Development of Spatial-MRC For Cooperative Networks with Dual Hop Communication

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Abstract - The wireless communication is the fast growing field in telecom industries. The demand of high speed data rate and error free communication has brought revolution for development of advanced communication system. The communications with any desired speed is not possible yet. This service must be as cheap as possible. Regarding these properties of a desired wireless communication system, clearly there is big challenged and and as a result of this fact numerous advancement can be made in view of the user needs. There is a significant work has done to addressing the fairness problem with respect to throughput and delay performance in multi-hop wireless networks. A development of Spatial-MRC for cooperative networks with dual hop communication has been reported in this work. The proposed approach contains the combining techniques employed at the receiver to combine various signals received from different cooperative channels like SD, SR and RD. The joint scheme referred here is Spatial-MRC and SC with four different relay modes and two cooperative modes AF (Amplify and Forward) and DF(Detect and Forward). The combined signals are followed by detection technique, Minimum Mean Square Error(MMSE) to reduce the bit error rate(BER) and found enhancement in the existing results.

Keywords - Dual Hop, AF, DF, Spatial-MRC Combining, MMSE.

I. INTRODUCTION

Since the early 20th century, impressive developments in wireless communications technology have dramatically changed the way people live and communicate. This progress will continue for many more years in the future as the demand for wireless connectivity to systems and devices is increasing day by day. Current wireless technology not only provides connectivity for voice and video data but also redefines the way in which people interact with technology. Extensive progress in research has resulted in many improvements in the data rate of communication channels and mobile devices.

Even though, many new efficient network protocols, modulation and coding schemes have improved network data rates and the quality of service significantly, coping with the ever increasing data rate demand is still a challenge.

While signal is transmitted from the transmitter to the receiver, distortion takes place e.g. multipath, noise etc. Therefore, there are many methods to implement in order to improve the quality of the received signal. In present, cooperative communications is one of the well-known methods in this regard.

Figure 1.1 shows the basic concept of cooperative communications. Transmitted signal reaches from source to destination via two paths i.e direct link and via relay. At destination, the received signals from direct link and relay are combined using the combiner to find the optimized signal.

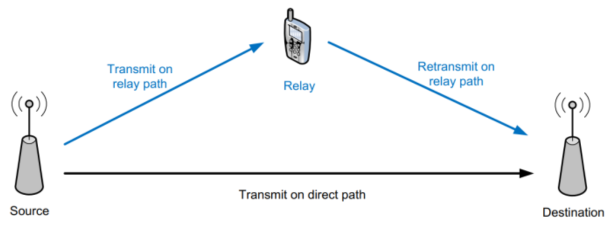

Figure1.1 The cooperative communication system.

Wireless communications, as the name indicates, a type of communication in which the information is exchanged between two or more than two points but they are not physically connected.

Wireless communications is the fastest growing segment of the communication industry. The modern communication technology can witness its applications and uses almost everywhere. Cellular communication, wireless local area networks (WLAN), wireless sensors, Bluetooth etc are used most commonly everywhere. The research has shown that there are more than two billion mobile phone users worldwide.

Broadband access to the Internet has become necessary in all of todays networks to support high quality multimedia services, such as video, voice, high definition TV or interactive games. Network communications with end devices are becoming increasingly wireless. Many standards for wireless networking are now taking the next step to support mesh architectures in which data is commonly forwarded on paths consisting of multiple wireless hops. These multi-hop network architectures have great flexibilities; however it will be shown that they suffer from a performance limitation.

II. MULTI-Hop WIRELESS NETWORKS

Multi-hop wireless networks (MWNs) are being used as alternative solutions to the wired back-haul links. They are similar to the mobile ad hoc networks (MANETs), but differ in terms of mobility, topology, and architecture. Nodes in MWNs are relatively fixed with relatively robust connectivity and often follow a hierarchical architecture. MWNs can be classified into relay architecture, where nodes form a sink tree, or mesh topology, in which multiple connections exists among mesh nodes.

