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Bit Error Reduction in MIMO-OFDM Using Filtering Method

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***Abstract*— A spectrally efficient digital modulation mechanism in which multiple carriers are present that are mutually orthogonal to each other over particular time is known as Orthogonal Frequency Division Multiplexing (OFDM) system. A subcarrier is known as a carrier in which a pair of sine wave as well as cosine wave is involved. Even though there is an overlap of the sidebands from each carrier, there is no interference involved within the signals that are received here since they are orthogonal with respect to each other. The carrier spacing that is equal to reciprocal of the symbol period is used here. The bit error rate is the major issue of OFDM due to dynamic nature of the network. The space-time trellis coded is the extra codes which reduce bit rate error over the multipath fading channel. This research work is based on wireless channel to reduce bit error rate using space-time trellis codes. In this research work, the bit error rate is reduced over the wireless channels using space time trellis codes and KALMAN filters. The simulation of the proposed modal is performed in MATLAB and results show that bit error rate is reduced in the network.**

***Index Terms*— KALMAN, OFDM, Bit Error Rate**

I. Introduction

Wireless communication can be defined as the process through which data is transmitted to two locations that are not connected to each other physically. For providing communications in the wireless technology, electromagnetic waves are utilized. On the basis of different applications in which this communication is being used, these waves travel in smaller distances [1]. Several fixed, mobile as well as portable applications include such mode of communication. There are two-way
radios, personal digital assistants (PDAs) and various other modes included here. Other components such as keyboards, radio receivers, headsets etc. are include within the radio wireless applications as well. For providing communication, the light, sound, magnetic or electric fields are included within the wireless communication technology [2]. However, in comparison to the above mentioned mediums, these modes of communication are used less. Orthogonal frequency-division multiplexing (OFDM) is the technology in which the digital data is encoded on multiple carrier frequencies. There are wireless and wired communications available within the wideband digital communications being performed. Thus, the OFDM systems have also begun to utilize these two modes. Within several other applications like internet services, digital televisions and audio broadcast, etc. these systems can be used. Multiple-input and multiple-output (MIMO) is defined as the technology in which the transmitter and receiver ends have multiple antennas [3]. The performance of communications that are being held within the network is enhanced using this technology. Diversity is known as a strong communication receiver mechanism through which the wireless link can be improved at very less cost. Several diversity approaches are utilized by wireless communication systems for enhancing the fading radio channel. In the systems that are attained from receiver's end, there are several copies provided for similar type of information signal. From more than two real or virtual communication channels, the transmission of these copies can be done. The basic work provided within diversity in the repetition or redundancy of data present in the networks [4]. In the diversity method, the decisions are made by receiver and the transmitter also does not know about them. Further, for transmission of signal, several propagation paths are also available. Several wires can be used as transmission modes due to the involvement of wired applications. The wireless transmissions can provide antenna diversity by using multiple transmitters and receiving antennas. The diversity integration mechanism is used for providing signal processing. In case if the distance of antennas is huge like within various cellular base station locations, a macro diversity or site diversity is provided. If the antennas are present at one order to wavelength's distance, this scenario is called micro-diversity. The phased antenna arrays that also include MIMO channels and space–time coding (STC) can be used for creating beam. The occurrence of fading process within wireless channel can result in affecting the signal across particular propagation media [5]. There is variation in fading as per the time, geographical location or radio frequency being used. The processing here is done in random manner. A fading channel is known to be the one in which there is communication as well as fading included. The fading might be caused in wireless systems either because of multipath propagation or because of shadowing from the obstacles. Multipath induced fading is another name of multipath propagation. The channel code is provided for forwarding error correction code along with bit interleaving that occurs during the communication as well as storage of data in digital communications [6]. The frequency division multiplexing (FDM) system is the one in which multiplexing is provided in the networks with the help of digital carrier modulation technique. For transmission of data across the network, there are closely spaced orthogonal sub carriers available within these systems. The data is divided amongst the parallel streamed channels for individual sub carrier. Each sub carrier is modulated using the conventional modulation mechanism. Total data rates relevant to conventional single carrier modulation techniques in which similar bandwidth is provided require less symbol rate [7]. The frequency division multiplexing when in signal multiplexing systems, the non overlapping frequency channels are converted. Amongst these channels, distance is left here. When OFDM is presented in frequency domain, the

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modulated QPSK data symbols are provided to orthogonal sub carriers. The signal can be transmitted across the channel present in the time domain. Due to the modifications of OFDM signal into frequency domain, IDFT is implemented [8]. Further, the time domain signals are created by converting these channels. The IDFT that is a linear transformation can be implemented using this system. DFT is applied at receiver end for regaining the original data in frequency domain.

