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A New Bit Split and Interleaved Channel Coding for MIMO Decoder

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***Abstract*– In wireless communications, the use of multiple antennas at both the transmitter and receiver is a key technology to enable high data transmission without additional bandwidth or transmit power. MIMO schemes are widely used in many wireless standards, allowing higher throughput using spatial multiplexing techniques. Bit split mapping based on JDD is designed. Here ETI coding is used for encoding and Viterbi is used for decoding. Experimental results for 16-QAM and 64 QAM with the code rate of ½ and 1/3 codes are shown to verify the proposed approach and to elucidate the design tradeoffs in terms the BER performance. This bit split mapping based JDD algorithm can greatly improve BER performance with different system settings.**

***Index Terms*—Multiple Input Multiple Output (MIMO), Embedded Transition Inversion (ETI), Joint Detection and Decoding (JDD), Quadrature Amplitude Modulation (QAM).**

I. INTRODUCTION

Wireless communication is the transmission of information or power between two or more points [1], [5] that are not connected by an electrical conductor. The primary usage of wireless communication technologies are LTE, LTE- advanced, Wi-Fi and Bluetooth. Wireless operations allows services such as long-range communications that are impossible to implement with the use of wires. In wireless communication an information is transferred into short and long distances. Wireless communication using Multiple-Input Multiple Output (MIMO) systems provides increased spectral efficiency [3] for a given total transmit power. This wireless networking technology greatly improves the range and capacity of a wireless communication system. In wireless communication MIMO system refers to the use of more than one antenna at both sides of transmission.

A key feature of MIMO systems is the ability to turn multipath propagation. This paper discusses the recent advance technologies from theory to practical issues. From the mathematical point of view [6], the MIMO communication is performed through a matrix and not just a vector channel, so it is possible to transmit multiple parallel signal streams simultaneously in the same frequency band. This will increase the spectral efficiency and that technique [3]-[7] is called as spatial multiplexing. Spatial multiplexing involves modulation and demodulation process.

Different from the repetitive scheme, a no repetitive method is proposed and the approach illustrated in [1] focused on linear block codes. However, a compromise between diversity and multiplexing has to be made since it is not possible to exploit both maximum diversity gain and maximum multiplexing gain at the same time. Ideally, adaptive system would adapt the exploitation of multiple antennas to current conditions and thus simultaneously increase both the throughput and the reliability of communication system. This paper presents an algorithm called Embedded Transition Inversion (ETI) of a reconfigurable JDD scheme that shows the MIMO detection and decoding of Viterbi codes currently. Most importantly, the proposed system design is highly improving BER such that it can be configured to operate with different combination of encoder code rates and QAM modulation techniques. The most commonly used modulation schemes in traditional wireless systems [1]-[3], [6], [10]. Compared with the previous CJDD method exploits in [1], this design can be applied to a generalized domain of MIMO communications and can be practically employed to the real world applications. In short, main contributions of this paper can be considered as follows.

1) The reconfigurable JDD algorithm is presented. This algorithm conducts the MIMO detection and decoding of Viterbi codes concurrently, and can be configured to operate with QAM modulation schemes and encoder code rates.
2) The proposed system approaches Embedded Transition Inversion scheme. In particular, shifting properties can be implemented to achieve high BER performance.
3) Experimental results for 16-QAM and 64-QAM with rate ½ and rate 1/3 codes are shown to verify the proposed approach gives the BER performance, complexity, power consumption.

This paper is organized as follows. A review of the system setup and CJDD approach is presented in section II. The proposed reconfigurable ETI algorithm result is presented in section III. ETI implementation results and BER analysis are given in section IV. Finally, this paper is concluded in section V.

Review of Configurable Joint Detection and Decoding Algorithm

An important idea of CJDD algorithm [1] lies in an innovative tree enumeration scheme. The system settings that might change the tree-searching behavior and explicitly define the control parameters that are used to configure the performance of the algorithm. The CJDD processor that can perform the MIMO detection and decoding of convolutional codes simultaneously were designed and implemented.

