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MPLNC Using Cyclic Code and Select-Max Protocol

Faizy Fazal[1], Ann Susan Varghese[2]

[1, 2]Department of Communication Engineering, Mount Zion College of Engineering, Kadamanitta, Kerala, India

Abstract: ***The important advantage of a wireless network compared with a wired network is its broadcast nature. The concept of network coding can be applied at the physical layer to turn the broadcast property into a capacity-boosting advantage in wireless networks. Relay is a node between the transmitter and receiver to amplify and forward(AAF) the signal. Here a cooperative coded modulation technique, namely, multi-level physical-layer network coding (MPLNC), is proposed to exploit the structure of multiuser, multilevel coding. Multi level coding means the information's are transmitted at different code rate . Specifically in the MPLNC scheme proposed, both sources send information using multi level coding (MLC) and the receiver node performs PLNC and Multi stage Decoding (MSD) . At the multi relay system a protocol named SELECT-MAX protocol is used. This help the relay to decide whether relaying is needed or not needed at the destination based on SNR and to select the best relay from multiple relay system . this improves the reliability and efficiency of physical layer network coding(PLNC) .Also by using cyclic codes for coding will provide efficient error detection and error correction at multi level physical layer network .***

Keywords: PLNC, MLC**,** MPLNC, MSD, AF relaying, Select-Max Protocol, Cyclic Coding

1. Introduction

Coding at physical layer has the ability to improve throughput of the network .most of these works are considering a three node model with two way relaying .the three nodes are source ,relay, destination respectively. in fact there may be other neighboring nodes that can cause or receive interferences .S.Zhang and Lamin [1]distributed a wireless MAC layer mechanism that make a spatial reservation of the shared wireless medium similar to the familiar RTS/CTS mechanism in IEEE 802.11 wireless networks For designing physical layer network coding(PNC) a method known as nested lattice is considered by employing compute and forward (C&F) relaying strategy of Nazer and Gastpar [2].a common framework was developed for observing nested lattice based PNC method called Lattice Network Coding (LNC) was introduced .The physical network coding(PNC) which is also known as Analog Network coding (ANC) was proposed by Z,Ding [3].[4] propose a transmission scheme for two way Amplify and Forward (AAF) relaying scheme .when network coding is applied in this scheme ,the data rate rates transmitted by the relay to the receiving stations can be adjusted according to their individual link qualities subject to a constraint Bit Error Rate (BER).this system supports only symmetric traffic that means sources included in the network have same data rates .this introduced scheme has less complexity and can be applied for system with single or multiple antennas .the idea is that the relay combines the data rate in such a way that some bits in each transmit symbols are priori known to weaker link receiver

The main contributions of the paper are follows

- We design the multi-level physical-layer network coding Exploiting multiple encoders, MPLNC is suitable for the Symmetric as well as *A*symmetric relaying traffic
- Encoding decoding using cyclic code for error detection and corrections to be done easily through shift registers.
- Proposed a method to decide whether relaying is needed or not needed at the destination and this method to select best relay from N relays.
- At destination priority decoding is done for multi stage detection(MSD).

2. System Model

Consider the following system which consist of two source nodes .let it be source A and B, they simultaneously transmit their message to the relay node .each messages are coded and modulated at the source nodes .the signal received at the relay node is expressed as

$$Y_r = \sqrt{P_A X_A} + \sqrt{P_B X_B} + Z_r \qquad (1)$$

Z_r is the zero mean complex Gaussian noise of variance $\sigma^2 = N_0/2$. Xi ,*Pi*, respectively denote the transmitted symbol and the average symbol energy of node *i*, *i* = *A,B*. Let a and b be the transmitted code words of *A* and *B*, respectively. With PLNC, the relay node does not decode both messages separately, but only recovers the network codeword c = a $\oplus$ b.

