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Unitary Differential Space Time Frequency Codes For MB-OFDM Uwb Wireless Communications

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ABSTRACT — In recent day's military and government applications of UWB communications have demanded the accommodation of larger numbers of users, each with ever increasing bandwidth requirements. Spectral resources are potentially wasted in order to avoid narrowband interference in the case single carrier based multi band system. For channel state information channel estimation requires large number of pilot symbols need to be transmitted, thus reducing the bandwidth efficiency and it will also lead complexity in the receiver side. This paper proposes unitary differential space-time-frequency codes (DSTFCs) for MB-OFDM UWB communications, which increase the system bandwidth efficiency because no channel state information (CSI) is required. The proposed system would be useful when CSI is unavailable at the receiver. The paper also quantifies for the variable puncture rate Forward error correction scheme for significant improvement in the bit error performance of proposed MB-OFDM. Performance of proposed system is analyzed in deep fading environment (Nagakami-m channel) results are presented which show that the variable rate forward error correction (FEC) with MB-OFDM UWB communication is better than that with conventional system, and the BER performance is also be improved significantly .

KEYWORDS — reconfigurable FFT architecture,radix-2^k algorithm, orthogonal frequency-division multiplexing(OFDM) , ultra wideband (UWB).

I. Introduction

In telecommunications, 4G is the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. Multi-band orthogonal frequency-division multiplexing (MB-OFDM) is one of 4G ultra wideband (UWB) radio standards, which provides high-speed connectivity in a wireless personal area network (PAN) [1] with specification of the data rates from 53.3 to 480 Mbps [2]. Due to the high data rates, the MB-OFDM standard requires to process large amount of computations in very short time; its modem has to compute one symbol that consists of 165 complex numbers in every 312.5 ns. Even though its performance requirement results in large hardware complexity, a low power design with small chip size is absolutely essential for applying this technology to portable handheld devices. Also, an operating frequency of a circuit is one of the dominant factors that determine power consumption.

MB-OFDM defines two constellation mapping schemes: QPSK and DCM modulations. The QPSK spreads data into several subcarriers and the DCM requires data reordering. The spreading and reordering processes involve non-trivial amount of buffer storages and also latency.

Conventionally those processes are done as separate phases: interleaving first and then spreading or reordering. But, we can unify the spreading and the (inverse)-reordering with the (de)interleaving process. With the proposed interleaver architecture, we can perform the spreading before the interleaving process by fully utilizing array cells of our interleaver.

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II . MULTIBAND SYSTEM BASED ALGORITHM

The N-point DFT is formulated as

$$X(k)=\sum_{n=0}^{N-1} x(n)W_N^{nk}, k=0,1,\ldots N-1 \qquad (1)$$

Where the twiddle factors is defined as $W_N^{nk}=e^{-\frac{2\pi nk}{N}}$.The n denotes the time index and the k denotes the frequency index. The radix 2^k algorithm can be derived by integrating twiddle factor decomposition through a divide and conquer approach.

A. UWB specifications

This standard specifies an ultra-wideband (UWB) physical layer (PHY) for a wireless personal area network (PAN), utilizing the unlicensed 3100 - 10600 MHz frequency band, supporting data rates of 53.3, 80, 106.7, 160, 200, 320, 400, 480, 640, 800, 960 and 1024 Mb/s. Support for transmitting and receiving data rates of 53.3, 106.7, and 200 Mb/s using the convolutional code shall be mandatory. For each of the rates 160, 200, 320, 400 and 480, if LDPC coding is provided then convolution coding should also be provided.

The UWB spectrum is divided into 14 bands, each with a bandwidth of 528 MHz the first 12 bands are then grouped into 4 band groups consisting of 3 bands. The last two bands are grouped into a fifth band group. A sixth band group is also defined within the spectrum of the first four, consistent with usage within worldwide spectrum regulations. At least one of the band groups (BG1 - BG6) shall be implemented.

B. Forward Error Correction

The puncturer omits some of coded bits in order to support different code rates with one convolutional encoder. The depuncturer inserts dummy bits for the omitted bits.

