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Performance Analysis Of Low Density Parity Check (LDPC) Encoded Cooperative Communication System With Implementation Of Orthogonal Frequency Division Multiplexing

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ABSTRACT : *Cooperative communication is a new paradigm that draws from the ideas of using the broadcast nature of the wireless channel to make communicating nodes help each other, of implementing the communication process in distributive fashion. Due to the requirement of ubiquitous coverage for wireless broadband services, demand for high data rate is increasing rapidly for the future wireless generations. More base stations are needed to deliver these services, in order to cope with the increased capacity demand and inherent unreliable nature of wireless medium. Usually wireless communication performance is badly affected by channel fading, noise, attenuation, crosstalk, less signal quality etc. This paper presents performance analysis and comparison of a three node cooperative communication system with orthogonal frequency division multiplexing (OFDM) and low-density parity check matrix (LDPC) encoded system. The simulation results show that the system performance can be improved by using cooperative communication techniques even when the inter-user channel is not good. The performance metric used for analysis is BER at a particular direct link SNR. In this thesis work we examine the performance of a cooperative communication system and its ability to realize the advantages and the ideas behind its invention. We model a simple amplify and forward, decode and forward repletion based cooperative communication system. To evaluate the performance of cooperative communication system using computer simulation. We focus on Bit Error Rate (BER) performance analysis of cooperative communication system with either an amplify-and-forward (AF) and decode-and-forward (DF) cooperation protocol using MATLAB. Our results shown that a better performance of a communication system could be achieved by allowing wireless network partners to communicate cooperatively.*

KEYWORDS *Cooperative communication, OFDM,LDPC,AF,DF*

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I. INTRODUCTION

Wireless communications have seen a remarkably fast technological evolution. Although separated by only a few years, each new generation of wireless devices has brought significant improvements in terms of link communication speed, devices sizes, battery life, applications, etc[1]. In recent years the technological evolution has reached a point where researchers have begun to develop wireless network architectures that depart from the traditional idea of communicating on an individual point-to-point basis with a central controlling base station. One of the most appealing ideas within these new research paths is the implicit recognition that the wireless channel is broadcast by nature [3].]. This implies that any wireless transmission from an end-user, rather than being considered as interference, can be received and processed at other nodes for a performance gain. This recognition facilitates the development of new concepts on distributed communications and networking via cooperation.

The basic ideas behind cooperative communication can be traced back to the groundbreaking work of Cover and El Gamal on the information theoretic properties of the relay channel [1]. This work analyzed the capacity of the three-node network consisting of a source, a destination, and a relay. It was assumed that all nodes operate in the same band, so the system can be decomposed into a broadcast channel from the viewpoint of the source and a multiple access channel from the viewpoint of the destination .Many ideas that appeared later in the cooperation literature were first exposited in [1].

1.1 Objectives of the studyThe main objectives of this study are as follows:

I. To remove the limitation of wireless communication system.
II. To concern the sharing of network resources among users in cooperative communication system.
III. To develop the signal performance of a cooperative communication system by minimizing signal error and increasing signal strength.

To use limited bandwidth to serve as many as users. methods for monitoring systems of solar plants. The third section discusses communication and monitoring system for wind turbines, and finally the conclusion is discussed in the fourth section.

II. COOPERATIVE COMMUNICATION SYSTEM

Cooperative communication

In any wireless system, it is desired to maintain a high quality link between the Source (S) and the Destination (D) nodes but in any practical system, issues like multipath fading, shadowing and distance may decrease the actual performance below acceptable limits. With the help of a cooperating Relay(R) node, performance can be improved by combining signals from this second path via the relay with those transmitted from the originating source [2]. The cooperative communication system consists of a source, relay, channels, and destination. The output of the source is transmitted through two different channels. One channel is from source to destination, the other is from the source to relay and then from relay to destination. The signal once received at the relay is then transmitted to the destination, possibly after applying some signal processing techniques on it. The processing of signal at the relay incurs some delay in the transmission of signal.

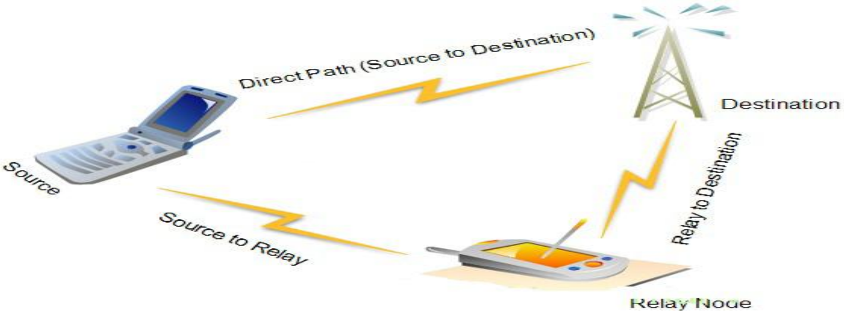


Fig1: Three node wireless cooperative network.