This design comprised of three major elements, VSF, Path Metric Computer and Sorter. Furthermore a number of registers are also used for storing intermediate results. Considering the fact that multiple paths with multiple tree level could be computed, and each computation is involved with a number of arithmetic operations, PMC becomes the primary bottleneck of the design. Moreover, since the most prominent feature of CJDD design is to be configurable to support different system settings, multiple stages of states could be traversed before proceeding. Even though path metric computer provides required path coverage through testing many paths are impossible to exercise due to relationship of data. Approximately a 3dB improvement is achieved for the 16 QAM and more than 3dB is achieved for the 64 QAM structure. However it is important to notice that such non iterative scheme also incurs a non-affordable complexity and a huge processing delay.

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II. SYSTEM MODEL

An existing system of a CJDD scheme for MIMO wireless communication systems with convolutional codes can be modified as ETI scheme for MIMO with Viterbi codes. In an existing system provides a complex trace back unit in decoder that reduces efficiency and throughput. In order to overcome this, Bit split mapping based on JDD is designed. Here Embedded Transition Inversion coding is used for encoding and Viterbi code is used for decoding.

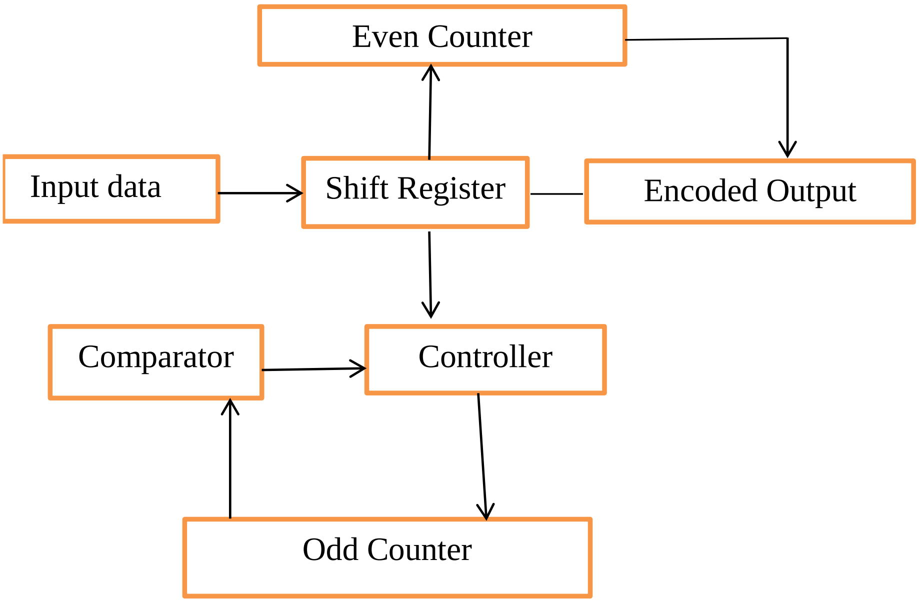

Fig 1. Embedded Transition Inversion Encoding

A technique of converting high bit depth and / or high sample rate digital audio signals to a form that can be recorded at lower bit depth and sample rates. A device that can do bit splitting will break the high resolution audio into several tracks of lower resolution data for recording. Error coding is a method of detecting and correcting errors to ensure information is transferred from its source to its destination. The decoder uses two metrics the branch metric and the path metric. The key insight in Viterbi algorithm is that the receiver can compute the path metric for a (state, time) pair incrementally using the path metrics of previously computed states and branch metrics.

A general technique called bit splitting gives us a way to do that. The idea is straight forward: the encoder does not send every parity bit produced in each stream, but "splitter" the stream sending only a subset of the bits that are agreed-upon between encoder and decoder. This technique gives the BER performance up to 5 dB .The reason for the superior performance of the codes is that they have the greater space distance. The greater space distance allows for a large number of closely spaced errors to be corrected.

Bit error rate testing is a powerful methodology for end to end testing of digital transmission systems.