Our system used a convolutional encoder with code rate 1/3 and constraint length 7. To decode the convolutional codes at 8-bits per cycle, we implemented a four-stage radix-4 Viterbi decoder by extending the two-stage radix-4 decoder proposed in [10], where the trace-back length is 48. The two-stage radix-4 Viterbi decoder was implemented by cascading two radix-4 decoders.

III . PROPOSED SCHEME

In this brief, Space-time frequency encoder which encodes a single stream through space using all the transmit antennas and through frequency by sending each symbol at different frequencies .

A. Functional Units

In a MB-OFDM system, a guard interval (9.5 nanoseconds) is appended to each OFDM symbol and a zero-padded prefix (60.6 nanoseconds) is inserted at the beginning of each OFDM symbol. The guard interval ensures that there is sufficient time for the transmitter and receiver to switch to the next carrier frequency. A zero- padded prefix provides both robustness against multi-path and eliminates the need for power back-off at the transmitter. More details about the zero-padded prefix will be described in a later section.

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The structure of the MB-OFDM solution is very similar to that of a conventional wireless OFDM physical layer, except that the carrier frequency is changed based on the time-frequency code. In addition, other modifications have been made to reduce the area and size.

MULTI-BAND orthogonal frequency-division multiplexing (MB-OFDM) is one of ultra-wideband (UWB) radio standards, which provides high-speed connectivity in a wireless personal area network (PAN) [1] with specification of the data rates from 53.3 to 480 Mbps [2]. Due to the high data rates, the MB-OFDM standard requires to process large amount of computations in very short time; its modem has to compute one symbol that consists of 165 complex numbers in every 312.5 ns. Even though its performance requirement results in large hardware complexity, a low power design with small chip size is absolutely essential for applying this technology to portable handheld devices.

B . MB-OFDM baseband modem

Fig.1 and 2 shows an overall architecture of our MB-OFDM PHY baseband modem that supports both transmission (TX) and reception (RX) according the MB-OFDM protocol in the standard [2]. Our architecture was designed to process eight complex numbers of TX and RX signals at one time with 8-way parallel data paths. By having the high degree of parallel data paths, the baseband modem can operate at 66MHzthat is one-eighth of the sampling frequency 528 MHz with providing up to 480 Mbps throughput.

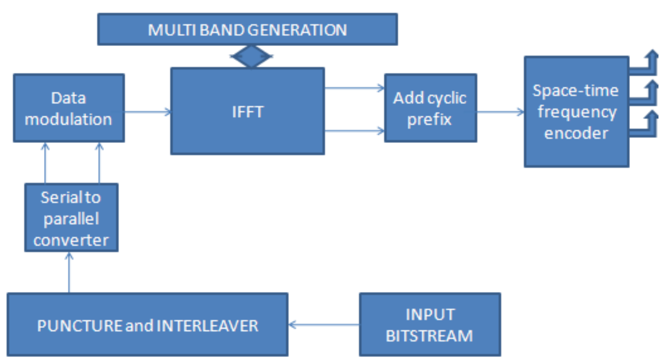

Fig 1 MB OFDM Transmitter

The baseband modem is composed of various components which process the incoming data and then deliver the processing results to each following component in a streaming fashion. We used an 8-bit fixed-point representation for complex numbers that are passed through input and output ports of each component.

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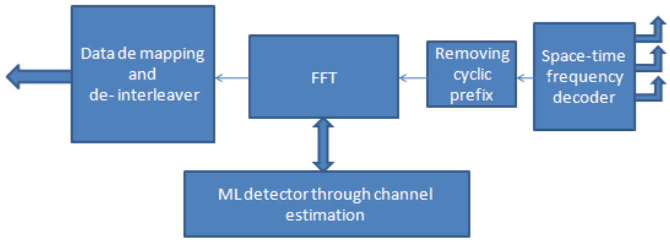

