Orthogonal Differential Space-Time Network Coding with Transmit Antenna Selection and Maximal-Ratio Combining

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Abstract: ***In this orthogonal space time network coding, we investigate orthogonal differential space-time network coding (OSTNC) in cooperative multiple-input multiple-output net- works, where U users communicate with a common destination D with the aid of R decode-and-forward relays. The transmit antenna selection with maximal-ratio combining (TAS/MRC) is adopted in user-destination and relay-destination links where a single transmit antenna that maximizes the instantaneous received signal-to-noise ratio is selected and fed back to transmitter by receiver and all the receive antennas are combined with MRC. In the presence of perfect feedback, we derive new exact and asymptotic closed-form expressions for the outage probability (OP) and the symbol error rate (SER) of STNC with TAS/MRC in independent but not necessarily identically distributed Rayleigh fading channels. We demonstrate that STNC with TAS/MRC guarantees full diversity order. To quantify the impact of delayed feedback, we further derive new exact and asymptotic OP and SER expressions in closed form. We prove that the delayed feedback degrades the full diversity order to (R + 1) ND, where ND is the antenna number of the destination D. Numerical and Monte Carlo simulation results are provided to demonstrate the accuracy of our theoretical analysis and evaluate the impact of network parameters on the performance of STNC with TAS/MRC***

Keywords: Cooperative communications, orthogonal differential space-time network coding (DSTNC), multiple-input multiple-output (MIMO), delayed feedback..

1. Introduction

Cooperative communications have recently attracted considerable attention in emerging wireless applications due to their advantages of network coverage extension and capacity expansion. The inherent concept of cooperative communications is to provide spatial diversity by employing relay nodes to forward signals from the source to the destination. Against this background, various cooperative diversity schemes have been proposed and analyzed. We note that most research contributions in cooperative communications assumed perfect synchronization. Such an assumption may be difficult or impossible in practical multi-node wireless networks as it is very challenging to align all the signals from multiple sources at multiple destinations. High-accuracy synchronization requires complicated control mechanisms and extra control messages, which leads to high system complexities and overheads. When synchronization is imperfect, the performance of cooperative communications can be severely degraded.

To overcome the problem caused by imperfect synchronization, the space-time network coding (STNC) scheme was proposed in [8], which uses time-division multiple access (TDMA) to deal with the imperfect synchronization issues. Importantly, this scheme achieves the full diversity order. STNC combines information from different sources at each relay node and transmits the combined signal in dedicated time slots, which jointly exploit the benefits of both network coding and space-time coding. To quantify the benefits offered by STNC, the symbol error rates (SERs) of STNC over Rayleigh and Nakagami-*m* fading channels were investigated, respectively, and the outage probability (OP) of STNC in Rayleigh fading channel was analyzed. It was assumed that the channel state information (CSI) is known at the receivers. To avoid the requirement of channel estimation, the differential space-time network coding (DSTNC) and distributed differential space-time-frequency network coding (DSTFNC) schemes were designed for narrowband and broadband cooperative communication systems, respectively, in. Similarly to STNC, both the DSTNC and DSTFNC schemes provide the full diversity. By allowing each relay to exploit the overheard signals transmitted from not only the sources but also the previous relays, a new STNC scheme with overhearing relays was proposed. When there is no dedicated relay in the systems, users are required to help each other to exploit the cooperative diversity gain. In a novel clustering based STNC scheme was proposed to achieve a better trade-off between diversity gain and bandwidth efficiency. The core idea of this scheme is to divide the whole network into several small clusters and allow different clusters to help each other to relay signals. In [14], the STNC with optimal node selection scheme was presented to allow multiple users to exchange their data simultaneously. We note, each node in the network is equipped with a single antenna. Since multiple-input multiple-output (MIMO) technology, in which communication nodes are equipped with multiple transmit and/or receive antennas, can significantly increase communication reliability through the use of spatial diversity, we focus on multi-antenna STNC in this work.

In this paper, we examine STNC in the cooperative MIMO network, where *U* users communicate with a common destination D with the assistance of *R* relays and all the nodes are equipped with multiple antennas. We consider the independent but not necessarily identically distributed (i.n.i.d.) Rayleigh fading channels and include the direct links between the users and destination. Particularly, we focus on decode-and-forward (DF) relaying protocol due to its application in the Third Generation Partnership Project Long-Term Evolution and IEEE 802.16m [16], [17] such that the relays need to decode the received signal, re-encode it, and forward it to the destination. For user-destination (u−D) and relay-destination (r−D) links, we adopt transmit antenna selection with maximal-ratio combining (TAS/MRC) [18], [19], where a single transmit antenna that maximizes the output signal-to-noise ratio (SNR) is selected and all the receive antennas are combined using MRC. As such, the transmitter can be easily implemented with a single frontend and an analog switch, and the receiver only needs to feed back the index of the selected transmit antenna.

