An Extensive Review on Cooperative Diversity-Based on STBC with Amplify Forward (AF) & Decode Forward (DF)

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Abstract-In this review paper we have prepared a literature review on Cooperative Diversity-Based Body Area Network Using STBC. Wireless channels suffer severely from the effect of multi-path and fading. To moderate these effects of fading and, STBC is used with cooperative diversity, two or more users may share their antennas to create a virtual MIMO system. Therefore in cooperative communication numerous single antenna relays assist the transmission between a source and a destination. Cooperative communication protocols such as amplify and forward and decode and forward are studied for relaying. In addition to this, for a 3 node cooperative communication contain a source, relay and destination the impact of relay location is studied for 3 different location of relay that is relay placed closer to the source, which is closer to the destination and at the midway between the source and the destination. As the relay has been located in the middle of source and the destination gives the best system performance. When the relay is located closer to the source, the class of source-relay link is good, and the relay may decode the received information. We have done the analysis through the various research works.

Keywords- Cooperative diversity & Amplify-and-forward (AF), Space-time block code (STBC) Decode Forward (DF).

I. INTRODUCTION

Cooperative communications is a new way of communication that draws from the ideas of using the broadcast nature of the wireless channel to make communicating nodes help together, of implementing the communication process in a distribution fashion and of gaining the same advantages as those found in MIMO systems. That results in a set of new tools that improve communication speed, capacity, and performance. It also reduce power consumption and hence improve battery life and extend network lifetime; increase the throughput and stability region for multiple access schemes; expand the transmission coverage area; and provide cooperation tradeoff beyond source–channel coding for multimedia communications [1].

Various diversities of the wireless channels are used as potential solutions to mitigate some of these channel impairments. Spatial diversity has been used to moderate the deleterious effects of fading via transmitting the signals from different locations, thus allowing independently faded versions of the signal at the receiver. The multiple input multiple output (MIMO) system was proposed to generate spatial diversity by equipping the wireless device with multiple antennas.

Many wireless devices are limited by size and hardware complexity to one antenna and MIMO is not realizable in these cases. The Cooperative communication provides an alternative solution for this problem via enabling single antenna wireless devices in a multi-user environment to share their antennas and generate a virtual multi-antenna transmitter in order to achieve spatial diversity. Broadcast nature of the wireless channel is exploited in cooperative communications. The wireless devices which 'overhear' the transmission between two entities meant to forward the overheard information and provide another independently faded version of the information at the receiver. Consequently each device in the network transmits its own information as well as cooperates in delivering the information originating from other devices. The, combinations of several diversity relaying protocols and different combining methods are examined to see their effects on the performance. Transmission protocols have been used in this are *Amplify and Forward* and *Decode and Forward.* Basically two types of combining protocols are examined which differs in the knowledge of the channel quality they need to work. One combination that may be achieved a good performance is then used to see the effect on the performance depending on the location of the relay.

Cooperative Transmission Protocol

The cooperative transmission protocols used at the relay are amplify and forward (AF), decode and forward (DF), compress and forward and coded cooperation. The most commonly used strategies are AF and DF.

Amplify and Forward

In this case the relay forwards the information received from the sender during broadcast phase and it amplifies and retransmit the signal to its destination during the cooperation phase. In this noise also get amplified, which is the major drawback of this method. This method is used when the time delay caused by decoding and re encoding is to be minimized.

