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Research Article

# Optimization of the Number of Active Subcarriers and M-PAM Modulation Constellation Pattern for OFDM-IM Systems

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**Abstract**

Orthogonal Frequency Division Multiplexing with Index Modulation (OFDM-IM) is a system that exhibits superior power efficiency and bandwidth compared to the conventional OFDM system. In the OFDM-IM system, some subcarriers are inactive, and instead of transmitting modulation symbols, zero values are sent on these subcarriers. Additionally, in the OFDM-IM system, data is transmitted through the inactive subcarriers based on their specific locations. This paper aims to determine the optimal number of active subcarriers to maximize the transmitted data rate and spectral efficiency of the OFDM-IM system. Through mathematical relationships and simulation results, it is demonstrated that the identified value of active subcarriers is indeed optimal, leading to the maximization of the data rate of the system and spectral efficiency. The proposed optimal method, particularly designed for 4-symbol Pulse Amplitude Modulation and 8-group OFDM-IM, has resulted in a 6.25% increase in the number of transmitted bits compared to previous methods. As a secondary objective, a modified constellation with equal intervals is introduced for M-PAM modulation, aiming to reduce the bit error rate of the OFDM-IM system and enhance overall system performance. Simulation results and bit error rate curves illustrate the effectiveness of the proposed constellation. For 4-symbol Pulse Amplitude Modulation and 16-group OFDM-IM, utilizing 9 active subcarriers and a signal-to-noise ratio of 12 dB, the proposed constellation has demonstrated a tenfold improvement in the bit error rate of the system.

**Keywords:** Spectral efficiency, optimal active subcarrier, constellation pattern, data rate, OFDM-IM.

**Highlights**

- Calculation and correction of the optimal number of active subcarriers in OFDM-IM systems in order to maximize the transmitted bit rate and spectral efficiency.
- Proposing a modified constellation pattern with fixed distances for M-PAM modulation in order to reducing the bit error rate of the OFDM-IM system.
- Keeping the average energy of the proposed modulation symbols the same as the standard M-PAM modulation.

**Citation:** [in Persian].