Fig. 2 MB OFDM receiver

IV .RESULTS

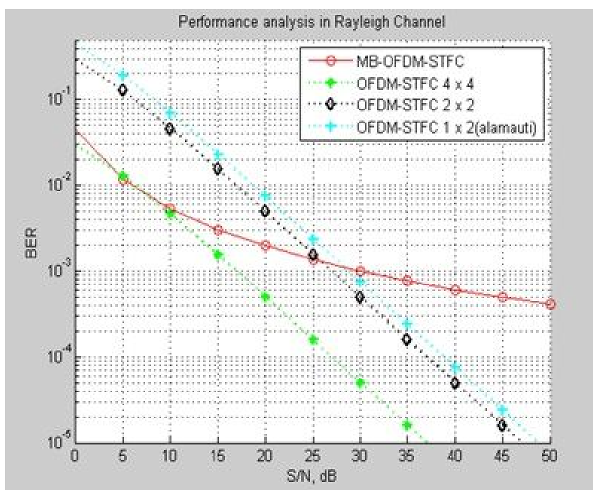

Fig .3 MB OFDM vs STFC

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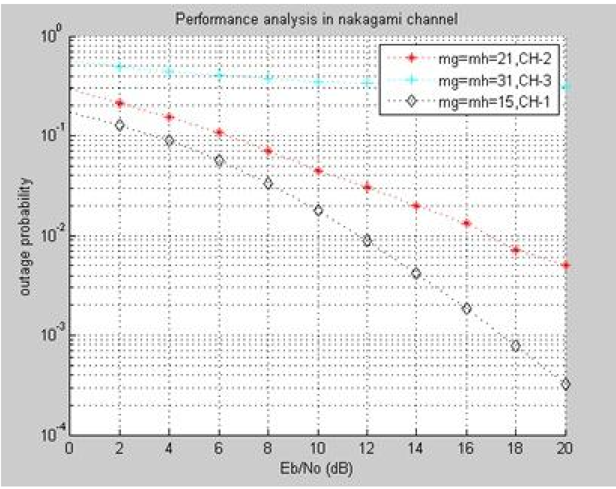

Fig .4 MB OFDM in UWB chanenel

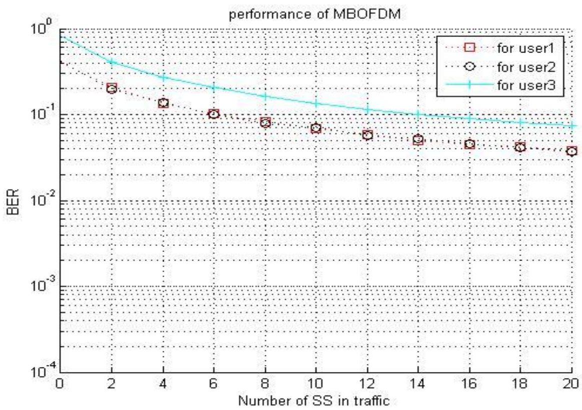

Fig.5 OFDM vs MBOFDM

V . DISCUSSION

In fig.3 Improved performance for OFDM-STFC(1*2)alamouti coder.MultibandOFDM STFC has the moderate performance and the remaining 2 OFDM-STFC has least and average performance .Here Multipath interference is successfully overcome by MB-OFDM.In fig .4Here when we increase the number of taps in frequency selective fading channel interference level will also be increased.From all UWB channels we will get better performance in CH-1 model with 15 PATHS.In fig.5User1 and user2 uses BPSK modulation which has the same interference level since flatfading is used .User3 uses QPSK modulation since BER increased

VI .CONCLUSION

The paper has proposed for the first time the framework of DSTFC MB-OFDM UWB systems using the unitary Alamouti DSTFC with either constant envelope modulation scheme or multi-dimensional modulation one. The proposed DSTFC MB-OFDM concept is useful when the transmission of a large number of MB-OFDM symbols for the channel estimation purpose is uneconomical or even impractical. It has been shown that the DSTFC MB-OFDM system could provide much better bit error performance, compared to the conventional differential MB-OFDM UWB without MIMO, and even better than the conventional coherent MB-OFDM system without MIMO at a high SNR range.

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