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Abstract— Optical background noises produced by conventional fluorescent light sources, tungsten filament sources or AC power light-emitting diode (LED) are major source of interference in LED optical wireless communication, which can be significantly affect the performance and produce the challenges to implementation. This paper presents a review of mitigation of optical background noises using Manchester coding & Hadamard coding technique. The aim of this paper is to reduce the effect of background noises by enhance the transmission performance by using Hadamard error correcting codes.

Keywords— Hadamard matrix, optical communications, light-emitting diode (LED), noise mitigation, free-space communication.

I. INTRODUCTION

Light-emitting diode (LED) lighting has many attractive and unique features over the conventional lighting sources, such as long lifetime, high power efficiency and compact size, due to which it has been deployed in many places such as traffic lights, lighting displays, flashlights, automobile indicators and lighting for indoor and outdoor. The optical Wireless communication using LED can provides many transmission advantages at very little extra cost, such as high security, license-free, and electromagnetic interference (EMI) free. There are several challenges for the practical implementation of the LED optical wireless communication. Recently, several approaches have been proposed to increase the direct modulation speed of phosphor-base LED, which has the modulation bandwidth of only 1 MHz. These include the use of pre- or post equalization or advanced modulations. Advanced modulation, such as orthogonal frequency division multiplexing (OFDM), provides high spectral efficiency, hence allowing high-data-rate transmission in the bandwidth-limited LED communication. Another challenge faced by the LED optical wireless communication is the optical noises produced by the AC-LEDs or conventional fluorescent lamps, which can significantly affect the performance of the optical wireless Communication link.

Figure shows the generation of optical background noises in LED optical wireless communication system. In this block diagram an arbitrary waveform generator (AWG) generated a pseudorandom binary sequence (PRBS) of NRZ and Manchester electrical signals. These signals were then directly applied to a LED light. The LED has a 3-dB direct modulation bandwidth of about 1 MHz. The white light was transmitted across free space via a pair of focusing lens and then received by a silicon based PIN diode. Then, the received electrical signal was amplified by an amplifier and recorded by a real-time oscilloscope. Manchester coding can used for the LED to mitigate the optical noise. No adaptive monitoring, feedback, or optical filtering is required. Other advantage of the Manchester coding is that it can provide signal synchronization and enhance the clock recovery. The experiment results show that Manchester coding performs better than the conventional non-return-to-zero (NRZ) when the optical noise frequency is <500 kHz. Manchester coding can mitigate the low-frequency background noise; however, it requires twice the modulation bandwidth of non return to zero (NRZ) and limits the data rate of optical wireless system. Besides the Manchester coding, other forward error correction (FEC) techniques can also be used as the second layer of coding to further enhance the transmission performance.
In this paper, we are proposing Hadamard error correcting code to reduce background optical noises in LED optical wireless communication that is used for error detection and correction when transmitting messages over very noisy or unreliable channels. The rest of the paper is organized as follows. Section II is a brief on literature reviews of the related topics. Section III describes the proposed work with the conclusion in section IV.

II. LITERATURE SURVEY

In this section we discuss the survey of various techniques to reduce the optical background noises implemented previously. Several papers are published with the impact of noise in LED optical wireless communication. This topic is among the interest of many of the researchers. Several papers are published to reduce the optical background noises in LED optical wireless communication. Some of the relevant papers are discussed here:

Firstly, C. W. Chow, C. H. Yeh, Y. F. Liu, P. Y. Huang proposed Manchester coding for the LED to mitigate the optical noise. No adaptive monitoring, feedback, or optical filtering is required. The theoretical and numerical analysis of Manchester decoding process to mitigate the optical background noise is provided. Their experimental result shows that Manchester coding can significantly eliminate optical noise generated by the AC-LED operated at <500 kHz and fluorescent light [1].

Later Y. F. Liu, C. H. Yeh, Y. C. Wang, and C. W. Chow proposed Non return-to-zero inverted (NRZI) coding can also mitigate the background optical noise in the VLC system. The comparison between non-return-to-zero (NRZ) code and NRZI code was performed. The parameters of interference frequency and the signal to interference ratio (SIR) were varied to test the robustness of the transmission under different conditions. The result shows that NRZI can effectively reduce the optical interference in low frequency band from DC to over 200 KHz. This implies that as long as the interference signal has low pass characteristics, it can be effectively rejected by using NRZI code [2].


This scheme needs to estimate the channel characteristics and the interference signals. It then uses a linear prediction coefficient technique to equalize the received signal. However, continuous adaptive monitoring and feedback are required [3].

Later S.-H. Yang, H.-S. Kim, Y.-H. Son, and S.-K. Han proposed wavelength filtering to reduce the optical interference, red-green-blue (RGB) LED and optimized planning of illumination coverage are required [4].

Later C. W. Chow, C. H. Yeh, Y. F. Liu and P. Y. Huang proposed using orthogonal frequency division multiplexing (OFDM) to effectively mitigate the optical background noises. Besides, by using simple equalization at the receiver side, the transmission capacity can be extended from 1 Mb/s to 12 Mb/s. The theory and analysis of the equalization are presented. Experiments at different data rates and different OFDM subcarriers are preformed, and results show that, by adjusting the number of OFDM subcarriers, the influence of the background optical noises can be significantly circumvented [5].

III. PROPOSED WORK

A. Hadamard code:

The Hadamard code is an error-correcting code that is used for error detection and correction when transmitting messages over very noisy or unreliable channels. The Hadamard code is named after the French mathematician Jacques Hadamard. The Hadamard code is an example of a linear code over a binary alphabet that maps messages of length $k$ to code words of length $2^k$. Normally, Hadamard codes are based on Sylvester's construction of Hadamard matrices, but the term “Hadamard code” is also used to refer to codes constructed from arbitrary Hadamard matrices. The Hadamard code is a locally decodable code, which provides a way to recover parts of the original message with high probability.

B. Hadamard matrices:

A Hadamard matrix of order $n$ is a matrix $H_n$ with elements 1 or -1 such that $H_nH_n^T = nI_n$. Hadamard code uses Hadamard matrices for encoding and decoding error-correcting codes. Figure shows the Hadamard matrix where each row is a possible code.
IV. CONCLUSION

In this paper, we studied the different techniques to reduce the noises in LED optical wireless communication. After the analysis of proposed work & previous work, we can conclude that if we will use the Hadamard error correcting code, then we can mitigate the effect of background noises by enhance the transmission performance.

REFERENCES