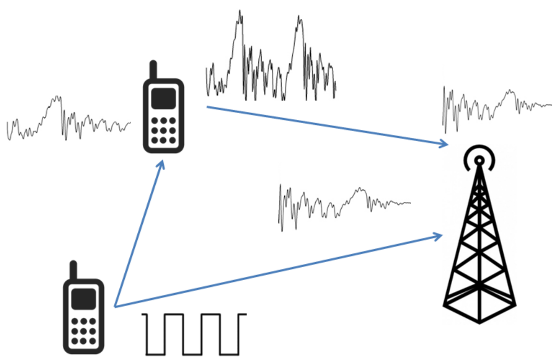

Fig.1.Amplify and Forward [20]

1.7 Spatial Diversity

The variation in time, frequency or space results in signal fading in the channel which is a major challenge to a communication engineer. However these impairments are not necessarily harmful and it can take these variations in the channel impulse response as an advantage to increase the overall signal to noise ratio. For example, when transmit two identical signals into two different channels experiencing independent fading effects. The two copies of the same signal are received at the receiver and there is low probability that both these copies are severely affected than the case when only one copy of the signal is transmitted over the fading channel. Hence a better estimation of the transmitted signal can be done by combining both the copies of the received signal.

II. SYSTEM MODEL

A cooperative communication strategy with two phrases is considered for wireless communication networks [11]. There are two phases in cooperation i.e., broadcast phase and cooperation phase. A two user cooperation scheme in which the user X sends the information to its destination in broadcast phase, and user Y also receives the information. User Y forwards the information in cooperation phase. Likewise, when user Y sends its information to its destination in broadcast phase, user X receives the information and forwards it to the destination of user Y in cooperation phase. Due to symmetry of the two users, it may consider only the performance of user X. The source broadcasts its information to both the destination and the relay in broadcast phase. The received signals $y_{s,d}$ and $y_{s,r}$ at the destination and relay [11] respectively can be given as

$$y_{s,d} = \left(\sqrt{P_1}\right)h_{s,d}x + \eta_{s,d} \qquad (2.1)$$

$$y_{s,r} = \left(\sqrt{P_1}\right)h_{r,d}x + \eta_{r,d} \qquad (2.2)$$

where P1 is the transmitted power at the source, where x is the transmitted information symbol, and $\eta_{s,d}$ and $\eta_{r,d}$ are the additive noise. In above two equations $h_{s,d}$ and $\eta_{r,d}$ are the channel coefficients from the source to the destination and the relay respectively. Channel coefficients are modeled as complex, zero-mean, Gaussian random variables with variances as δ2 s,d and δ2 s,r respectively. The noise terms $\eta_{s,d}$ and $\eta_{r,d}$ are modeled since zero-mean, complex Gaussian random variables with varianceN_0.

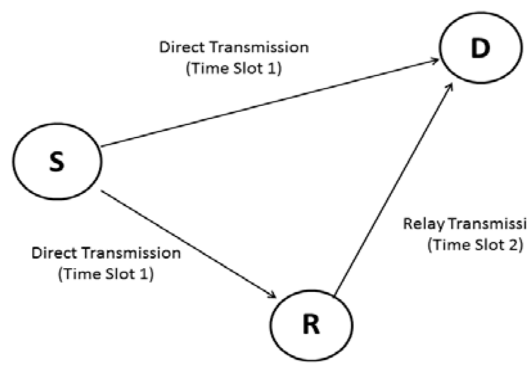

Fig.2. A simplified cooperation model [11]

Decode and Forward (DF) Protocol

If the relay is able to decode the transmitted symbol correctly in cooperation phase, then for DF protocol, the relay forwards the decoded symbol with power P2 to the destination, otherwise it remains idle. The received signal in cooperation phase is given as [11]

$$y_{r,d} = \left(\sqrt{P_2}\right)h_{r,d}x + \eta_{r,d} \qquad (2.3)$$

If the relay decodes the transmitted symbol correctly then otherwise 2 P = 0. In (3.1.3), hr,d is the channel coefficients from the relay to the destination and is modeled as zero-mean, complex and Gaussian random variables with variances as δ2 r,d . The noise term r,d is modeled as zero-mean, complex Gaussian random variables [1] with variance No.