II. Literature Review

Hen-Geul Yeh, et.al (2016) presented that for OFDM systems, coding gain as well as diversity gain are provided along with ensuring that bandwidth efficiency is not minimized by using Space-time trellis code (STTC) techniques. In order to generate a novel STTC-ST-OFDM system, new STTC-ST method is introduced initially [9]. Further, to generate new STTC-WH-ST-OFDM system with limited growth of computation, a Walsh–Hadamard (WH) transform is used as a pre-coder. Thirdly, a STTC-WH-STCC-OFDM transceiver is generated through the integration of STTC-WH-ST-OFDM system with a ST conjugate cancellation (CC) scheme. The compatibility of all three systems is good with respect to OFDM systems and they are also simple to implement. For multiuser OFDM systems, these algorithms serve as baseband building blocks.

Neethu V, et.al (2017) proposed a novel technique in order to enhance the overall performance of OFDM systems [10]. The trellis coded orbital angular momentum- quadrature amplitude modulation (OAM-QAM) and enhanced time frequency multiplexing techniques (eTFM) are integrated in order to generate a novel approach. The mapping of trellis coded data to the OAM-QAM constellation points is done and by utilizing viterbi decoder, this data is identified. By ensuring that the bandwidth is not expanded, the coding gain is enhanced here. In comparison to traditional approaches, there is minimization of BER value due to the increase in Euclidean distance. Thus, there is enhancement in performance of results achieved through proposed technique.

Houshou Chen, et.al (2018) proposed a novel algorithm in order to minimize the peak-to-average power ratio (PAPR) within OFDM signals [11]. Within the least trellis of block codes, partial transmit sequence (PTS) is executed here. In order to select the transmitted OFDM signal that has least PAPR, a linear code that includes good minimal trellis is applied. Through correct of error, the side information is then transmitted. As per the simulations performed and results achieved it is seen that the complexity is minimized along with minimization of PAPR through the application of proposed technique.

Samet Yıldız, et.al (2016) proposed an enhancement maximum-likelihood decoding method in order isolate each of the transmitted signals at the relevant receiver [12]. Here, at the transmitter, a multiplexer is used and at the receiver, a de-multiplexer is used. Enhanced frame error rate (FER) performance is achieved by applying STTC-OFDM as per the experiments conducted. In order to aggregate the system such that the proposed as well as existing methodologies can contrast, the Doppler impact is included here. Enhancements in simulation results show that the proposed mechanism is better in comparison to other already existing approaches.

Ryota Yoshizawa et.al (2016) proposed a novel constellation design in which at the receiver end, the controlling bits as well as information bits can be separated perfectly [13]. Appropriate constellation subset is selected for reducing PAPR such that the signal transition can be controlled. The trellis-based constraint that is generated through a bank of memories is used to control the bits. The performance of proposed system is analyzed in terms of several performance parameters. Further, the practical advantage of this approach in high spectral efficiency system is seen through the comparisons made amongst proposed and several existing approaches.

Funmilayo B. Offiong, et.al (2016) proposed a novel pilot-assisted method in this paper by which the peak-to-average-power-ratio has been minimized for which they utilized the optical orthogonal frequency division multiplexing systems in this paper. DCO-OFDM and ACO-OFDM are the two systems was studied in this paper, these are the time domain signals. They also provided the statistics in order to elaborate the PAPR distributions of the two systems [14]. Due to the higher value of P and due to the minimization of PAPR, there is huge complexity. They performed various experiments and comparisons on the basis of various parameters and concluded that proposed method has better performance as compared to other methods.

III. Research Methodology

In order to mitigate ICI, the 2x1 STCC-OFDM systems are developed which are majorly inspired from the 2-path transmission mechanism of CC-OFDM scheme. There is backward compatibility of most of the existing OFDM systems with that of STCC-OFDM system. Through the selection of either time division multiplexing (TDM), frequency division multiplexing (FDM) or code division multiplexing (CDM), the multiplexing (MUX) circuit is applied at transmitter and de-multiplexing (DEMUX) circuit at the receiver. Through these steps, the STCC-OFDM systems are designed. Here, a novel STTC-WH-STCC-OFDM system is presented by integrating STTC-WH-ST-OFDM and the STCC-OFDM system. At the transmitters end, multiplexing (MUX) circuit is added and at receivers end, de-multiplexing (DEMUX) circuit is added. A high transmission diversity gain is provided amongst the subcarriers present in OFDM block by the pre-coder WHT. However, within the two blocks, the conjugate data copies are transmitted externally with the help of two-path transmission method. It is also possible to extend the MISO model to MIMO architecture here.

