International Journal of Engineering & Technology, 7 (4.4) (2018) 9-10

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Interference Analysis of PLC Convergence System

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Abstract

In this paper, we propose a convergence system with visible light communication (VLC) and powerline communication (PLC) for home network. Also, we analyze the performance of interference mitigation scheme for the proposed system model. The proposed system is able to offer multimedia services with high speed in indoor wireless environment. Interference scenario is suggested to demonstrate the proposed system. And the scenario analyzed by applying minimum mean square error (MMSE) and zero-forcing (ZF) schemes to reduce the interference. From simulation results, we confirm that interference has a significant effect on the proposed system performance and the applied detectors are highly effective for interference mitigation.

Keywords:Home network, PLC, VLC, Interference mitigation.

1. Introduction

Among the wire systems, PLC is one of a spotlight technology by transmitting data through power lines. Since this technology uses existing power line, advantages with PLC are considerable. First, it is possible to construct the infrastructure in a variety of places. Second, costs of system installation and maintenance are reduced by using the existing power lines. Third, it is easy to access in anywhere since the power line system is the most robust and national wide infrastructure [1-2].

Recently, VLC is interpreted as an indoor wireless communication technology which can be not only used as a lighting device, but also used as communication device [3-4].

There are few literatures dealing with the integrated system of PLC and VLC, moreover, there has not been any literature to handle interference issue for the convergence system of PLC and VLC in detail. In this paper, we propose novel wireline-wireless home network architecture based on the PLC and VLC, and analyze and simulate performance of the proposed convergence system. Also, we suggest interference scenario and employ promising detector structures to mitigate interferences.

The rest of this paper is structured as follows: Section II introduces the proposed convergence system, interference scenario and interference mitigation schemes, respectively. Then, BER performance is analyzed and simulation results with practical simulation parameters are presented in Section III. Finally, Section IV concludes the paper.

2. Introductory Material

2.1 Convergence system with PLC and VLC

Each user has a mobile terminal with VLC module so that they can transmit and receive the data to each other. In VLC part, the input data is modulated format. The modulated signal transmitted from user via the visible light (i.e. illumination) is carried on AC signal, and then transmitted to information center through power lines. The information center loads the interested information for the user from its own database or searches them on the web. After searching the information suitable for the user, it is delivered to the user in the reverse process.

In the receiver block, we employ the ZF and MMSE detector structures for mitigation of the interferences.

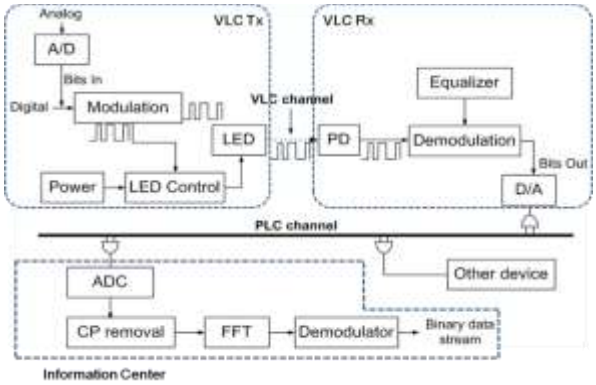

Figure 1. The proposed system model.

2.2. Interference Scenario

It is assumed that that the interference environment for VLC system is severer than that for PLC system because wireless communication suffers from more interference than wire communication. If one of people sends the request signal through the illumination for the object, other signals for the rest of people act as interferences. Therefore, interference mitigation scheme is highly required for proper operation of the proposed convergence system.

2.3. Interference Mitigation Schemes

In order to mitigate interference, we employ typically well-known detector structures. The ZF linear detector satisfies the following condition given by

$$\mathbf{W_{ZF}H} = \mathbf{I}, \tag{1}$$

where, $\mathbf{W_{ZF}} = \left(\mathbf{H^H H}\right)^{-1}\mathbf{H^H}$ is ZF decoding matrix, $(\cdot)^H$ denotes Hermitian transpose, $\mathbf{H}$ is channel matrix and $\mathbf{I}$ is identity matrix. Given the received signal $\mathbf{Y}$, the receiver can obtain the estimated signal by ZF equalization given by

$$\hat{\mathbf{X}} = \mathbf{W_{ZF}Y}, \tag{2}$$

where $\hat{\mathbf{X}}$ is an estimate matrix of the transmitted signal. If the determinant of $\mathbf{H}$ is not zero so that there exists the inverse matrix of $\mathbf{H}$. Also, in order to minimize power of the noise component, we employ the MMSE algorithm given by

$$\mathbf{W_{MMSE}} = \arg\min_{\mathbf{W_{MMSE}}} \mathbf{E}\left[\left\|\mathbf{W_{MMSE}Y} - \mathbf{X}\right\|_{\mathbf{F}}^2\right], \tag{3}$$

3. Simulation Results

For simulations of the proposed convergence system, we set up simulation to validate our proposal from a practical point of view. We refer to version 2.1 of HomePlug AV specification for PLC simulation parameters summarized [5]. The whole system performance is evaluated in terms of BER. We can easily find that the interference significantly affects BER performance. We can also confirm that MMSE scheme can achieve more improved BER performance by 2~3dB than ZF scheme.

4. Conclusion

In this paper, we proposed the novel home network architecture based on the PLC and VLC, and analyzed performance of interference mitigation scheme for the proposed convergence system considering the suggested interference scenario. From simulation results, we confirmed that the interference has significant effects the propose system performance and MMSE scheme was more efficient than ZF.

Acknowledgment

This work was supported by the Basic Science Research Program through the National Research Foundation of Korea funded by the Ministry of Education under Grant NRF-2016R1D1A1B03933872.

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