$$r[l] = \sum_{p=0}^{P_w-1} f_w[p]\, Z^{-p} \left(\sum_{k=-\infty}^{\infty} h_c[l-k]s[k] + n[l]_c\right)$$

$$= \sum_{k=-\infty}^{\infty} s[k] \sum_{p=0}^{P_w-1} f_w[p]h_c[l-p-k] + \sum_{p=0}^{P-1} f_w[p]\, n_c[l-p]$$

III. LITERATURE REVIEW

M. Ilic-Delibasic and M. Pejanovic-Djurisic, [1] Performance of two-hop cooperative relaying system employ regenerative decode forward (DF) technique. Infrastructure based relay equipped with dual-polarized antenna has been assumed, performing maximal ratio combining of received signals. Link between the source and the relay has been characterized as two correlated and non-identical Rician fading channels. There are also direct communication between the source and the destination. For determining the level of improvement introduced through the execution of polarization diversity, performances of the considered system are compared with the DF relay system with single antenna relay. The obtain outcomes show that, using polarization diversity, the same BER values can be obtained with significantly lower SNR, despite a certain level of correlation and power unbalance between the diversity branches. In that manner, compared to the system with no diversity needed transmit power for achieving the same level of system performances is reduced, and thus more energy efficient communication is enabled.

Author Mr. Jamjareegulgarn, P., [2] In this research work they proposes cooperative diversity-based wireless body area network (WBAN) for healthcare service in order to mitigate the undesired effects of WBAN due to high path loss and fading as well as to keep a low transmit power while meeting to the desired WBAN quality of services, low outage probability and low bit error rate. In this research work, they consider all of the sensors which are placed on the human body, so CM3 B channel model has been taken into account for computing the path loss of each WBAN link. Three known schemes for proactive relay selection have been addressed and applied in WBAN so as to compare the performance with the direct communication. The performance may be evaluated in terms of outage probability (P_{out}) and bit error rate (BER). The results confirm that P_{out} of cooperative diversity-based WBAN can be reduced higher 99.68%.

Chanpuek, T.; Uthansakul, P.; Uthansakul, M., [3] proposed the cooperative MIMO communications is a new challenge to provide more reliable transmissions from the collaboration between users. The MIMO employment is performed by using a simple diversity scheme. There are many MIMO schemes that can be implemented in practice. The modified STBC system may be used for cooperative MIMO communications. Also the performance analysis of the proposed system in terms of the data error rate and the outage probability is presented. The result indicates that the proposed system can offer a better bit error rate and improve the outage probability than the diversity scheme.

Feteiha, M.F.; Hassanein, H.S., [4] investigated the Cooperative communication to vehicular networks to enable coverage extension and enhance link reliability through distributed spatial diversity. In this work, they investigate the performance of cooperative vehicular relaying over a doubly-selective (i.e., frequency-selective and time-selective) fading channel for an LTE-Advanced downlink session. Using Amplify-and-Forward (AF) relaying with orthogonal cooperation protocol and Multiple-Input Multiple-Output (MIMO) deployment at the source and destination, they derive a pair wise error probability (PEP) expression and demonstrate the achievable diversity gains. Space-Time Block Coding (STBC) is used to ensure the orthogonality of the transmitted-received signals. Their results demonstrate that, via proper linear precoding constellation, the proposed method is capable of extracting the maximum available diversity in frequency (through multipath diversity), time (through Doppler diversity) and space (through cooperative diversity as well as the MIMO deployment) dimensions.

Argyriou, A, [5] this study they proposed a new cooperative packet transmission scheme that allows independent sources to superimpose over-the-air their packet transmissions. Relay nodes have been used and cooperative diversity is combined with distributed space-time block coding (STBC). With the proposed scheme the participating relays create a ST code for the over-the-air superimposed symbols that are received locally and without proceeding to any decoding step beforehand. The lead of the proposed method is that communication is completed in fewer transmission slots because of the concurrent packet transmissions, while the diversity benefits from the use of the STBC results in higher decoding performance. The proposed method does not depend on the STBC that is applied at the relays. Result reveals significant throughput benefits even in the low SNR regime.