Cooperative Relaying System Model

Cooperative relaying techniques can be realized in systems with either single relay or multiple relays per user. These system models are illustrated below.

(a) Single Relay System Model **(b)Multi Relay System Model**

(a) Single Relay System Model

The basic model for cooperative system is a three terminal system model with on source, one relay and one destination as shown in the fig-4.2. Suppose terminal 1 (source) and terminal 3 (destination) want to communicate with each other but the link between is too weak and there is another terminal 2 (relay) which resides in between terminals 1 and 3. However, the link from terminal 2 to both sides is fairly good so it will act as a relay to assist the direct communication. Terminal 2 receives the data from the terminal 1, performs some signal processing and then forwards that processed data to the terminal 3. The terminalsmay interchange their roles as source, relay and destinationat different instants in time [3].

Fig.2: Cooperative system model with single relay

(b)Multi Relay System Model

However, in practical systems there are multiple sources, all transmitting at the same time to the multiple destinations? This requires multiple relays in the system as depicted in Fig-4.3. In this case relays form a virtual antenna array and exploit some of the benefits of MIMO systems [13]. But this scenario causes problems in resource allocation strategies, since multiple relays have to be allocated resources to assist the cooperation between them. Thus,multiple access schemes must be devised to separate theirsignals in time (TDMA), frequency (FDMA), code (CDMA)or space (SDMA). In TDMA/FDMA systems, sourcestransmit over orthogonal time or frequency channels, whereradio resources must be properly allocated to fully exploitthe advantages of cooperation. In CDMA or SDMA systems,users transmit simultaneously over different code or spatialdimensions.

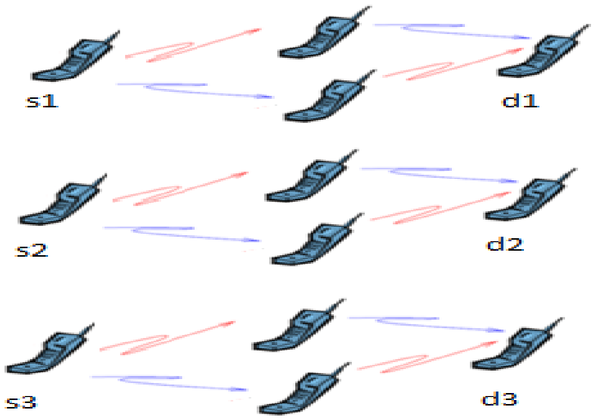


Fig.3: Cooperative system model with multiple relays

III. COOPERATION STRATEGY

Fixed Cooperation Strategies

In fixed relaying, the channel resources are divided between the source and the relay in a fixed (deterministic) manner. The processing at the relay differs according to the employed protocols. The most common techniques are the fixed AF relaying protocol and the fixed relaying DF protocol.

(a)Fixed Amplify & Forward (Single Relay)

In a fixed AF relaying protocol, which is often simply called an AF protocol, the relay scales the received version and transmits an amplified version of it to the destination. The amplify-and-forward scheme is presented in Fig-4.4

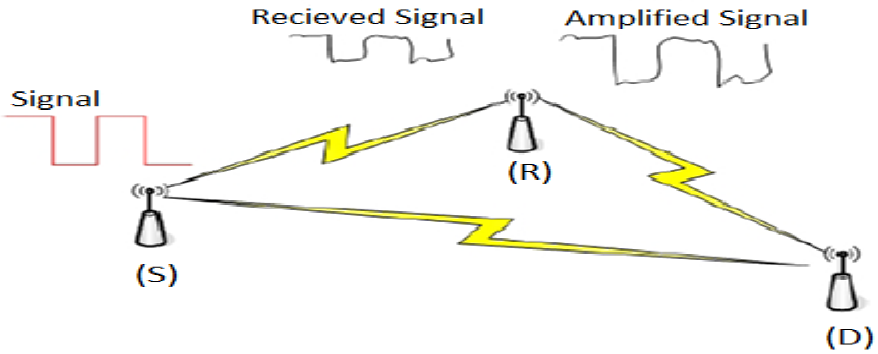
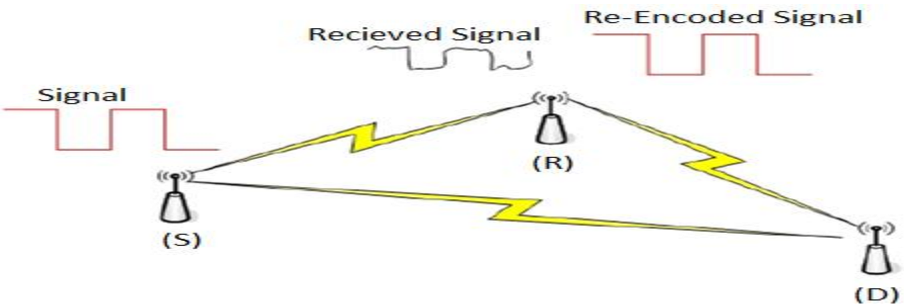