Most of wireless networks operate in high frequency bands above 2 GHz. However, at higher carrier frequency cell size needs to be decreased because of an increase in path loss [1] and increased power consumption. In order to conserver power, base stations (BSs) need to be placed closer together. Therefore more BSs are needed to achieve the same coverage. MWNs overcome these problems by extending ranges through increasing capacity and reduce power consumption through route diversity. A MWN can be arranged in one of two architectures: relay or mesh. The relay and mesh topologies have some of the same elements. They both have BSs and subscriber stations (SSs). The SSs are trying to connect with the BS, but each topology does this in a different way.

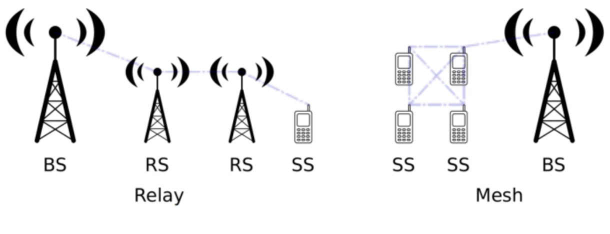

Figure 2.1 Relay and Mesh.

In relay, the network infrastructure includes relay stations (RSs) that are mostly installed, owned and controlled by a service provider. A RS is not directly connected to wire infrastructure and has the minimum functionality necessary to support multi- hop communication. The important aspect is that traffic always leads from or to a BS. SS to SS communication paths that do not include a BS are not considered.

SSs may forward traffic to another SS, RS or BS, and can communicate directly with each other. Nodes are comprised of mesh routers and mesh clients. Therefore, the routing process is controlled not only by BSs but also by SSs. Each node can forward packets on behalf of other nodes that may not be within direct wireless transmission range of their destination. A system that has a direct connection to backhaul services outside the mesh network is termed a mesh BS. All the other systems are called a mesh SS [2]. So, every SS can be RS but not every RS can be a SS.

Issues and Difficulties

There are many benefits for using multi-hop technology such as rapid deployment with lower-cost back-haul, extend coverage due to multi-hop forwarding in hard-to-wire areas, enhanced throughput due to shorter hops and extended battery life due to lower power transmission.

III. PROPOSED METHODOLOGY

The cooperative relay system is made the communication possible with relay based approach which is the operation similar like amplification during transmission to reduce the effect of interferences and noises mixed with the signal during transmission over wireless channel.

But system still need to be improved to make long distance communication possible with less noises and distortions during transmission. The same thing kept in mind the a cooperative relay system is proposed in this work. This is briefed hare. The block diagram of the proposed cooperative relay system with relay selection scheme with multiple modes amplify and forward (AF) and detect and forward(DF) followed by combining technique Spatial-maximal ratio combining (SPATIAL-MRC) and selection combining (SC). To reduce the effects of errors detection algorithms are applied which are maximum likelihood (ML), minimum mean square error(MMSE) and zero forcing (ZF). The whole system is shown with the major blocks in Fig. 3.1. Where data is randomly generated to achieve the all the possibility of noise encounters. The channel considered here Gaussian channel which is the most near to practical channel behavior. After applying combining techniques at the receiver signal is then detected by the detection algorithms and then finally get the data at the output.

The proposed system is explained using the block diagram in the Fig. 3.1, and this system is simulated in the simulation environment and the simulation steps are shown in the Fig. 3.2 with the help of flow chart. In the simulation step first the simulation environment need to be created with the help of variables, followed by the initialization of the channel coefficient initialization which are source to destination (SD) , source to relay (SR) and relay to destination(RD) having four different relay selection schemes. The data is generated randomly to achieve all the possibilities with the system integration. Then the proposed methodology is applied i.e. combining techniques followed by linear(MMSE, ZF) and nonlinear(ML) detection techniques to get the optimum results. Last step is to compare and display all the possible relay selection results with different techniques and modes.