Sheng Luo; Yongxu Hu; Kah Chan Teh, [6] analyzed the energy efficiency of a wireless relaying system based on an automatic repeat request (ARQ) protocol is investigated. System with multiple relays between a source node (SN) and a destination node (DN) has been considered. The signal transmission consists of two phases and in each phase the ARQ protocol had been used. Some of the relay nodes are selected for forwarding the message and overhearing between them in the second phase has been allowed. As a result, the number of relay nodes that can decode source message increases since the ARQ round goes on. The energy efficiency of two relaying schemes, namely the selection relay (SR) scheme and the distributed space-time block coding (D-STBC) method, are investigated. It is shown that the energy efficiency of the system can be improved through inter-relay listening and the SR-ARQ scheme has better energy efficiency as compared with the D-STBC scheme.

Chih-Wen Chang; Hsing-Tai Wu, [7] in this study, they propose a new cell architecture for the orthogonal frequency division multiple access (OFDMA) systems by jointly taking frequency allocation scheme (FAS) and cooperative relay strategy into consideration. To serve the mobile stations (MSs) in the inner zone and relay stations (RSs) in the outer zone, larger portion of frequency spectrum is allocated to the central base station (BS) such that the transmission from BS to RSs can never be a bottleneck during the two-hop relay process. The lower interference level by using FAS and half transmission power, the selection and the transmission diversity gains may also contribute to a higher capacity and a lower outage probability. The advantage of the proposed architecture have shown via simulation and analytical results by taking the intercell interference in the multicell environment and complete channel effects into the consideration, including small and large scale fading. Analytical framework fulfills the task of complete performance analysis.

James, A.; Madhukumar, A.S.; Tio, S.D., [8] in this context, a novel spectrally efficient distributed space-time block coded (STBC) transmission scheme with error protection for such networks had been proposed. The proposed scheme retains the spatial diversity and enhances the bandwidth efficiency by integrating incremental redundancy techniques into such cooperative systems. The guard against error propagation had been provided by cooperatively transmitting the additional redundancy bits in an STBC fashion. Theoretical framework has been also developed for the proposed system to provide an understanding on the impact and severity of error propagation, and characterize the fundamental performance of such practical cooperative relay networks.

IV. PROBLEM FORMULATION

In the research work, Cooperative communications presents various challenges to researchers along with the plethora of advantages. The main concern for realization of cooperative communication is the relay functionality. This difficulty has received large attention of researchers, and significant progress has been made in this area. The major concern in cooperative communication is the sharing of network resources among users and to investigate resource allocation schemes. The performance of amplify and forward and decode and forward, the two basic signal relaying protocols have been analyzed for a three terminal cooperative system in Rayleigh fading environment. The BER analysis for AF for single relay as well as multiple relays has been done in Rayleigh and Rician fading environments. The outage probability for AF and DF has been studied for single relay in Rayleigh fading environment.

V. PROPOSED METHODOLOGY

The proposed cooperative diversity techniques, where some relay nodes provide the alternative paths to transmit information from a source to a destination, have also considerably drawn the attention and exploited in wireless networks. Cooperative communication can enhance the network performance e.g., increasing spectral and energy efficiency, expanding network coverage, and reducing bit error rate etc. Three cooperative transmission protocols, exploited in the relay node, are amplify-and-forward (AF), decode-and forward (DF), and compress-and-forward (CF).

VI. CONCLUSIONS

In this review researches work the possible benefits of a wireless transmission using cooperative diversity to raise the performance of lower the bit error rate (BER) and decrease the outage probability. The diversity has realized by building a network using a third station. The data is sent directly from the base to the destination or through the relay station. Space–Time codes for transmission in wireless Rayleigh fading channel using multiple antennas at either the transmitter or receiver side. Many subfamilies of space–time codes were also introduced. We analyzed the performance of these codes and a comparison between them is made. To perform of these has been studied the diversity feature of each code.

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