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Implementation of Space Time Block Codes for Minimizing the Error Rate in Cognitive Radio Networks

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Abstract— Cognitive Radio (CR) have become a promising innovation to raise the spectrum utilization through spectrum sharing between licensed users (primary users) and additionally unlicensed users (secondary users). An significant rule mandated for the improvement of such systems are to develop solutions that do not require any progressions to the current primary user (PU) infrastructure. An Orthogonal Frequency Division Multiplexing (OFDM) is usually worn technologies in current wireless communication systems which has the opportunity of satisfying the interest for cognitive radios essentially or with lightly changes. Space time block codes is utilized as a part of this paper. The numerous antennas used at both ends for reliable data transmission and interference nulling. These codes can achieve full transmit diversification indicated by the amount of transmit antennas. The MIMO is utilized for improving the capacity of a wireless link, to resolve the problem for lower BER and attain a better performance.

Index Terms— *Cognitive Radio, Multiple input and Multiple output, Orthogonal Frequency Division Multiplexing, Space time block codes.*

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1 INTRODUCTION

Cognitive Radios (CRs) are utilized to increase the spectrum capability in wireless communications [4]. The Cognitive radio(CR) is a type of wireless communication in which the transceiver can wisely sense the communication channels are in use and which are not and directly move into available channels while avoiding occupying ones. A License user has higher priority called primary user. The user which has an absolute right to a specific spectrum band. The secondary user which is unlicensed user, the user may access under certain arranged conditions. Cognitive Radio (CR) allows the secondary user which is lower need than primary user.

Cognitive Radio ready to share the spectrum of primary user to secondary user without influencing the current primary user [8]. A spectrum hole [7] (or additionally called white space) is a band of frequencies assigned to a primary user, however at a proper time and correct geographical area, the band is not being utilized by that user.

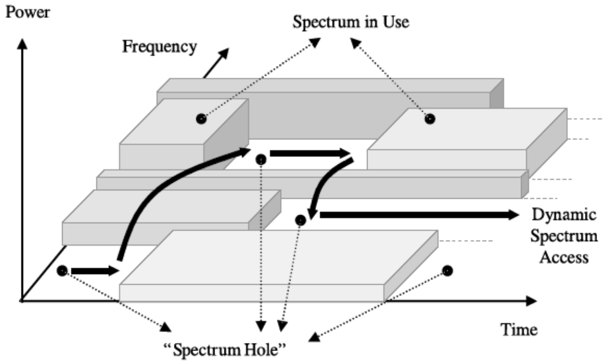

Fig. 1 Spectrum Hole

Cognitive Radio uses Dynamic Spectrum Access [6] to permit the secondary user to utilize the heavy spectrum holes or white spaces in the licensed spectrum bands. The Dynamic Spectrum Access is to alleviate the spectrum insufficiency issue and gain the spectrum efficiency as shown in Fig. 1.

2 EXISTING SYSTEM

The end to end multipath RPC transmission only accesses one relay route at a time, when concurrently transmitting various packets through various relay paths. This route is selected depends on the data sequence in the packet. Hamming distances based RPC codes is used. RPC encodes the data packet in two ways, i.e., by transferring the symbols with Quadrature Amplitude Modulation (QAM) and by using a permutation cluster (PC) which consists of a set of route indices [1]-[3]. The coded packet in each relay path is then enlarged and forwarded towards the destination node. When the packet relaying between the nodes experience the long end to end transmission latency, the packet is discarded, thus causing an erasure. Erasures also occur due to deep fading or to the imperfection of spectrum sensing, which results in severe intervention or collisions [2], when the coded packet is forwarded to a link occupied by the primary or other Cognitive Radio users.

3 SYSTEM MODEL

3.1 Space Time Block Codes (STBC)

Space-time block codes (STBC), the codes are orthogonal as well can achieve complete transmit diversification [5] specified by the number of transmit antennas. Use various antennas on both sides for reliable data transmission. It is designed to achieve the greatest diversification order on both sides. This have made space-time block codes mainly used scheme. On the encoding side, two transmit antennas are used as part of the multiple input multiple output technology.

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3.2 Block Diagram

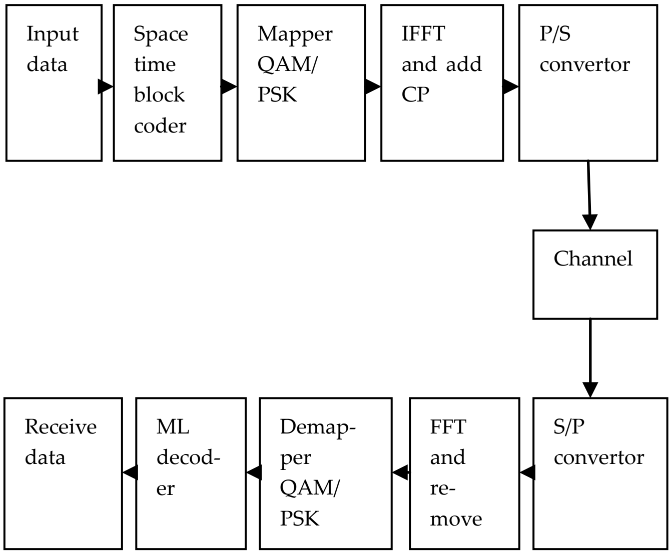

Fig. 2 Block diagram

OFDM Transmitter

At OFDM transmitter, give random input data for transmitting purposes. The input data is provide to the encoding. At the transmitting side, an STBC encoder system can attain a momentous gain of capacity or error rate reduction. The Constellation mapper consists of a QAM modulator. It maps the inward bits against divided sub-carriers. The IFFT converts frequency domain constraints to a time domain. Cyclic Prefix (CP) wholly erases inter-symbol intervention which arise due to Multipath. Then the data are transmitted to a channel.