2.1 MPLNC: Encoding Structure

Let $x_{NC} = x_A + \gamma x_B$ denote the superimposed signal, where $\gamma = \sqrt{P_B/P_A}$. Then

$$Y_r = \sqrt{P_A X_{NC}} + Z_r \qquad (2)$$

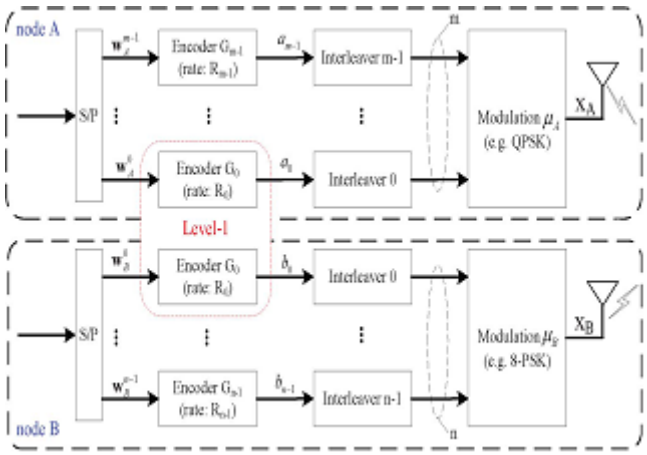

Figure 1: MPLNC Transmitter block diagram

The encoder we used here is cyclic encoder shown in fig 2 .cyclic codes are those whose every circular shifts produce a codeword ,the circuit diagram of encoder is shown below

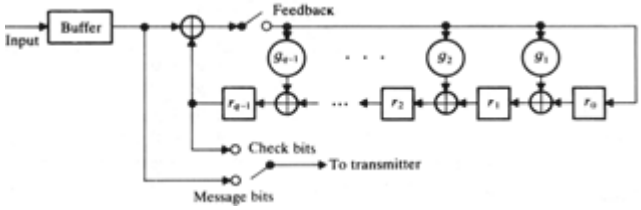

Figure 2: Cyclic encoder

- cyclic codes can be generated by using shift registers whose feedback coefficients are determined directly by the generating polynomial
- In the circuit, first the message flows to the shift register, and feedback switch is set to '1', where after check-bit-switch is turned on, and the feedback switch to '0', enabling the check bits to be outputted

Fig 1 depicts the general transmitter structure of our developed MPLNC scheme consider source A consist of m data streams $\{W_A^0, \ldots\ldots\ldots W_A^{m-1}\}$ .after encoding produce a cyclic binary code C_i of length N code rate $R_i = K_i/N$. K_i is the number of message bit per transmitted codeword .after encoding the bit sequence a_i are then interleaved separately. the interleaved bits are then given to a 2ˆm-ary modulator μ_A , yielding the transmitted symbol x_A

Similarly source B consist of n data streams $\{W_B^0 \ldots\ldots\ldots W_B^{n-1}\}$ .after encoding produce a cyclic binary code C_i of length N code rate $R_i = K_i/N$. K_i is the number of message bit per transmitted codeword .after encoding the bit sequence b_i are then interleaved separately. the interleaved bits are then given to a 2ˆn -ary modulator μ_B, yielding the transmitted symbol x_B. during multiple acces stage the channel coding serves to protect the network information $W_A^i \oplus W_B^i$ rather than individual codeword W_A^i and W_B^i .we refer to m=n scenario called symmetric traffic means source A and B have same data rate and also asymmetric traffic $m \neq n$ where source A and B have different rate .in this case L= max{m,n} as the number of levels to be selected .the code rate of A and B is selected as

$$R_A = \sum_{i=0}^{m-1} R_i = \sum_{i=0}^{m-1} K_i/N$$

$$R_B = \sum_{i=0}^{n-1} R_i = \sum_{i=0}^{n-1} K_i /N \quad (4)$$

2.2 Select Max Protocol

In co-operative communication networks relay selection is a challenging issue .in multipath fading environments co-operative diversity uses relay to assist source destination transmissions to reduce outage rates .here at the channel between source and destination relays do amplify and forward (AAF) over Rayleigh fading channel. the communication between source and destination node are directly or indirectly through multiple relays .the relay that have highest signal-to-noise ratio(SNR) at the destination is selected .the relay selection reduces the amount of required resources .thus this protocol is an application of Green Communication .here focus on amplify and forward (AAF) dual hop co-operative diversity network for best relay selection diversity scheme over Rayleigh fading channel as shown in fig 3

