ULTRASONIC THROUGH-WALL COMMUNICATION TECHNIQUES

By

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ABSTRACT

This thesis describes the optimization of a transmitter and receiver for high data throughput using Orthogonal Frequency Division Multiplexing (OFDM) through steel using ultrasonic waves. This optimization was accomplished with the design and testing of algorithms for Digital Signal Processing (DSP) boards in both the transmitter and the receiver using complier optimized libraries for fixed point arithmetic. Special considerations were taken due to the channel's Signal to Noise Radio (SNR). These consisted of using smaller subchannels with lower modulation rates to reduce the inter-symbol interference (ISI). Because only phase modulations were used, optimizations and simplifications could be made for the purely phase oriented system.

The primary focus of this work was the design and implementation of an adaptive equalizers in the receiver. The slowly varying channel allows for an adaptive equalizer to improve longterm system performance without decreasing channel throughput or creating a significant load on the signal processors. A number of different variations on the Decision Directed Linear Mean Square (DDLMS) adaptive filter were simulated in Matlab and implemented in hardware. These variations included discretization of the error signal as well as use of phase as an error signal. The equalizer was optimized to ignore the magnitude of the signal and adjust only the phase. Performance is evaluated by comparing Bit Error Rates (BER) with and without the DDLMS equalizer as the parameters of the equalizer's update equation are varied. The results found on the target hardware platform of an Analog Device's digital signal processor show that discretization of the phase error between the desired symbol and the received symbol is a computationally efficient method to update equalizer taps with a low computational overhead.