Transmission performance improvement using maximum likelihood decision and frequency domain equalization for multi-layer single-carrier optical wireless communications

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1. Introduction

Optical wireless communications have attracted attention in recent years owing to the rapid proliferation of the IoT and smartphones [1]. Orthogonal frequency division multiplexing (OFDM) has been widely studied in optical wireless communications because of its inherent resistance to inter symbol interference and high spectral efficiency, but pose a problem of high peak-to-average power ratio (PAPR). Therefore, a single-carrier frequency-domain equalization (SC-FDE) scheme with low PAPR has been studied [2]. Asymmetric clip optical SCFDE (ACO-SCFDE), which is a suitable SC-FDE scheme for optical wireless communications, has low spectral efficiency. To overcome this problem, multi-layer schemes have been proposed [3]. However, multi-layer schemes degrade the required signal-to-noise ratio (SNR). In this study, a novel transmission performance improvement technique for multi-layer ACO-SCFDE is proposed to reduce noise and the required SNR.

2. Proposed method

In this research, the maximum likelihood decision method and an adaptive filter are employed. The maximum likelihood decision uses the characteristic that the waveform after the inverse fast Fourier transform (IFFT) has positive and negative inversion in the first and the second halves [4]. In all the frequency components, the third layer uses even multiples of the fundamental frequency, so the maximum likelihood decision is not applicable. The frequency components of four times the fundamental frequency in the third layer are considered as a new fundamental frequency; thus, the maximum likelihood decision can be applied by comparing the corresponding amplitudes at the N/8 points (N is the total number of frequency components). Furthermore, an adaptive filter using an iterative decision-directed algorithm was applied, in which the decision is performed in the time domain and equalization is performed in the frequency domain [5].

3. Simulation results

The modulation method was 16 quadrature amplitude modulation (16QAM) single carrier and the FFT size of the frequency-domain equalization was 64. Simulations were performed by applying the adaptive filter using the iterative decision-directed algorithm to the first layer and the maximum likelihood decision to the third layer. Fig. 1 shows the bit error rate (BER) performance of the third layer, and Fig. 2 shows the BER performance of all layers. Fig. 1 shows that applying the maximum likelihood decision to the third layer improved the required SNR by approximately 0.5 dB at BER = 10^{-4}. Fig. 2 shows that applying the adaptive filter to the first layer and the maximum likelihood decision to the third layer also improved the required SNR by approximately 0.5 dB at BER = 10^{-4}.

4. Conclusions

In this study, multi-layer ACO-SCFDE was improved by applying a new maximum likelihood decision in the third layer and an adaptive filter in the first layer.

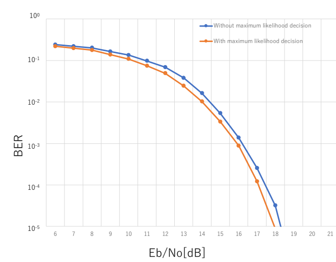

Fig.1 Third layer BER performance.

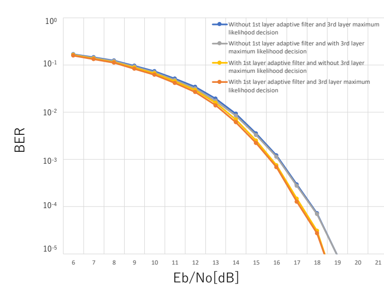

Fig.2 First to third layer BER performance.

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