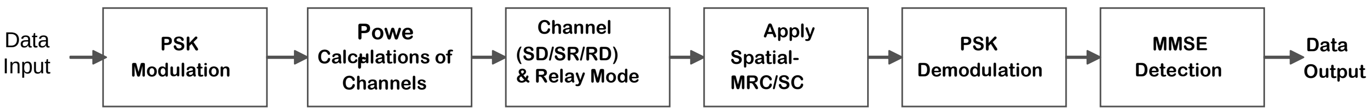

Fig. 3.1 Block Diagram of Proposed Methodology

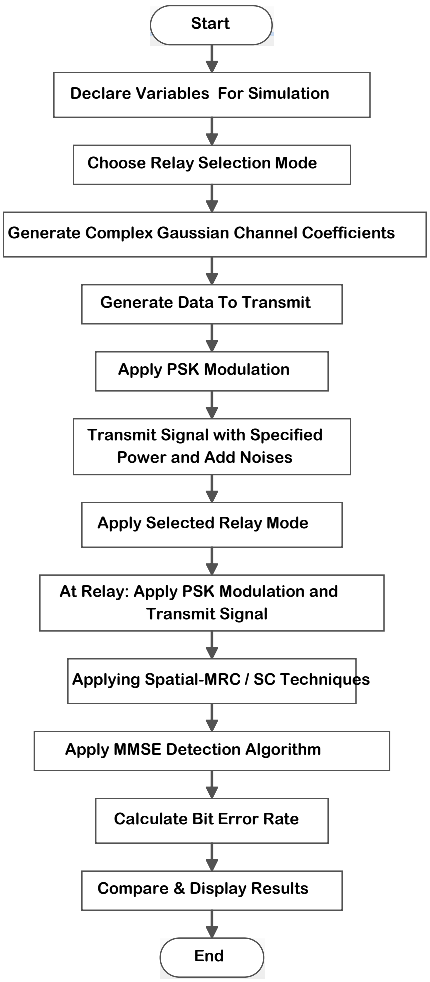

Fig. 3.2 Flow Chart of Proposed Methodology

IV. SIMULATION RESULTS

In this section the simulation results of the proposed system utilizing different cooperative modes (RD/SD/SR) and Various Relay Selection Modes and the optimum BER is achieved using minimum mean square error(MMSE) detection. The detected signals at the receiver side from various cooperative modes are than combined using efficient combining techniques(e.g. MRC, SC, SPATIAL-MRC etc.) and outcomes are given in below figures.

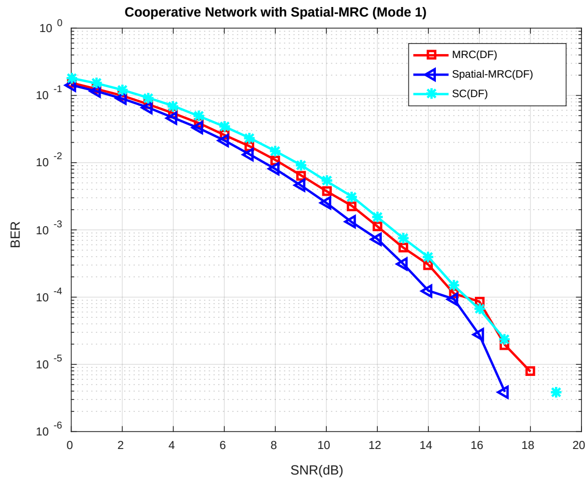

Fig. 3.1 BER Vs SNR Curves using No collaboration threshold Max (min (snr)) Mode(3) Relay Selection with MMSE Detection, Different Combining Techniques and Cooperative Modes

