

Functional Description

Design and Implementation of Orthogonal Frequency Division Multiplexing (OFDM) Signaling

Study by: Alan C. Brooks • Stephen J. Hoelzer

Advisors: Dr. In Soo Ahn • Dr. Thomas L. Stewart

The purpose of this project is to research OFDM as a means to combat the problem of Inter-Symbol Interference (ISI) common in high speed wireless communication. The project will be divided into simulation and implementation phases.

Through MATLAB simulation, an understanding of the mathematical algorithms involved in this communication technique will be developed. Simulation of a transmitter, a receiver, and a channel will be included. As shown in **Figure 1**, our input and output are both digital signals.

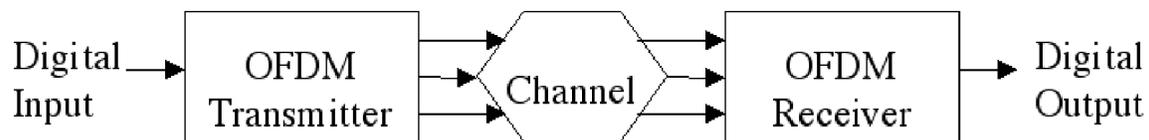


Figure 1 - General Block Diagram

Following simulation, a small-scale real-time implementation of OFDM communication will be developed on a DSP board. The necessary algorithms will be designed using a modular, graphical design tool such as System View or dSpace. The feasibility of creating an employable OFDM system using high level graphical design will be evaluated.

The single input to either phase of the design will be any digital signal. This can range from simple binary data to sampled sound signals. The transmitter's output will be the OFDM representation of the source. **Figure 2** shows how a high frequency input signal is multiplexed onto many orthogonal carriers at a lower frequency. The lower frequency signals have longer symbol times which greatly reduces the ISI problems in high speed digital communication.

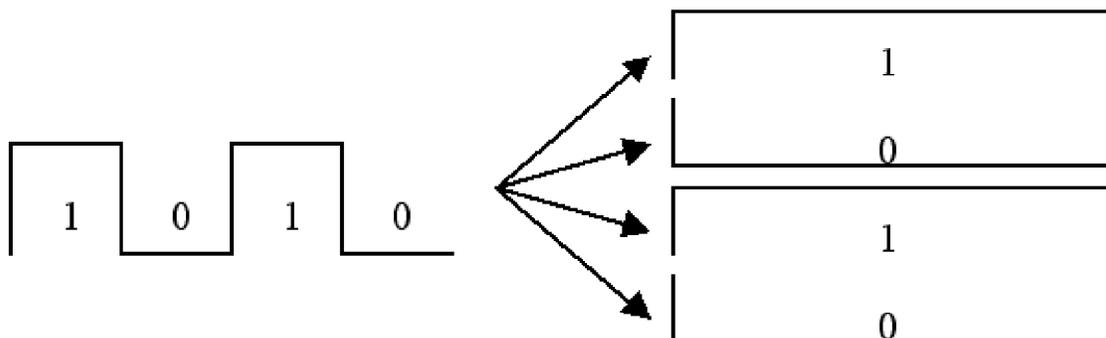


Figure 2 - OFDM Multiplexing

In detail, the MATLAB code will be divided into Transmitter, Channel, and Receiver simulation. See **Figure 3** for a flow chart of the code.

The transmitter first converts the input data from a serial stream to parallel sets. Each set of data contains one information bit for each carrier frequency. Then, parallel data are modulated to the orthogonal carrier frequencies. The IFFT converts the parallel data into time domain waveforms. Finally, these waveforms are combined to create a single time domain signal for transmission.

The channel simulation will allow for us to examine the effects of noise and multipath on the OFDM scheme. By adding small amount of random data to the transmitted signal, simple noise can be simulated. Multipath simulation involves adding attenuated and delayed copies of the transmitted signal to the original. This simulates the problem in wireless communication when the signal propagates on many paths. For example, a receiver may see a signal via a direct path as well as a path that bounces off of a building.

The receiver basically performs the inverse of the transmitter by first separating the data into parallel streams. Then, the FFT converts these parallel data streams into frequency domain data. The data are now available in modulated form on the orthogonal carriers. Demodulation down-converts this information back to the baseband. Finally, this parallel data are converted back into a serial stream to recover the original signal.

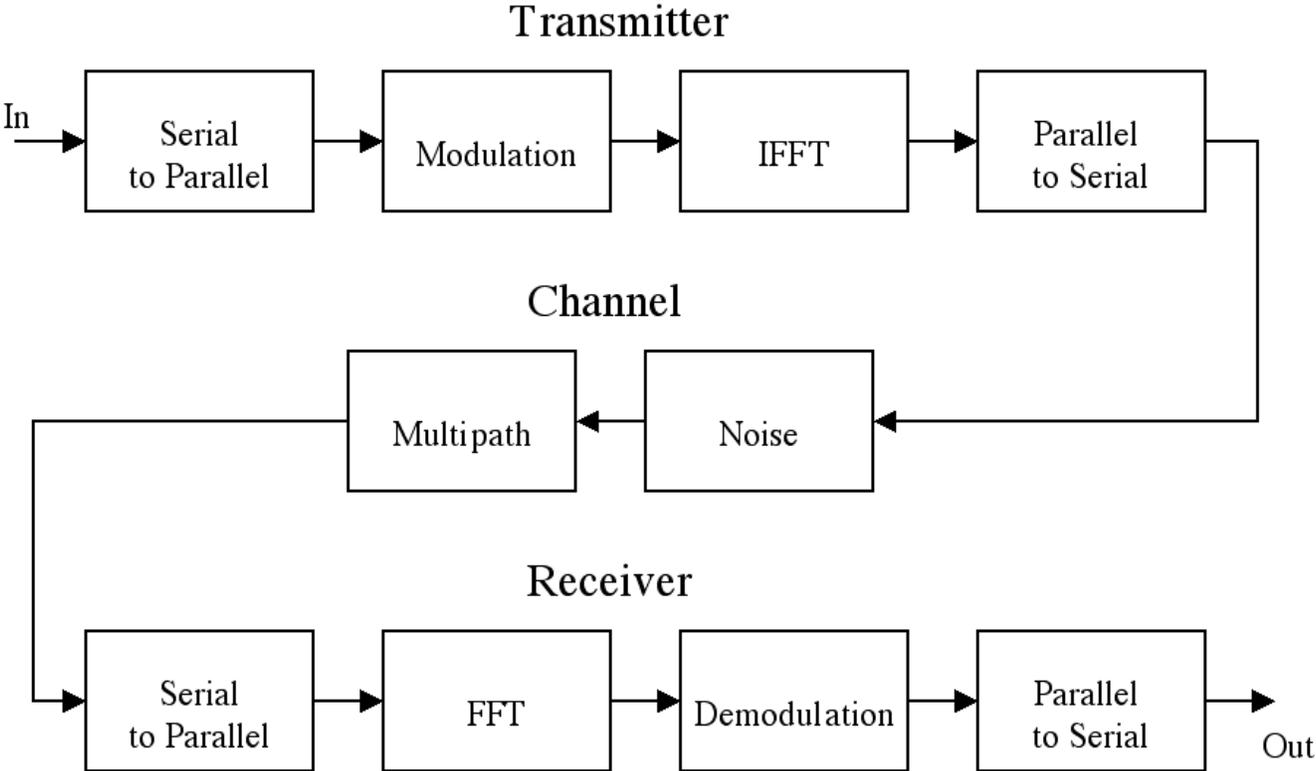


Figure 3 - Detailed MATLAB Flow Chart