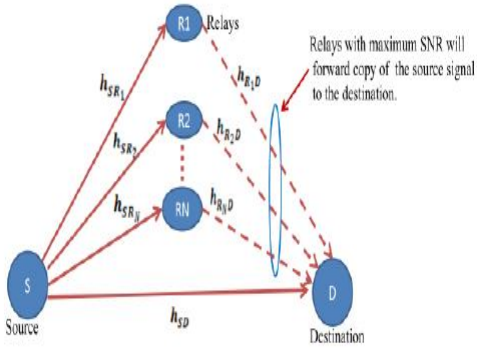

Figure 3: select max protocol

consider the source has one transmit antenna and destination has one receive antenna .at the first step the source terminal transmit signal X to the relays and to the destination terminal .all the N relays and the destination(receiver) receive the noisy faded version of the source signal ,then the receiver measures the signal-to-noise ratio(SNR) of the received signal .the destination decides whether the relaying is needed or not needed because at the destination .the signal-to-noise ratio(SNR) of received signal from source is compared with SNR threshold (γth),which defines the minimum SNR for which destination can detect the signal without the need of the relayed signal .if the signal-to-noise ratio is sufficient the relays do nothing and the destination can detect using source signal and source send a new message in the second time slot .if the signal-to-noise ratio at the destination is insufficient the Select Max Protocol is used . Select Max Protocol will select the relay that have maximum SNR to take part in

communication. For insufficient signal to noise ratio (SNR) at the destination, the select-max protocol is used. Select-Max protocol selects relay with maximum SNR, to take part in the communication. In particular, the relay which maximizes an appropriately defined metric is selected. This metric account for both the S-Ri and Ri-D links and reflects the quality of the i-th end-to-end path.

γ_i = min(γSRi, γRiD) (5) Here, we adopt the minimum value of the intermediate link SNRs, Hence, the relay that is activated in the select-max protocol, is selected according to the rule

$S_r = \arg\{\gamma_i\}i \in R max$ (6)

where R = {1, 2, . . .,N}, γi is the instantaneous SNR for the relay i

2.3 Multi Stage Decoding

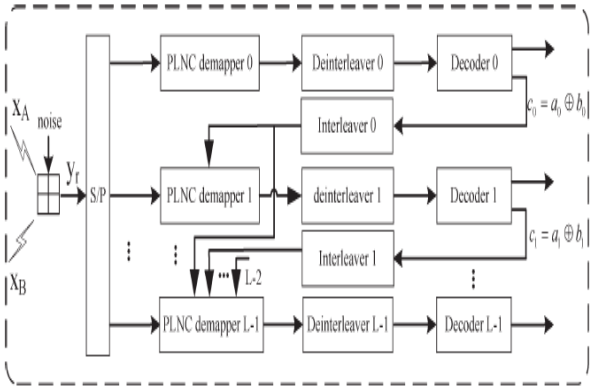

Figure 4: MPLNC/MSD

To reliably recover the network codeword at the relay node, two decoding approaches are considered for the proposed MPLNC scheme. Note that both decoding approaches have identical encoding structure MPLNC/MSD: The multistage decoding structure for MPLNC is shown in Fig. 4 which includes the maximum aposteriori probability (MAP) demapper and an individual channel decoder for each level. The decoding is performed in L stages, in which each level is decoded individually starting from the lowest level. The decisions from all lower levels are considered for the high levels decoding. Based on a priori information about the previous levels from the individual decoders.this priori decoding system is not found in parallel independ decoding (PID) .SO MSD perform well as PID.