We first consider perfect feedback and derive new closed form expressions for the exact and asymptotic OP and SER. As TAS could be performed by using outdated CSI due to feedback delays, we then quantify the effect of delayed feedback in u−D and r − D links on the OP and SER. In doing so, we derive new closed-form expressions for the exact and asymptotic OP and SER by taking the delayed feedback into account. The primary analytical contributions of this paper are summarized as follows.

1) We integrate cascaded TAS/MRC into STNC as a solution to preserve full transmit and receive diversity with low computational complexity and reduced feedback overhead;
2) We derive new closed-form exact and asymptotic expressions for the OP and SER. These results are valid for general operating scenarios with arbitrary number of antennas and arbitrary number of relays;

We derive new closed-form exact and asymptotic expressions for the OP and SER with feedback delays to examine the impact of outdated CSI on the performance. Based on our results, it is demonstrated that the transmit diversity vanishes and that the diversity order is entirely independent of the number of transmit antennas.

2. Existing System

Cooperative communications have recently attracted considerable attention in emerging wireless applications due to their advantages of network coverage extension and capacity expansion. The inherent concept of cooperative communications is to provide spatial diversity by employing re- lay nodes to forward signals from the source to the destination. Against this background, various cooperative diversity schemes have been proposed and analyze. We note that most research contributions in cooperative communications assumed perfect synchronization. Such an assumption may be difficult or impossible in practical multi-node wireless networks as it is very challenging to align all the signals from multiple sources at multiple destinations. High-accuracy synchronization requires complicated control mechanisms and extra control messages, which leads to high system complexities and over- heads when synchronization is imperfect, the performance of cooperative communications can be severely degraded.

To overcome the problem caused by imperfect synchronization, the space-time network coding (STNC) scheme was proposed, importantly, this scheme achieves the full diversity. STNC combines information from different sources at each relay node and transmits the combined signal in dedicated time slots, which jointly exploit the benefits of both network coding and space-time coding in cooperative MIMO network in terms of OP and SER, where multi-antenna diversity is guaranteed via TAS/MRC.

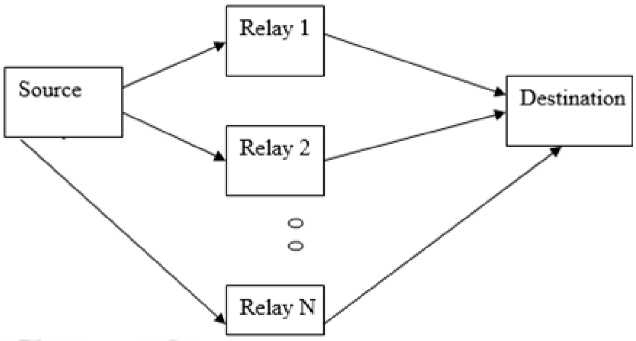
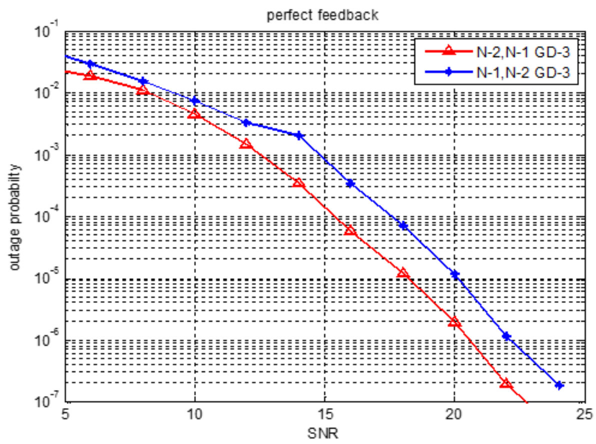