Fig.4: Amplify and Forward System Model

(b)Fixed Decode and Forward (Single Relay)

Another processing possibility at the relay node is for the relay to decode the received signal, re-encode it, and then retransmit it to the receiver. The decode-and-forward scheme is presented in Fig-4.6. This kind of relaying is termed as a fixed decode-and-forward (DF) scheme, which is often simply called a DF scheme without the confusion from the selective DF relaying scheme. If the decoded signal at the relay is denoted by x', the transmitted signal from the relay can be denoted by x', given that x' has unit variance.



Ldpc And Ofdm

LDPC (Low Density Parity Check Code):

At present, LDPC is the best error correction codes.It is a class of linear block code. The term "Low Density" refers to the characteristic of the parity check matrix which contains only few '1s' in comparison to '0s'.

Encoding of LDPC:

If the message bit=m,Generator matrix=G,then Encoded word,U=m*G,G can be defined as G=[P:Ik] , Where P is the parity check matrix.

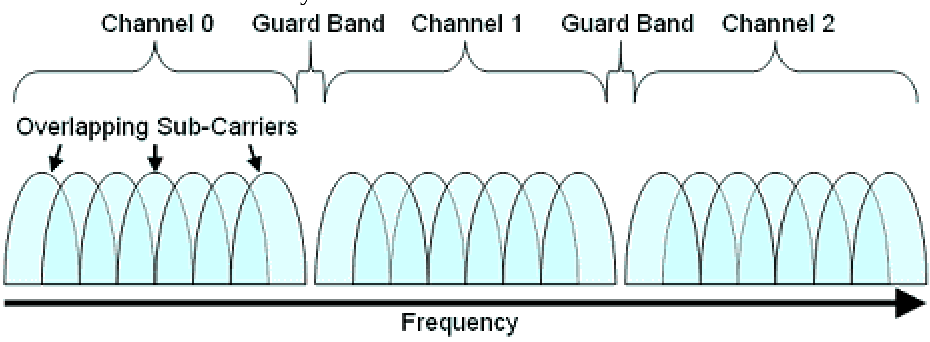
Interconnect representation of H matrix .Two sets of nodes: Check nodes and Variable nodes.Each row of the matrix is represented by a Check node .Each column of matrix is represented by a Variable node

$$H = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

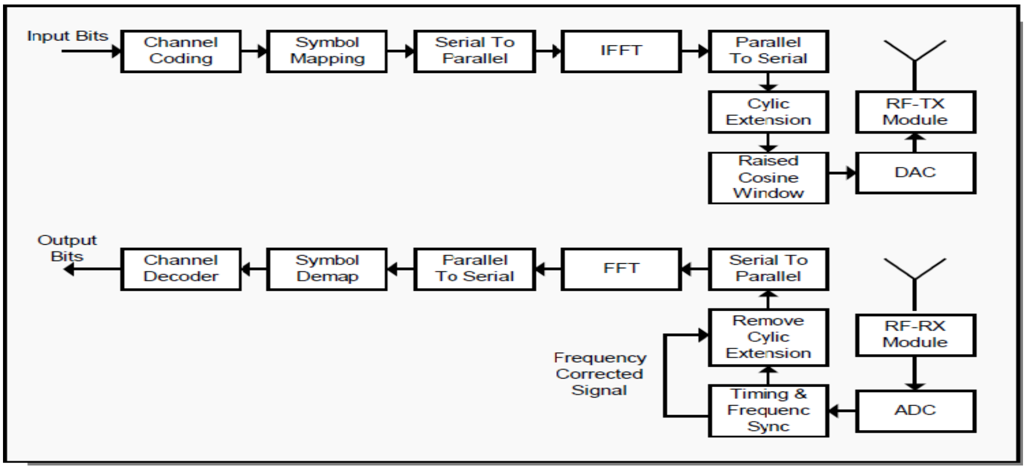
Decoding of LDPC Codes

OFDM

OFDM is a special kind of FDM. It is a multi-carrier transmission technique which divides the available spectrum into many sub-carriers. The concept of multi-carrier transmission is that a user can employ a number of carriers to transmit data simultaneously.