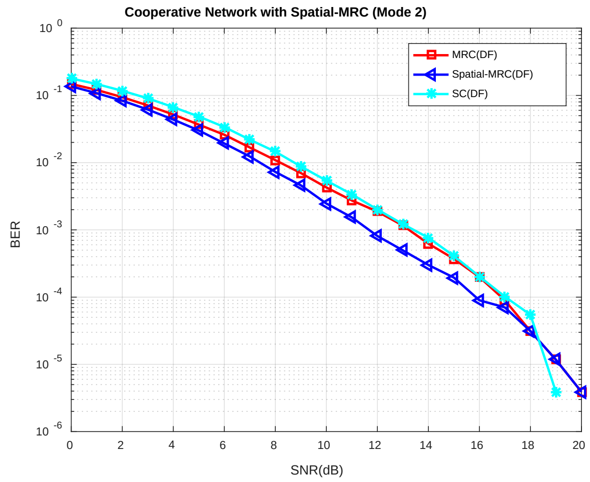

Fig. 3.2 BER Vs SNR Curves using No collaboration threshold Hamonic (snr) Mode(3) Relay Selection with MMSE Detection, Different Combining Techniques and Cooperative Modes

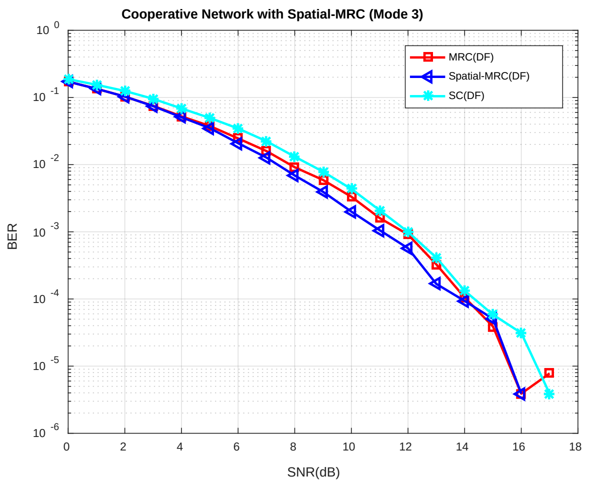

Fig. 3.3 BER Vs SNR Curves using Collaboration threshold Max (min (SNR))Mode(3) Relay Selection with MMSE Detection, Different Combining Techniques and Cooperative Modes

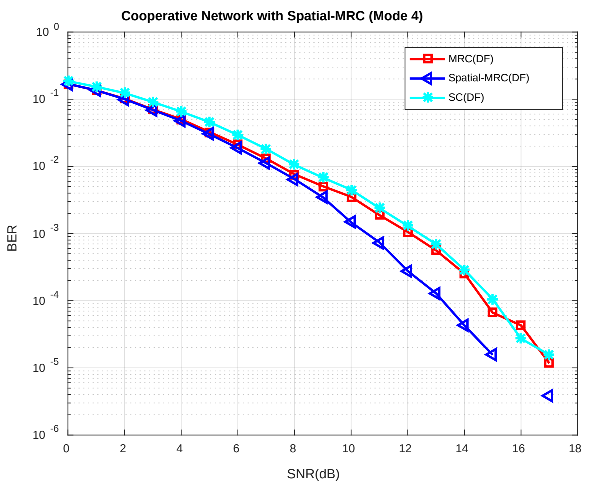

Fig. 3.4 BER Vs SNR Curves using Collaboration threshold Hamonic (SNR) Mode(4) Relay Selection with MMSE Detection, Different Combining Techniques and Cooperative Modes

From the above simulation results of proposed system with SPATIAL-MRC and SC with four different relay selection schemes and MMSE detection technique, and it can be seen that the cooperative relay communication system outperform with SPATIAL-MRC with AF cooperative mode with No Collaboration Threshold Harmonic(SNR) and SC with DF cooperative mode with Collaboration threshold Max (min (SNR)) relay mode.

