates in the range of 2.1208×10^7 to 4.2147×10^7 bits/s when the FOV changes from 30° to 90° . A VLC hardware design is further considered for real-time implementations. Our VLC hardware system achieved an average of 70% data recovery rate in the LOS propagation model and a 40% data recovery rate in the NLOS propagation model. This paper's analysis shows that our simulated VLC results are technically beneficial in real-world VLC systems.

Keywords: visible light communication (VLC); light-emitting diode (LED); optical communications; optisystem



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1. Introduction

With the development of the photophone, a device that transmits a voice signal on a beam of light, Alexander Graham Bell introduced the idea of using light as a communication medium in 1880 [1]. Bell focused sunlight with a mirror and then talked into a mechanism that vibrated the mirror. At the other end, the detector captured the vibrating beam and converted it back into the voice signal. Bell could not produce a helpful carrier frequency for transferring the light beam from one location to another; hence, his tests failed. Bell had to cease his studies since the laboratory area's sunlight, fog, and rain interfered with his research. The Morse code transmission [2] in 1844 also gave rise to the concept of visible light communication. In Morse code transmission, it transmits text as a series of on-off tones, lights, or clicks that a skilled listener or observer can only understand. After that, the concept of visible-light communication (VLC) was revived by the development

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