In OFDM, the link is divided into number of channel. The channels are separated to each other by guard band to prevent signal overlapping. As the sub-carriers are orthogonal to each other, there is no chance to occur ISI or ICI. But if there is no synchronization between transmitter and receiver, there is a probability to occur ISI or ICI. To overcome this, cyclic prefix insertion technique is used. The main advantage of OFDM is bandwidth efficiency.



Organization Of The Working Process Of The Thesis

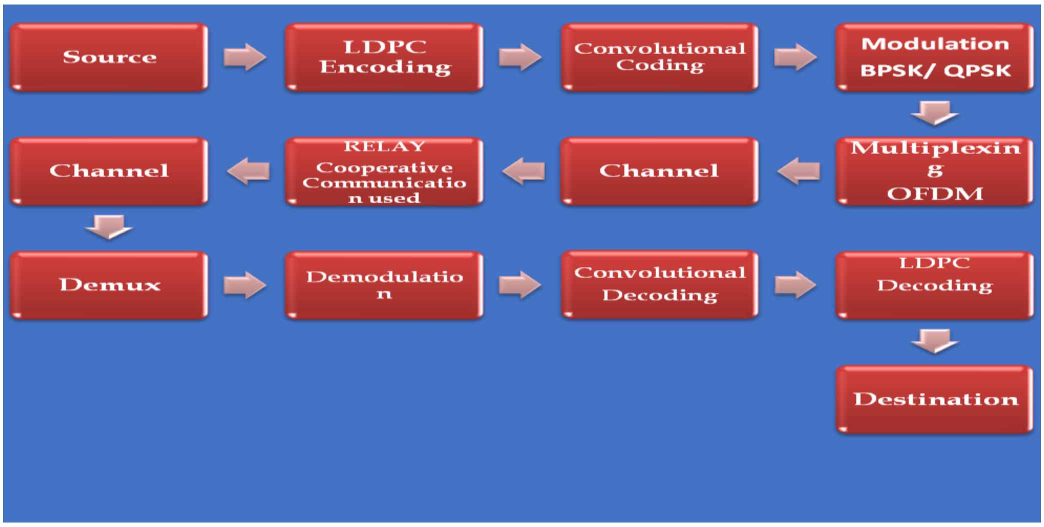


Fig.5. Organization Of Working Process Of The Thesis

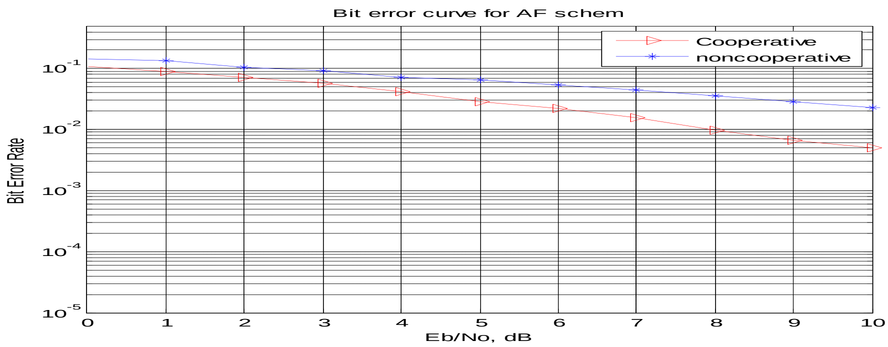
IV. RESULT AND PERFORMANCE ANALYSIS

Simulation Result & Performance Analysis

In this section we show and discuss the Simulation result of two Cooperative Communication protocols i.e. AF & DF. The MATLAB software has been used for the simulation and analysis.

Before we start our discussion on simulation results it is necessary to show a simulation diagram for better understanding. Beneath a diagram (Fig-6.1) is shown that explain the follow of our simulation. The MATLAB program has been compiled to produce the responses for the LDPC encoded cooperative communication implemented in OFDM.

