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Design a New Time-Diversity System Using Orthogonal Mapping Matrix and Symbols Interleaving for Rayleigh Flat-Fading Channels

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ABSTRACT A time-diversity system is implemented in this work using a time-diversity encoder. The diversity encoder uses an orthogonal matrix to map vectors of N modulated symbols to vectors of N diversity symbols. Each modulated symbol is implicitly transmitted N times in N successive periods when the N diversity symbols are transmitted. No changes in the symbols' transmission rate occur due to the proposed time-diversity scheme. The diversity symbols are transmitted with the same transmission rate of modulated symbols in the systems with no signal diversity. The proposed system uses the same bandwidth of the system with no signal diversity too. In the receiver, the outputs of the matched filter are stored in a buffer of length N during the diversity period. After filling the buffer, its contents are multiplied with the inverse of the fading matrix. A diversity detector remaps the diversity symbols to the modulated symbols. It also combines the corresponding modulated symbols in one decision variable. The noise samples in the decision variables are uncorrelated. A maximum-likelihood (ML) detector and a linear detector are used as diversity detectors in this work. The performance of the proposed system achieves the same performance as the N diversity channels system with a unity-gain-combiner (UGC) receiver.

INDEX TERMS Time diversity, flat fading channels, orthogonal mapping, maximum likelihood detector, linear detector, unity-gain-combiner.

I. INTRODUCTION

In wireless communications, channel fading reduces the average signal-to-noise ratio (SNR) of the received signal. It disperses the transmitted symbols causing inter-symbol-interference (ISI). Signal diversity is used to improve signal quality in fading environments. It usually provides the receiver with different replicas of the transmitted symbols. The receiver gathers these replicas with a suitable signal-combining method to increase the received SNR [1], [2]. Signal diversity is usually done in space, time, and frequency. In space diversity, different transmitting and receiving antennas are used to send and receive the modulated symbols. Space diversity does not increase the bandwidth of the transmitted symbols or reduce the transmission rate of the modulated symbols. However, it produces interference between the received symbols [3], [4]. Space-time codes may be used in the transmitter of the space-diversity system to guarantee that the transmitted symbols are orthogonal in both spatial and time domains [5], [6]. The sphere detector and the QR-detector are used in the receiver to detect the modulated symbols and remove the interferences [7], [8]. Space-time codes increase the complexity of the transmitter and the receiver in space-diversity systems, but it keeps the spectrum efficiency of the system with no changes. In time diversity, the modulated symbols are transmitted more than once at different time epochs. The bandwidth of the transmitted symbols in time-diversity systems is the same as the bandwidth of the symbols transmitted in systems with no signal diversity. Time diversity improves the reliability of transmitting symbols in fading channels. However, the rate of the transmitted symbols is decreased, and this also decreases the spectrum efficiency of the time-diversity systems [9], [10]. In frequency diversity, the modulated symbols are transmitted more than once on different carrier frequencies at the same time. The transmission rate of the modulated symbols does not change in frequency-diversity systems; however, the symbols' bandwidth increases, and this decreases the bandwidth efficiency of the transmitted symbols [11], [12]. In spread-spectrum systems, spreading

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