3. Simulation Results

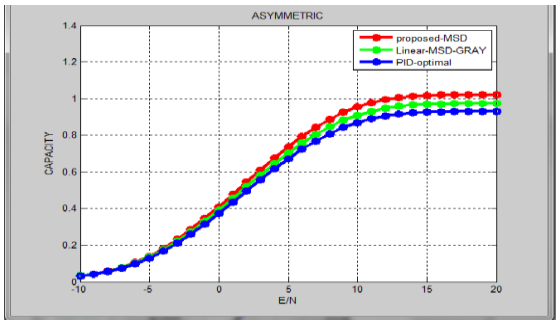

Figure 4: Capacity Vs SNR for Asymmetric system

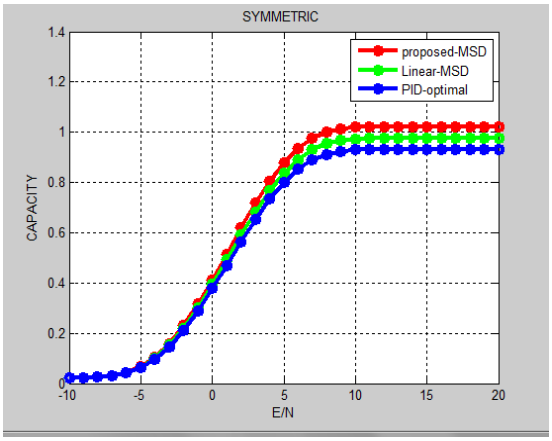

Figure 5: Capacity Vs SNR for symmetric system

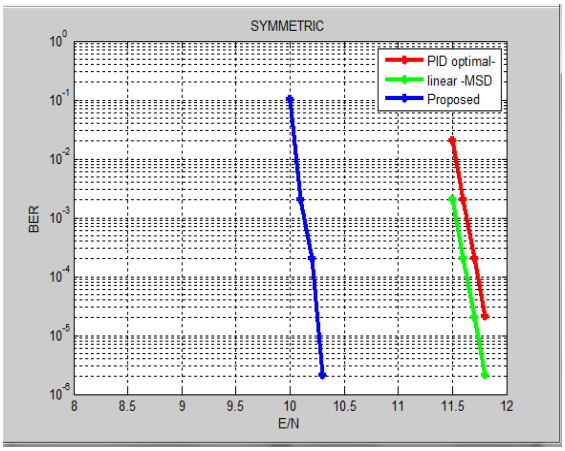

Figure 6: BER Vs SNR for symmetric system

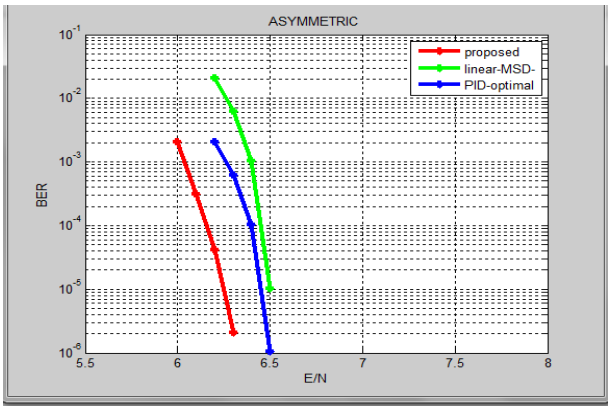

Figure 7: BER Vs SNR for Asymmetric system

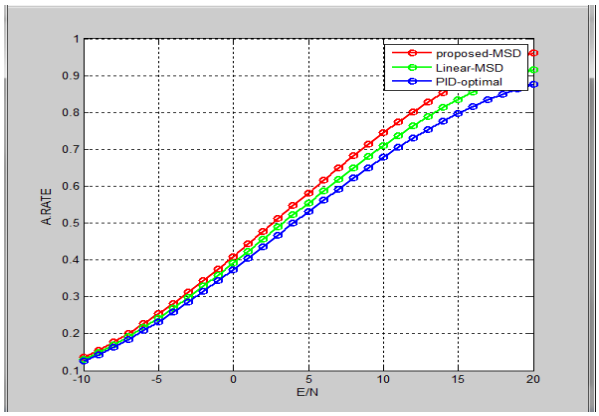

Figure 8: Achievable Rate Vs SNR

Capacity is calculated for symmetric and asymmetric proposed system multi level physical layer network coding with cyclic code and select max protocol .also the capacity calculated for linear coding and parallel independent decoding .capacity is plotted against signal to noise ratio and could observe that proposed system has best performance compared with the existing system is shown in fig 4 and 5. Bit Error Rate is calculated for symmetric proposed system multi level physical layer network coding with cyclic code and select max protocol .also the Bit Error Rate calculated for linear coding and parallel independent decoding . Bit Error Rate is plotted against signal to noise ratio and could observe that proposed system has best performance compared with the existing system is shown in fig 6 and 7. Achievable Rate is which shows the efficiency of transmission rate. Achievable Rate is calculated for proposed system multi level physical layer network coding with cyclic code and select max protocol .also the Achievable Rate calculated for linear coding and parallel independent decoding . Achievable Rate is plotted against signal to noise ratio and could observe that proposed system has best performance compared with the existing system is shown in fig 8.

4. Conclusion

Multi level physical layer network coding is employed using cyclic codes .Therefore Error detection, correction and syndrome calculation can be easily employed using shift registers, also Relay selection from multi relay system is based on select-max-protocol for best relay selection. This protocol decides whether relaying is needed or not. best relay selection reduces the number of unwanted resources .The overall reduces BER and increases achievable rate. This system is an application of wimax, green communication, this is the communication in which resource wastage is reduced

5. Acknowledgment

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Author Profile

Faizy Fazal. received the B.Tech degrees in Electronics and Communication Engineering from M.G University, Kerala at Musaliar College of Engineering in 2013. And now she is pursuing her M.Tech degree in Communication Engineering under the same university in Mount Zion College of Engineering.