In this section we have shown and discussed the simulation result of non-cooperative and cooperative communication, we focus on the Bit error rate (BER), performance analysis of both an amplify-and-forward (AF) & Decode-and- forward (DF) cooperation protocol. From Bit error curve we demonstrated that performance of the cooperation signal is better than the non-cooperation communication signal in AF scheme.



4.2 Amplify-and-forward scheme performance analysis:

The graph shows the LDPC encoded and BPSK modulated amplify-and-forward scheme with FRC and ERC.

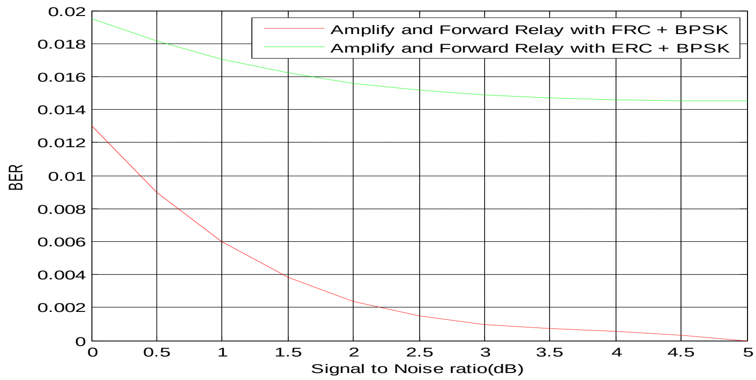


Fig.6: Cooperative communication AF scheme for BPSK modulation with ERC & FRC

Noise is added and amplified into the AF strategy. For recovery and correcting this noise we use the FRC and ERC. The graph illustrates that FRC is better than ERC whereas the bit error rate is maximum for the ERC which is presented by red line.

Decode-and-forward scheme performance analysis:

The graph shows the LDPC encoded and BPSK modulated decode-and-forward scheme with FRC and ERC

4.6 Relation between channel capacity and SNR of cooperative communication:

Discussion

In this section we will show and discuss the simulation result of MIMO two-way with cooperative relay of locally located nodes.

Here, the number of mesh nodes is N=7 and the number of antennas at mesh node M=3.

The figure shows the relationship between the channel capacity and signal to noise ratio. We see that, channel capacity is proportional to the signal to noise ratio, as the channel capacity increases, the signal to noise ration also increases. There is a very little difference between the real and ideal curve of the channel capacity and signal to noise ratio.

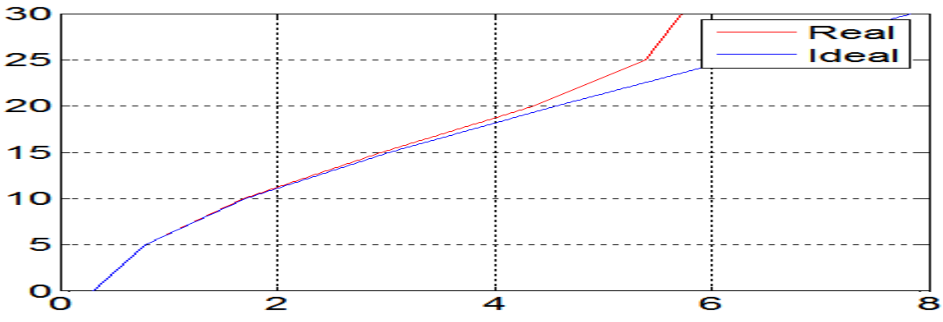


Fig .7: Channel capacity Vs SNR of cooperative communication.

V. CONCLUSION

In a cooperative cellular communication system two or more active users in a network share their antennas and jointly transmit their messages, either simultaneously or at different times to obtain greater reliability and efficiency than they could obtain individually. Through cooperation both terminals are able to simultaneously increase their throughputs and reliabilities even when they are connected via low quality links, or when one terminal has a much better link then the other.

The aim of our thesis is to obtain greater reliability and efficiency of bandwidth than the users could obtain individually. In this paper work we analyzed the LDPC encoded signal performance of cooperative communication methods.

In our paper work we presented the scenario of cooperative communication in cellular systems. We discuss several relaying schemes for cooperative communication. Another important aspect of Co-Op Communication is also presented in this paper is Relay Selection, it is important to understand “when to cooperate and with whom”. Since Co-Op is purposed for 4G systems so it is better to have OFDM modulation scheme rather BPSK or any other PSK scheme which we have implemented. By using OFDM and LDPC the cooperative communication system becomes bandwidth efficient. More users can communicate with each other in a little bandwidth. The signal quality also improves.

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