Design of transceiver block using TFT-OFDMA for wireless systems

Dhivya Bharathi.R, Mrs.R.Uma Maheswari

Abstract— In wireless communication, the use of multiple antennas both at the transmitter and receiver is a key technology to enable high data transmission. Multiple Input Multiple Output (MIMO) schemes are widely used in many wireless standards allowing higher throughput. In this paper, we propose the Time-Frequency Training OFDMA (TFT- OFDMA) transmission scheme for achieving high spectral efficiency as well as the bit error rate performance improvement. As the next generation wireless system is looking for multiple Gbps data rate, TFT OFDMA is proposed with low complexity. This paper proves the unification of the time and frequency domain channel estimation, whereby the path delays are firstly acquired by the time-domain received TSs without interference. Further implementation of transceiver architecture is done by FPGA Altera Cyclone IV E to support wireless standards with low complexity.

Index Terms— MIMO, OFDMA, spectral efficiency, time -frequency training, FPGA, OFDM.

1 INTRODUCTION

Orthogonal Frequency Division Multiplexing is a special type of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Here the different carriers are orthogonal to each other and they are totally independent of one another. This is achieved by placing the carrier exactly at the nulls in the modulation spectra of each other. OFDM has been utilized in wireless networks and mobile communications. In OFDM, the sub-carrier frequencies are chosen so that the sub-carriers are orthogonal to each other, thereby cross-talk between the sub-channels is eliminated and inter-carrier guard band is not required. This greatly simplifies the design of both the transmitter and the receiver.

Generally, there are three types of OFDM based block transmission schemes: cyclic prefix OFDM (CP-OFDM),Zero padding OFDM(ZP-OFDM) and time domain synchronous OFDM(TDS-OFDM). In case of CP-OFDM and ZP-OFDM, frequency domain pilots are required for synchronization and channel estimation, which reduce the spectral efficiency. Consequently, comparing with CP-OFDM and ZP-OFDM, TDS-OFDM has an improvement in spectral efficiency [3].

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The remaining section of this paper is organized as follows, Section II is about TFT OFDMA model. Block diagram of transceiver section is explained in section III. Simulation result is provided in Section IV and the final conclusion is section V.

2 TFT-OFDMA MODEL

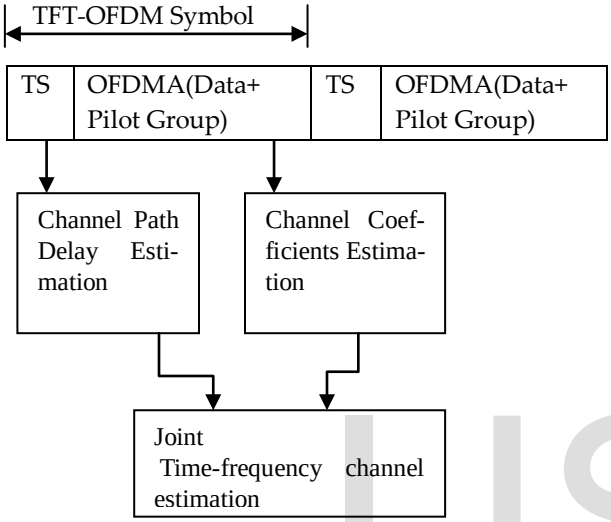
In the method of generating an OFDM symbol, initially, N input complex symbols are padded with zeros to get N_s symbols which are used to calculate the IFFT. The output of the IFFT is the basic OFDM symbol. Based on the delay spread on the multi-path channel, a specific guard-time is chosen .A number of samples corresponding to this guard time is taken from the beginning of the OFDM symbol and then added at the end of the symbol.

Similarly, the same number of samples is taken from the end of the each OFDM symbol and inserted at the beginning. The OFDM symbol is multiplied with the raised cosine window to remove the power of the out-of-band sub-carriers. The windowed OFDM symbol is then added to the output of the previous OFDM symbol with a delay of T_r, so that there is an overlap region of $\square T_r$ between each symbol which causes inter carrier interference

3 PROPOSED SYSTEM

The interference caused by the OFDM data block cannot be completely eliminated. So to overcome the deficiency of the existing system, Time-Frequency Training OFDMA (TFT-OFDMA) transmission scheme for large scale MIMO systems has been proposed in which each TFT-OFDMA symbol with-

out cyclic prefix adopts the time-domain training sequence (TS) and the frequency-domain orthogonal grouped pilots as the time frequency training information. At the receiver, the corresponding time-frequency joint channel estimation method has been proposed to track the channel variation, so the received time-domain TS is used for path delays estimation without interference cancellation, and the path gains are acquired by the frequency-domain pilots. The proposed TFT-OFDMA MIMO scheme achieves more spectral efficiency as well as the bit error rate performance.