V. CONCLUSION AND FUTURE SCOPE

The effect important factors under normal and extreme conditions show major limitations in terms of hop counts, traffic load and contention domain in terms of horizontal and vertical contentions. From the simulation results it can be concluded that the results of the proposed approach is better with the maximal ratio combining (SPATIAL-MRC). The results are examined based on signal to noise ratio, SNR and Bit Error Rate BER. It is found that the proposed work has batter performance as compared to existing approach. The multi hope networks require path management cause delay due to relaying. To an access point (AP) a packet follows a multi-hop path, this would raise the contention of the channel and potentially allow reduced data throughput for the source as well as other clients in the vicinity.

For further enhancement in the existing system the application of digital filtering with more efficient detection algorithms make system more robust and error free. A more complex simulation which includes multiple MWN protocols and dynamic SS placement, in other words the nodes are moving, may yield more limitation details.

REFERENCES

[1] D. N. K. Jayakody, V. Skachek and B. Chen, "Spatially-coupled LDPC coding in cooperative wireless networks," 2016 IEEE Wireless Communications and Networking Conference, Doha, 2016,

[2] D. N. K. Jayakody, "LDPC Coded Angular Modulation Scheme for Cooperative Wireless Networks," 2016 IEEE 84th Vehicular Technology Conference (VTC-Fall), Montreal, QC, 2016, pp. 1-5.

[3] L. Ferdouse and A. Anpalagan, "Relay Selection Based on Bayesian Decision Theory in Cooperative Wireless Networks," in Canadian Journal of Electrical and Computer Engineering, vol. 38, no. 2, pp. 116-124, Spring 2015.

[4] J. M. Choi and J. S. Seo, "Effects of imperfect channel estimation in three-node cooperative wireless network," 2015 IEEE 26th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), Hong Kong, 2015, pp. 228-233.

[5] Z. Iqbal and H. N. Lee, "Deployment strategy analysis for underwater cooperative wireless sensor networks," 2015 International Conference on Information and Communication Technology Convergence (ICTC), Jeju, 2015, pp. 699-703.

[6] X. Chen and M. X. Xie, "An LDPC Coded Adaptive Decode-and-Forward Scheme Based on the EESM Model," 2014 International Conference on Wireless Communication and Sensor Network, Wuhan, 2014, pp. 148-152.

[7] X. B. Li, S. Zhang, F. H. Zhao and H. W. Zhang, "A Multi-base Station Cooperative Algorithm for LDPC-OFDM System in the HF Channel," 2014 International Conference on Wireless Communication and Sensor Network, Wuhan, 2014, pp. 21-27.

[8] D. N. K. Jayakody and M. F. Flanagan, "LDPC coding with soft information relaying in cooperative wireless networks," 2013 IEEE Wireless Communications and Networking Conference (WCNC), Shanghai, 2013, pp. 4317-4322.

[9] J. Laneman, D. Tse, G. Wornell, “Cooperative diversity in wireless networks: efficient protocols and outage behavior,” IEEE Trans. Inf. Theory, vol. 50, no. 12, pp. 3062–3080, Dec. 2004.

[10] G. Kramer, M. Gastpar, and P. Gupta, "Cooperative strategies and capacity theorems for relay networks," IEEE Trans. Inf. Theory, vol. 51, pp. 3037–3063, Sept. 2005.

[11] J. Laneman, D. Tse, G. Wornell, "Cooperative diversity in wireless networks: efficient protocols and outage behavior," IEEE Trans. Inf. Theory, vol. 50, no. 12, pp. 3062–3080, Dec. 2004.

[12] G. Kramer, M. Gastpar, and P. Gupta, "Cooperative strategies and capacity theorems for relay networks," IEEE Trans. Inf. Theory, vol. 51, pp. 3037–3063, Sept. 2005.

[13] Z. Si, R. Thobaben, and M. Skoglund, "Bilayer LDPC convolutional codes for half-duplex relay channels," in Proc. IEEE Int. Symp. Inf. Theory, Aug. 2011, pp. 1464–1468.

[14] J. L. Fan, "Array codes as low-density parity-check codes," in Proc. 2nd Int. Symp. Turbo Codes, Brest, France, Sep. 2000, pp. 543–546.