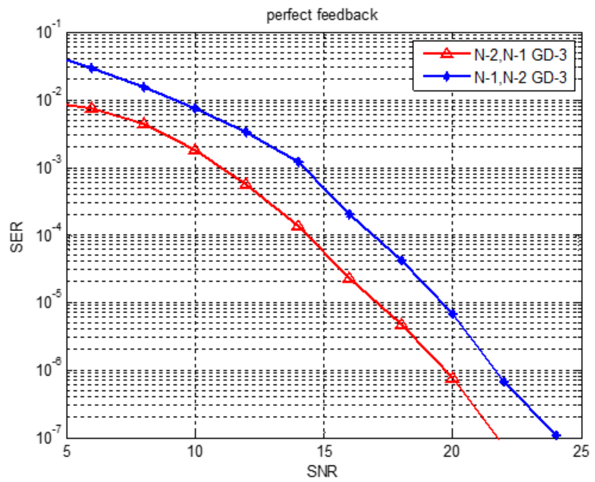
Figure: cooperative communication

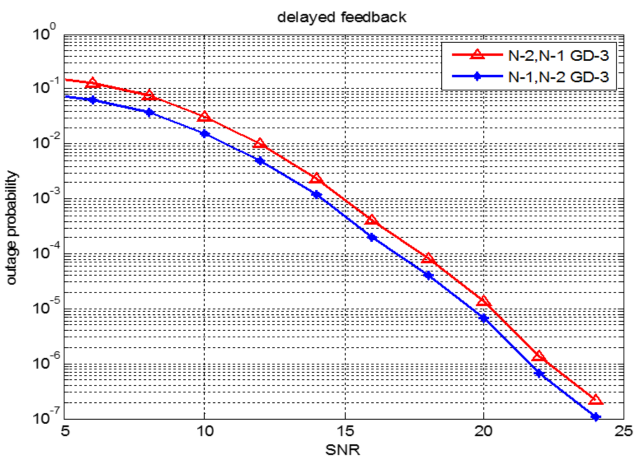
In this paper, we examine STNC in the cooperative MIMO network, where U users communicate with a common destination D with the assistance of R relays and all the nodes are equipped with multiple antennas. We consider the independent but not necessarily identically distributed Rayleigh fading channels and include the direct links between the users and destination. Particularly, we focus on decode-and-forward (DF) relaying protocol due to its application, such that the relays need to decode the received signal, encode it, and forward it to the destination. For user-destination (u − D) and relay-destination (r − D) links, we adopt transmit antenna selection with maximal-ratio combining (TAS/MRC), where a single transmit antenna that maximizes the output signal-to-noise ratio (SNR) is selected and all the receive antennas are combined using MRC.

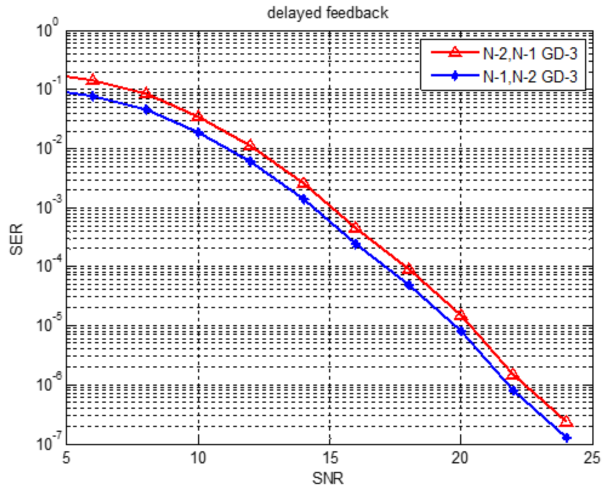
We first consider perfect feedback and derive new closed-form expressions for the exact and asymptotic OP and SER, then we quantify the effect of delayed feedback in u – D and r − D links on the OP and SER. In doing so, we derive new closed-form expressions for the exact and asymptotic OP and SER by taking the delayed feedback into account

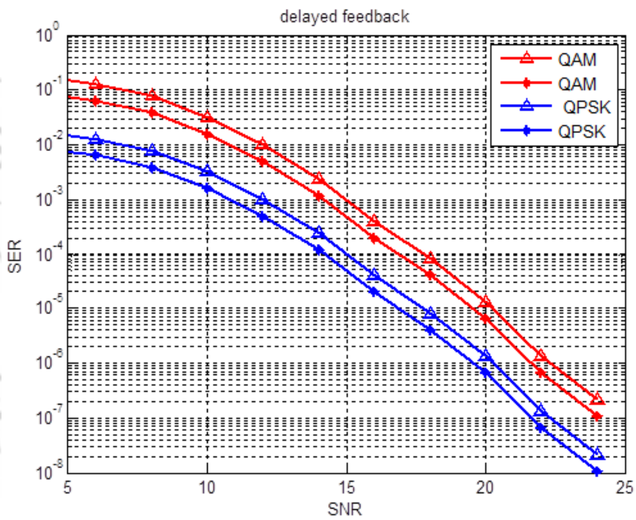
We have to derive new closed-form expressions of the exact and asymptotic OP and SER for both perfect and delayed feedback. In the presence of perfect feedback, we have confirmed that STNC with TAS/MRC preserves the full diversity and Prove that the delayed feedback degrades the full diversity against this background various co-operative diversity schemes have been proposed and analyze