Channel

Individual route among the transmitter and the receiver exist and an uninterrupted attenuation and noise is considered in channel. Additive white Gaussian noise (AWGN) is a vital noise model worn in Information theory to minimize the cause of several random processes that ensue in nature. It is just that noise is added to the OFDM modulated signal when it is travelling through the channel.

OFDM Receiver

The OFDM receiving unit which observes its input straightly from the transmitter whenever its output is presented. The cyclic prefix was included at the transmitter part in order to ignore inter-symbol intervention, therefore during the reception it must be ignored for any further processing of the arriving signal. OFDM signals are received from the channel signal and are fed to the FFT, which converts them back to the frequency domain. The output data is fed as input to the Constellation de-mapper. The Constellation de-mapper consists of a QAM demodulator. The ML (Maximum Likelihood) decoder [11] is used for decoding the data.

4 SIMULATION RESULTS

For the simulation setup using MATLAB [4], the performance of RPC and STBC in various stages are demonstrated.

Table 1: BER performance of RPC and STBC without erasure

SNR dB	BER 1 for RPC	BER 2 for RPC	BER 3 for RPC	BER for STBC
5	0.0051189	0.0047892	0.0045000	0.003700
10	0.0002935	0.0003332	0.0006106	0.000506
15	0.0000407	0.00002625	0.0000415	0.0000187
20	0.0000013	0.00000110	0.0000071	0.0000039
25	0.0000003	0.00000052	0.0000006	0.00000059

Table 2: BER Performance of RPC and STBC with erasure

SNR dB	BER 1 for RPC	BER 2 for RPC	BER for STBC
5	0.0010324	0.00525936	0.0054309
10	0.0001389	0.00013754	0.00006468
15	0.0000708	0.00001686	0.00000947
20	0.00000358	0.00000383	0.00000128
25	0.000000039	0.000000565	0.00000033
30	0.000000038	0.000000028	0.000000102

Table 3: BER Performance of RPC and STBC under multiuser scenario

SNR dB	BER 1 for RPC	BER 2 for RPC	BER for STBC
5	0.00635262	0.0083593	0.0052900
10	0.00050242	0.0002316	0.00009821
15	0.00003793	0.0000165	0.00000490
20	0.000000987	0.000000178	0.00000570
25	0.000000380	0.0000002806	0.000000128
30	0.0000000394	0.0000000939	0.0000000115
35	0.0000000040	0.00000000028	0.00000000013
40	0.0000000005	0.00000000023	0.00000000016

Table 1 depicts that the performance of reliable RPC transmission and STBC without considering the transmission outage. The input signal is expressed as far as decibel. The BER analysis of various parameters of the RPC and STBC are compared. From this result, STBC delivers low error rate.

Table 2 depicts that the performance of RPC and STBC with erasure channels. The input signal is expressed in terms of decibel. The BER analysis of various parameters are compared. From this result, compared to RPC, STBC delivers low error rate.

Table 3 depicts that the performance of RPC and STBC in multiuser scenario. The input signal is expressed in terms of decibel. The BER analysis of various parameters of the RPC and STBC are compared. Even if the user increases STBC performs low BER compared to RPC.

Table 4: BER Performance of RPC and STBC using ML Decoder

SNR dB	BER 1 for RPC	BER 2 for RPC	BER 3 for RPC	BER for STBC
5	0.0038373	0.002726	0.00035425	0.000613748
10	0.000348	0.0004309	0.00031165	0.000270671
15	0.0000314	0.0000044	0.00004384	0.000017430
20	0.0000007	0.0000053	0.00000695	0.000004717
25	0.00000009	0.0000016	0.00000029	0.000000153

Table 4 depicts that the error rate performance of RPC and STBC after decoding. The input signal is expressed in terms of decibel. The BER analysis of various parameters of RPC and STBC are compared. From this result, STBC delivers low error rate compared to RPC.

Table 5: Capacities of RPC and STBC under multiuser scenario

SNR dB	Capacity of RPC	Capacity of STBC
2	5.7949	6.8083
4	6.9739	8.0393
6	8.1991	9.2908
8	9.4317	10.5798
10	10.7025	11.8624
12	12.0173	13.1643
14	13.3194	14.4847
16	14.6233	15.7998
18	15.9719	17.1389
20	17.2801	18.4542

Table 5 depicts that the capacities of RPC and STBC under multiuser scenario. For enhancing the capacity, MIMO is used. The input signal is expressed in terms of decibel. From this result, STBC delivers high capacity compared to RPC.

5 CONCLUSION

In this paper, the STBC-OFDM scheme for end to end transmission in CRN's was proposed. These codes can achieve full transmit diversification specified by the number of transmit antennas. Amplify and Forwarding diversity mechanism was utilized. We have proved this at different stages and got better performance in CRN with low BER. Also a decoding methodology Maximum Likelihood decoder (ML) proved that it is efficient in decoding to perform better in multiuser scenario. To achieve the low transmission power during transmission period, the proposed procedure is suggested for further implementation in future.

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