4 Block Diagram Of Transceiver Section

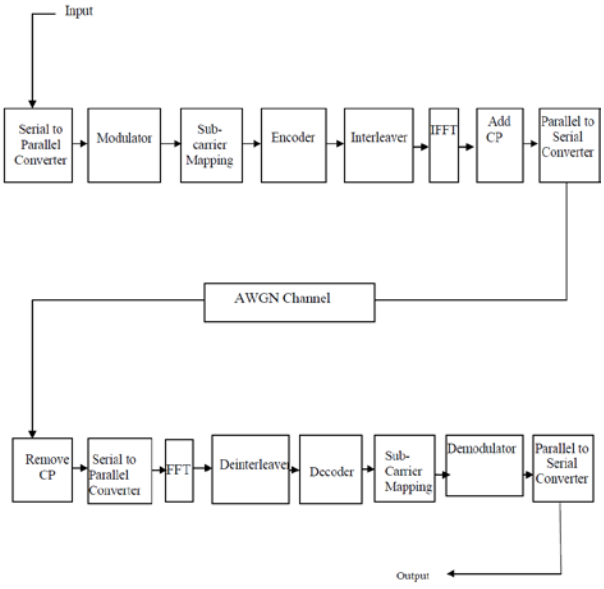


Fig 3.1 Block Diagram

The serially received data is converted into parallel data which is then modulated and given to the mapper. The mapper converts the input signal as complex valued signal points and is then sent to interleaver where the burst noise is removed. Interleaver arranges the input data in a random order so the consecutive data's are spaced apart. It is then given to IFFT and cyclic prefix is added to eliminate the intersymbol interference and it also acts as a guard interval. Now the parallel data is converted into serial data and the cyclic prefix is removed and is sent to FFT where the values are computed easily. It is again sent to deinterleaver and demapper to perform the reverse operation of mapper and interleaver. Finally the parallely received data is converted into serial data and achieves its original form that is the original signal is obtained [5].

Interleaver

Interleaving is a technique that is used in communication systems to overcome correlated channel noise such as burst error or fading. The Interleaver arranges the input data in a random manner so that the consecutive data that is present is spaced apart. At the receiver end, the interleaved data is arranged back into the original sequence by the de-Interleaver. As a result of this, the correlated noise introduced in the transmission channel appears to be statistically independent at the receiver and thus allows error correction.

Fast Fourier Transform

A Fast Fourier transform is an efficient algorithm that is used to compute the discrete Fourier transform and it's inverse. An FFT can compute the same result using O(NlogN) operations. The most common FFT is the Cooley-Tukey algorithm. This is an algorithm that recursively breaks down a DFT of any composite size $N=N_1N_2$ into N_1 and N_2, along with O(N) multiplications by complex roots of unity called twiddle factors. This algorithm is to divide the transform into two pieces of size N/2 at each step, These are called the radix-2 and mixed-radix. The main reason that the OFDM technique can be used on VLSI processors and to generate the signal using the inverse Fourier transform is the key to current system.

Mapper

A data is assigned to a particular channel based on the channel transmission code. Input data is converted to complex valued signal points by the mapper block. These data signals are converted to signal based on the constellation, that is used which is either BPSK or 64-QAM.

AWGN Noise

The serially transmitted data is corrupted by additive white Gaussian noise (zero mean) at a particular signal to noise ratio. As the SNR increases the chances of the bits being corrupted decreases.

Parallel To Serial Converter

The parallel data is converted to the serial form to be passed through the channel.

ENCODER

An encoder is a device, circuit, transducer, software program or an algorithm that converts one format of code to another code for the purpose of standardization, speed, and security and for the purpose of shrinking the size.

5 SIMULATION RESULTS

Some blocks of transceiver system of TFT-OFDMA has been discussed below:

INTERLEAVER

Fig 4.1 shows the output of the interleaver where BLOCK interleaving is used in which the codes are sent as blocks. The advantage of this interleaving scheme is that it can separate long burst errors effectively to irrelevant codes and avoid error propagation.

