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**Adaptive Relay Selection and Power Allocation for OFDM Cooperative Underwater Acoustic Systems**

**Abstract:**

The increasing use of relays in underwater acoustic (UWA) communications is a driving force to explore efficient techniques that can significantly improve the system performance. To fully exploit the benefits of cooperative systems, efficient management of resources including relays and power is required. In this paper, both optimal relay selection and power loading issues are investigated for an orthogonal frequency division multiplexing (OFDM) cooperative transmission over UWA channel. In our analysis, we consider amplify-and-forward (AF) relaying with perfect channel state information (CSI) at the source, relay, and destination nodes. Moreover, we assume sparse and frequency-selective Rician fading in the presence of colored Gaussian ambient noise. Unlike previous works on this topic, in our study, the power of noise is not identical for all subcarriers at both the relay and destination nodes. We solve two optimization problems that rely on the minimization of the bit error rate (BER) and maximization of the system capacity. In each problem, both optimal relay selection and power loading issues are addressed in two dependent phases. In the first phase, an unconstrained optimization problem is solved to determine the optimal relay out of multiple relays vertically located at different depths of water. We adopt all-subcarrier (AS) basis approach in our OFDM-based transmission model in which a single relay is engaged to transmit the entire OFDM block to the destination. In the second phase, after selecting the optimal relay, another optimization problem is solved to obtain the optimal power allocation. This is jointly done at both the source and relay nodes under total power constraint and fixed subcarrier rate. Extensive simulations are conducted to evaluate the performance of proposed algorithms under different scenarios.

**Existing System:**

In most of the existing literature on resource allocation in relay-assisted UWA communications, the objective function is selected as either to maximize the throughput or to minimize the power consumption, whereas in some applications of UW-ASNs the BER performance as well as the system capacity are more crucial design issues which should be considered as the objective function. To the best of our knowledge, the problem of resource allocation in cooperative UWA communications through minimizing the BER has not been yet addressed in literature. In this paper, two optimization problems are addressed with some new assumptions.

**Proposed System:**

We address both relay selection and power loading issues in our optimization problems. Each problem consists of two dependent phases. In the first phase of each problem, an unconstrained optimization problem is solved to obtain the optimal relay out of multiple relays while equal power loading (EPL) is utilized among subcarriers at both the source and relay nodes. In the second phase of each problem, optimal power loading (OPL) coefficients are jointly obtained for both the source and relay subcarriers. This is done under total power constraint and fixed subcarrier rate, i.e., by utilizing fixed modulation scheme for all subcarriers.