Figs. 1 and 2 plot the OP and SER of STNC versus transmit SNR P_u/N_0 for different antenna configurations in the presence of perfect feedback, respectively

Fig. 3 plots the OP of STNC with different delay correlation coefficients versus transmit SNR P_u/N_0. Figs. 4 and 5 plot the SERs of STNC with different modulations and different delay correlation coefficients versus transmit SNR P_u/N_0

3. Literature Survey

[1] Z. Gao, H.-Q. Lai, and K. J. R. Liu, "Differential space-time net- work coding for multi-source cooperative communications," *IEEE Trans. Commun.*, vol. 59, no. 11, pp. 3146–3157, Nov. 2011.

- DSTNC scheme for narrow cooperative communication to overcome the problem of imperfect synchronization
- DSTNC are derived to achieve full diversity

[2] H.-Q. Lai and K. J. R. Liu, "Space-time network coding," *IEEE Trans. Signal Process.*, vol. 59, no. 4, pp. 1706–1718, Apr. 2011.

- Traditional cooperative communication can improve communication reliability
- Signal transmission in TDMA manner cause large transmission delay
- Transmission from two or more node using FDMA and

CDMA are associated with the issue of imperfect frequency and timing synchronization

- STNC scheme is proposed to achieve full spatial diversity with low transmission delay and eliminate the issue
- TDMA requires N(R+1) time slots, it causes large transmission delay
- STNC provide appropriate spatial diversity with only(N+R) time slots

[3] M. W. Baidas and A. B. MacKenzie, "Space-time network coding with optimal node selection for amplify-and-forward cooperative networks," in *Proc. IEEE CCNC*, Jan. 2011, pp. 1202–1206.

- Many-to-many cooperative communication is achieved through the concept of STNC-ONS scheme.
- STNC scheme allow multipoint-to point(M2P) and P2M
- It has 2 phase

i) Broadband phase

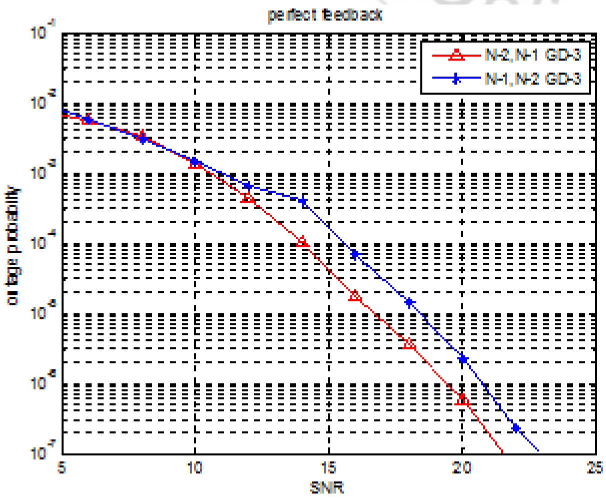
ii) Cooperation phase

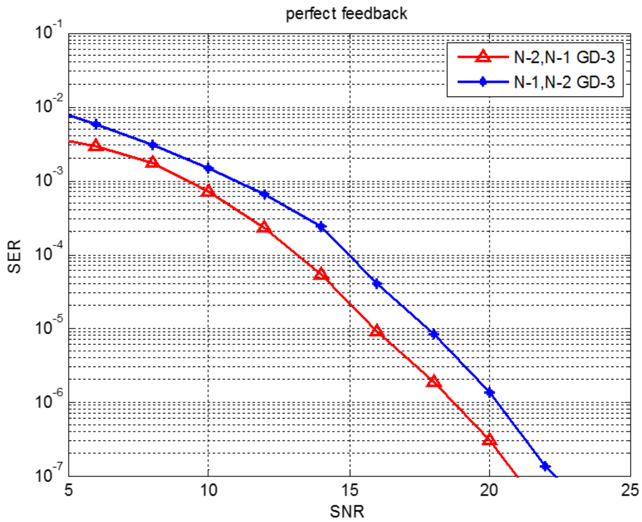
- Source node is assigned a time slot, it broadcast its own data symbol
- Each node act as destination node and receive from other node