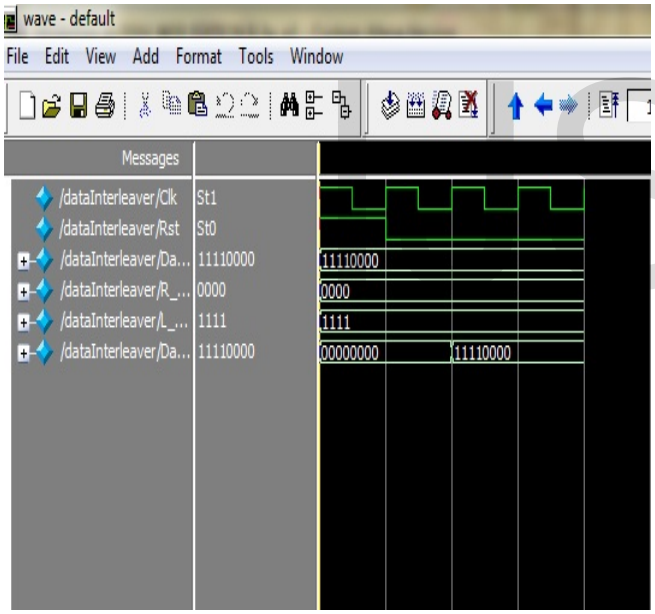


Fig 4.1 : Interleaver Output

CYCLIC PREFIX

The Cyclic Prefix or Guard Interval is a periodic extension of the last part of an OFDM symbol that is added to the front of the symbol in the transmitter, and is removed at the receiver before demodulation Fig 4.2 shows the corresponding output waveform for cyclic prefix.

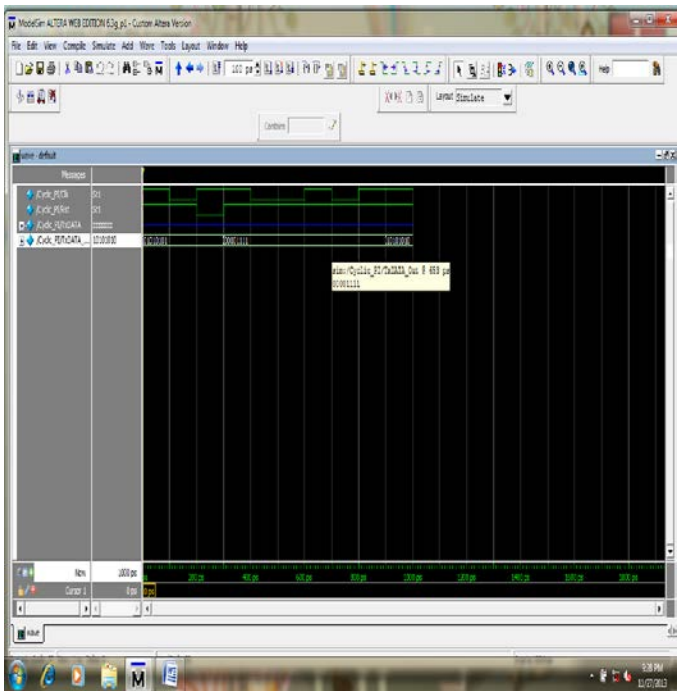


Fig 4.2: Cyclic Prefix Output

MAPPER

The input of the mapper is a desired data stream. Input data is converted to complex valued signal points by the mapper block. These data signals are converted into signal based on the constellation of 64-QAM. Fig 4.3 shows the simulation output of mapper.