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III. Results and Discussion

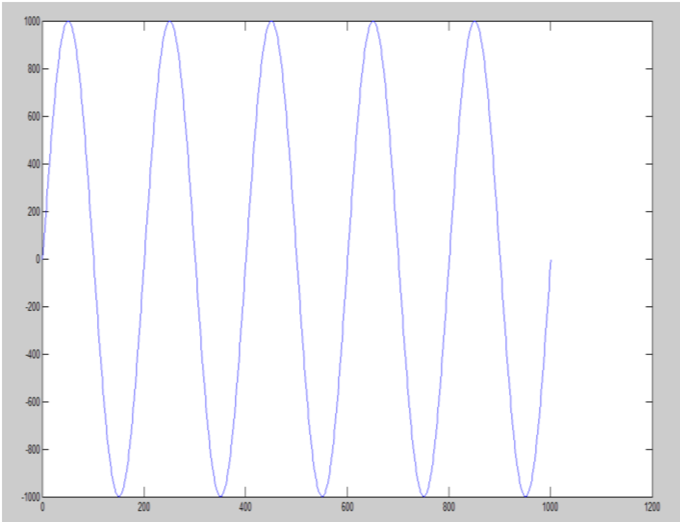

Fig 2. Signal Generation

Figure 2 shows the generation of an analog signal using matlab coding. Signal is important for transmitting the data. It is the basic step in the wireless data transmission. Analog signals are continuously varing signals with the response of time and amplitude.

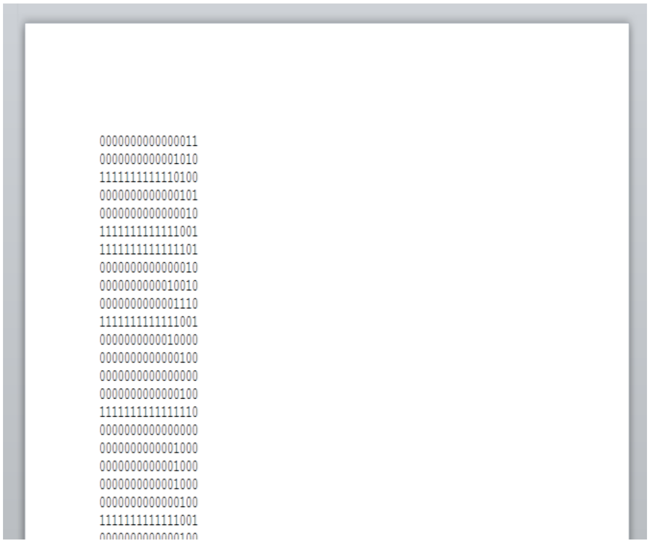

Fig 3. Binary Conversion of an Analog Signal.

Figure 3 shows that the binary conversion of signal. Wireless communication need the digital data for transmitting the information for better communication. The binary digits are representing the values of data to be transmitted from the encoder side from the source.

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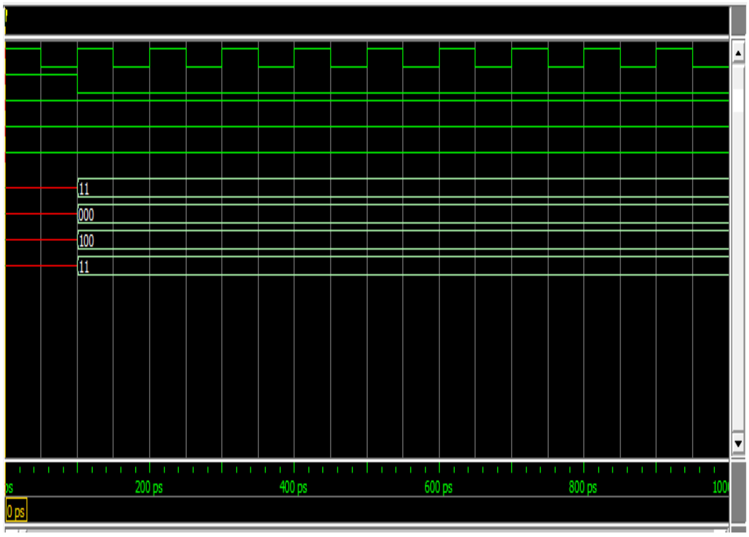

Fig 4. Signal generation of ½ rate encoder

Figure 4 shows the values of ½ encoder. The encoding signals are generated based on the clock, reset values. The clock signal is used for synchronizing the encoding. Reset values clear the past responses.