Filtering is a very common factor required within the radio communication systems as there is lot of noise present within them. For removing this noise from the electromagnetic signals, an effective filtering algorithm is applied. One of these techniques is the Kalman filtering technique which basically involves a set of mathematical equations. Here the state of process is estimation which further reduces the mean square error of the system. On the streams of noisy input data provided, this method is applied which further produces optimal results. With respect to various aspects, the filter is very efficient. The predictions provided from past, present and future states are considered within this filter.

IV. Experimental Results

The proposed research is implemented in MATLAB to evaluate its performance and the outcomes are shown below.

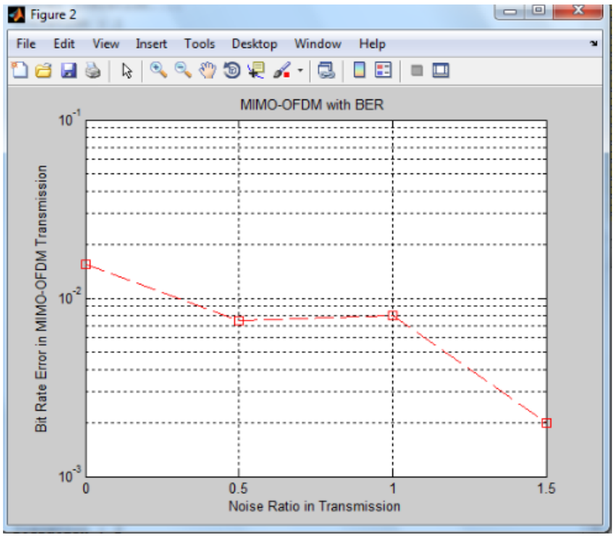

Fig. 1: Bit error rate due to noise

As shown in figure 1, the noise ratio within the MIMO-OFDM systems, the red line depicts the noise ratio.

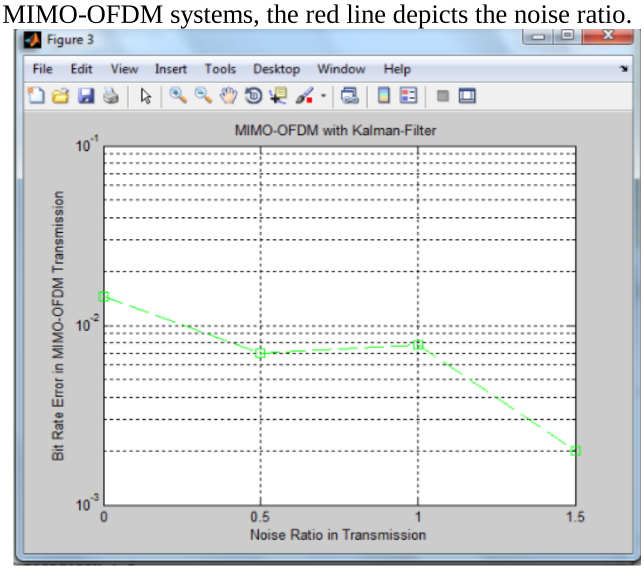

Fig. 2: Noise ratio with KALMAN filter

As shown in figure 2, the noise ratio is represented with the help of Kalman filter within the MIMO-OFDM systems.