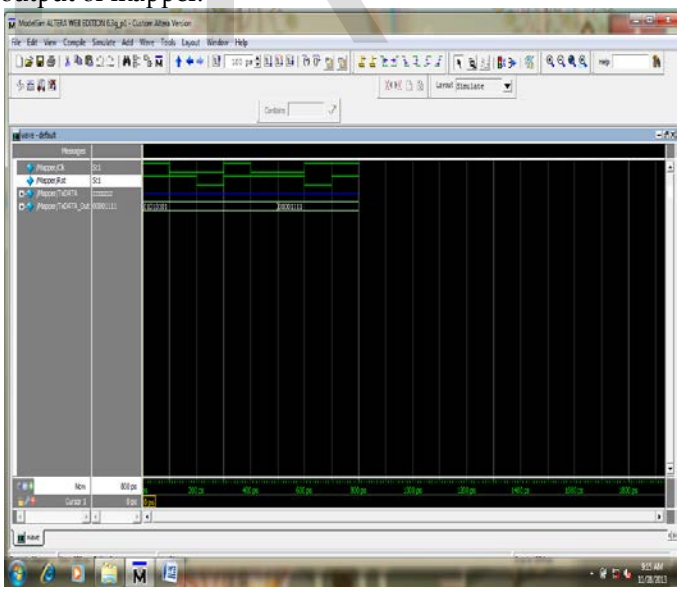


Fig 4.3: Mapper Output

FFT

A Inverse Fast Fourier transform is an efficient algorithm to compute the discrete Fourier transform and it's inverse. A FFT is a way to compute the same result more quickly. Fig 4.4 shows the simulation output of FFT.

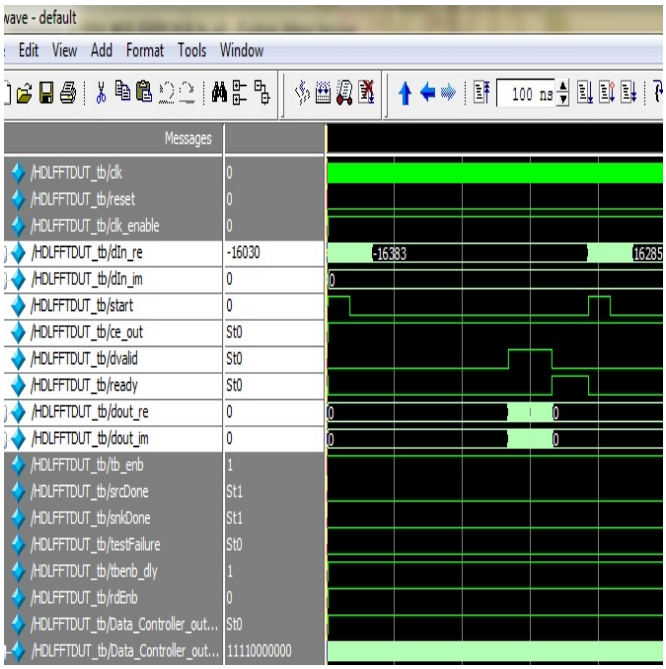


Fig 4.4: FFT Output

TRANSMITTER TOP MODULE

Fig 4.5 shows the simulation results of the entire transmitter module of TFT-OFDMA.

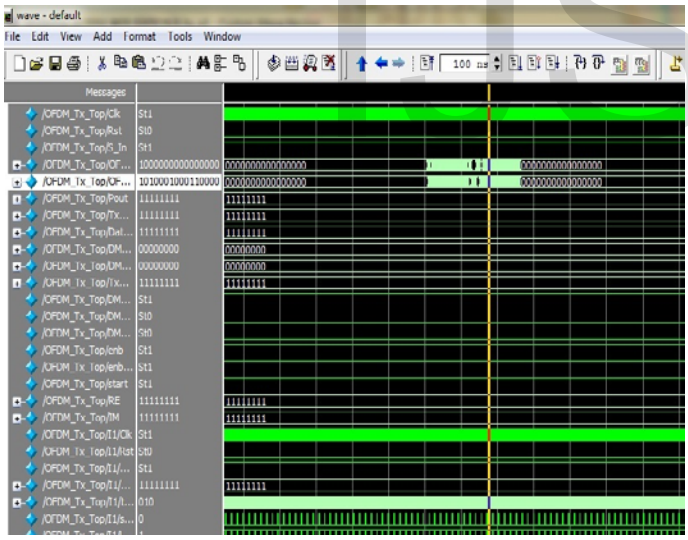


Fig 4.5: Transmitter Top Module Output

6 CONCLUSION

Design of transceiver architecture for TFT-OFDMA has been developed for the multi gbps data transmission. The simulation result of various blocks in transceiver module of TFT-OFDMA is carried out using Altera Quartus II. Further blocks in transceiver module will be simulated and implementation using FPGS will be done in mere future. The proposed TFT-OFDMA can be adapted for wireless systems.

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