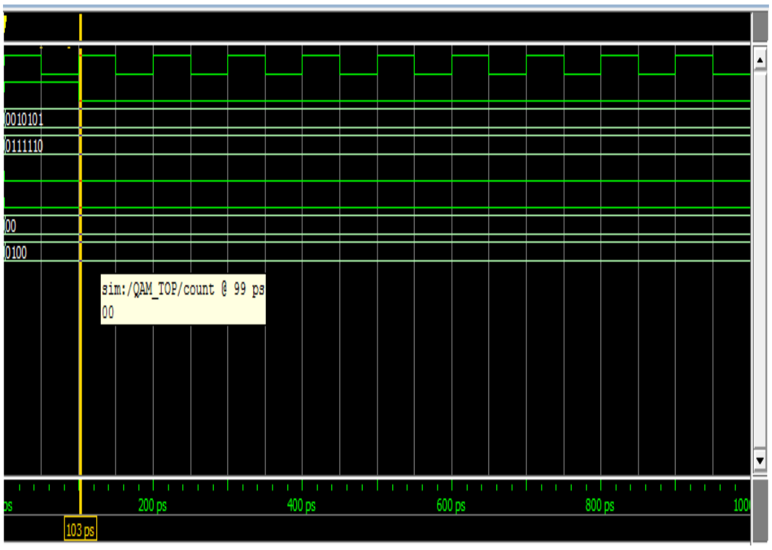

Fig 5. Encoded output

Figure 5 shows the encoded output. The error signal is transmitted in the input side. By using the MIMO decoder the correct encoding signals are generated. ETI plays an important role to produce the encoded data.

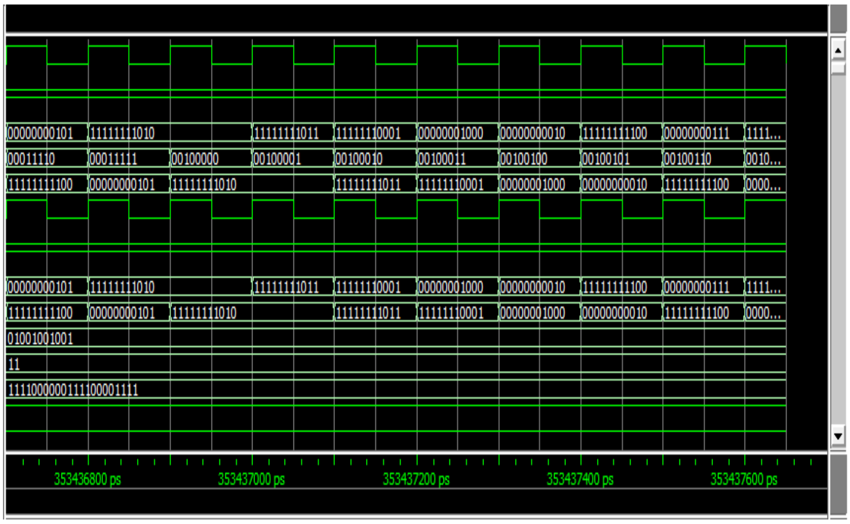

Fig 6. Bit Error Performance Analysis

Figure 6 shows the decoded output wave from generator for different code rate with QAM. The bit error improvement is analyzed by different code rate of the signals. Final results gives the decoded waveform of QAM using MIMO decoder.

IV. CONCLUSION AND FUTURE WORK

This paper presents an algorithm and the VLSI architecture of the CJDD approach for the MIMO wireless communication systems. A formal outline of algorithm is given and simulation results are presented showing that the proposed CJDD algorithm can greatly improve the BER performance with different system settings. In addition, the VLSI architecture and an implementation of the proposed CJDD processor are illustrated, and the optimization techniques to improve the design efficiency are introduced. The post synthesized experimental results show that this design can achieve a reduced system complexity compared with the conventional separate scheme with configurability.

As power densities continue to rise, interleaved boost designs become a powerful tool to keep input currents manageable and increase efficiency, while still maintaining good power density. With mandates on energy savings more common, interleaved construction may be the only way to achieve design objectives. The benefits of this approach are demonstrated by a two-phase boost converter design built around the LM5032 pulse-width modulation (PWM) controller.

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