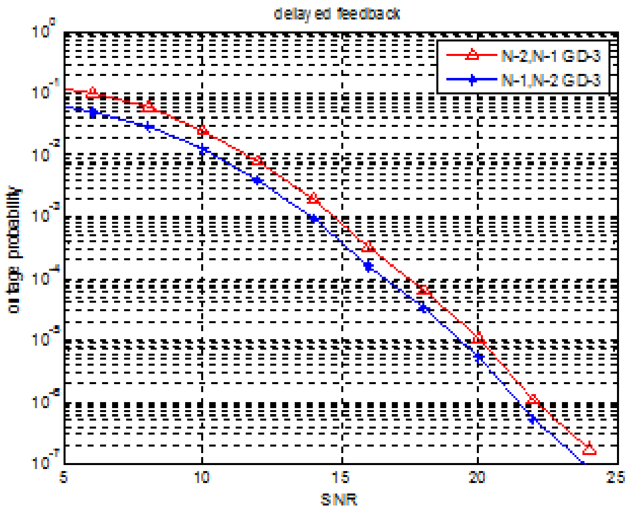
4. Proposed System

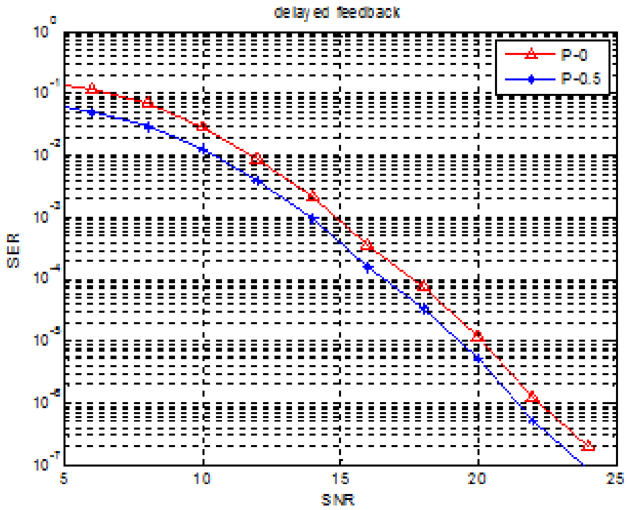
Using space-time network coding with transmit antenna selection and maximal-ratio combining technique there are some limitations. To avoid these limitations, we use the differential space-time network coding (DSTNC) and distributed differential space- time-frequency network coding (DSTFNC) schemes were designed for narrowband and broadband cooperative communication systems, respectively. Similarly to STNC, both the DSTNC and DSTFNC schemes provide the full diversity.

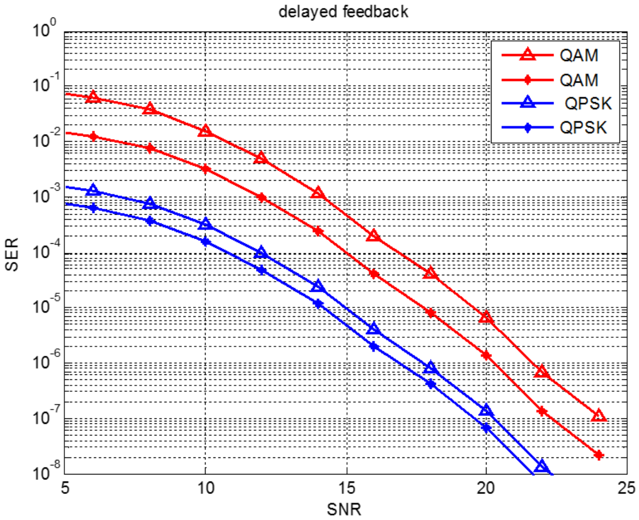
Incremental selection method can be used to avoid the drawback i.e., in this paper, if any one of the antenna get fault then the all system get lost. That can be avoid by using incremental selection method











Figs. 6 and 7 plot the OP and SER of DSTNC versus transmit SNR P_u/N_0 for different antenna configurations in the presence of perfect feedback, respectively Fig. 8 plots the OP of DSTNC with different delay correlation coefficients versus transmit SNR P_u/N_0. Figs. 9 and 10 plot the SERs of STNC with different modulations and different delay correlation coefficients versus transmit SNR P_u/N_0

5. Conclusion

In this paper, we have to study the performance of DSTNC and incremental selection method in a cooperative MIMO network in terms of Outage Probability and Symbol error Rate, for both perfect and delayed feedback,, where multi-antenna diversity is guaranteed. We have derived new closed-form expressions of the exact and asymptotic OP and SER for both perfect and delayed feedback. In the presence of perfect feedback, we have confirmed that DSTNC preserves the full diversity. In the presence of delayed feedback, we have quantified the detrimental effect of delayed feedback on the OP and SER of DSTNC. It is shown that the diversity advantage from the transmit end vanishes and the diversity order is degraded due to delayed feedback

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Author Profile

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