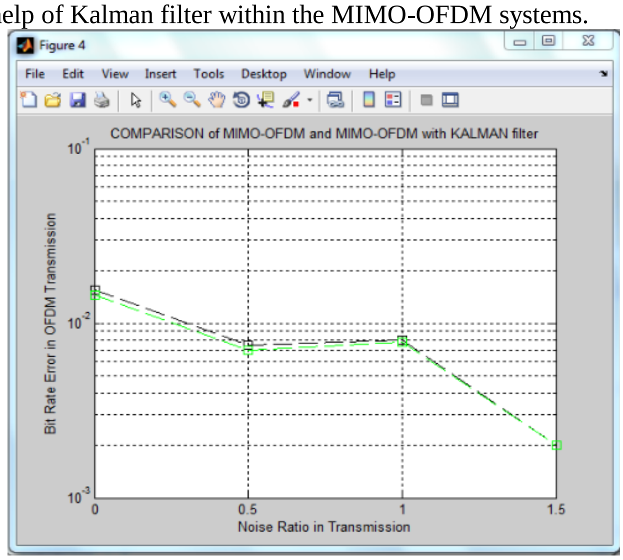

Fig.3: comparison between MIMO-OFDM and with KALMAN filter

As shown in figure 3, the noise ratio is represented with black line and green line shows noise ratio with the utilization of KALMAN Filter. There is reduction in noise ration and bit error with the utilization of Kalman filter in comparison to the genuine MIMO-ODFM systems.

V. Conclusion

A spectrally efficient digital modulation mechanism in which multiple carriers are present that are mutually orthogonal to each other over particular time is known as Orthogonal Frequency Division Multiplexing (OFDM) system. In this work, it is concluded MIMO-OFDM is the dynamic network in which bit error rate is very high. The space –trellis codes are applied on the fading channel. The wireless fading channel has very high bit error rate. In this research work, the space-time trellis codes and KALMAN filter is applied to reduce bit rate error. The simulation of proposed modal is implemented in MATLAB and results shows upto 20 percent improvement in the results.

References

[1] Kandarpa Kumar Sarma, "MIMO Channel Modeling using Temporal Artificial Neural Network (ANN) Architectures", 2010, IITM'10, December 28-30, Allahabad, UP, India, pp 37-44

[2] Hussein Hijazi, "Joint Data QR-Detection and Kalman Estimation for OFDM Time-Varying Rayleigh Channel Complex Gains", 2010, IEEE TRANSACTIONS ON COMMUNICATIONS, IEEE

[3] Jin Whan Kang, "Adaptive Modulation and Coding for MIMO-OFDM Systems using LMS Channel Prediction and CQI Table Adaptation", 2010, ICUIMC '11, Seoul, Korea

[4] Mitalee Agrawal, "BER Analysis of MIMO OFDM System for AWGN & Rayleigh Fading Channel", 2011, International Journal of Computer Applications (0975 – 8887), Volume 34– No.9, pp 33-37

[5] F. P. Calmon and M. D. Yacoub, "MRCS-selecting maximal ratio combined signals: a practical hybrid diversity combining scheme," 2009, IEEE Trans. Wireless Commun., vol. 8, pp. 3425-3429

[6] Satoshi Gounai and Tomoaki Ohtsuki, "Performance Analysis of LDPC Code with Spatial Diversity," 2005, IEEE international conference on Vehicular Technology, pp 1-5

[7] Kwok Hung Li , Kwok Hung Li and Kah Chan The, "Performance Analysis of LDPC Codes with Maximum-Ratio Combining Cascaded with Selection Combining over Nakagami-Fading", 2011, IEEE, Transactions on Wireless Communications, vol. PP, no. 99, pp.1-9

[8] F. P. Calmon and M. D. Yacoub, "MRCS-selecting maximal ratio combined signals: a practical hybrid diversity combining scheme," 2009, IEEE Trans. Wireless Commun., vol. 8, pp. 3425- 3429

[9] Hen-Geul Yeh, Samet Yıldız, "Space-Time Trellis Coded OFDM Systems in Frequency Selective Mobile Fading Channels", 2016, IEEE

[10] Neethu V, Ismayil Siyad C, "Performance Analysis of Diversity Techniques for OFDM system using Trellis Coded OAM-QAM union modulation", 2017 International Conference on Intelligent Computing and Control (I2C2)

[11] Houshou Chen, and Kuo-Chen Chung, "A Low Complexity PTS Technique Using Minimal Trellis in OFDM Systems", 2018, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, Vol. 67, No. 1

[12] Samet Yıldız, Hen-Geul Yeh, "The Performance Analysis of Space-Time Trellis Coded MIMO-OFDM Systems", 2016, IEEE

[13] Ryota Yoshizawa and Hideki Ochiai, "Trellis-Assisted Constellation Subset Selection for PAPR Reduction of OFDM Signals", 2016, IEEE

[14] Funmilayo B. Offiong, Sinan Sinanovi´c and Wasiu O. Popoola, "On PAPR Reduction in Pilot-Assisted Optical OFDM Communication Systems", 2016, IEEE