Adaptive Relay Protocol Based on Relay Node Location

Mudabbir Badar, Nafisa Maqbool

Abstract— There is several cooperative relay strategies developed and analyzed that exploit fading caused by multipath propagation in wireless networks. The basic working principal of all techniques is to utilize space diversity available through in time transmission from cooperating radios. In this research two cooperative relay amplify and forward (AF) and decode and forward (DF) strategies are analyzed. Location of relay node plays crucial role in cooperative communication. Therefore impact of relay node location on each relaying strategy is observed. The relay node is moved all the way between source and destination node and effects on performance is noticed. Later on keeping those location impacts in mind a new method called as "*Adaptive Relay Protocol Based on Relay Node Location*" is proposed. This new proposed method will help to mitigate the relay node location impact on overall performance, while relay node is moving (not static) all around. It will also provide ease to maintain a Qos throughout the whole of the transmission.

Key Words - Adaptive, AF, DF, Qos, Relay.

1 INTRODUCTION

NEEDS and expectations of now a days human towards communication technologies are rising day by day. Everyday we come up with new communication applications and services. That was the reason MIMO (Multiple-Input Multiple-Output) came into being. MIMO technology uses multiple antennas at the transmitting and reception side, which causes spatial diversity and ultimate result, which can be observed as an increase in capacity, gain and reliability, without increasing transmission power and bandwidth [1]. Practical implementation of this awesome technology faces some practical restraints like power, size, weight etc.

An alternate to those practical issues of MIMO is a newly developed technology called as *cooperative communication*. In which multi-user cooperative diversity is created by allowing a single antenna user to get transmit diversity advantages by sharing their physical resources through a virtual transmit and receive antenna array. The broadcast nature of wireless communications offers that a source signal transmitted towards the destination can be "overheard" by neighboring nodes. Cooperative communication is supposed to process this overheard information by the surrounding nodes and retransmission of that processed information towards the destination to create spatial diversity, thus to obtain higher throughput and reliability of transmission [2]. Operation performed on received data depends on, which type of relaying technique is used i.e. Amplify and forward (AF), Decode and forward (DF), Compress and forward (CF) etc. This research only deal's with AF and DF, and it is noticed, how location of a relay node impacts on the performance of the AF and DF. Later on in order to mitigate that location impact another new method called as adaptive relay protocol based on relay node location is proposed.

This paper is organized as following, section 1 is based on introduction, section 2 describes the system model, section 3 comprises of AF and DF techniques and impact of relay node's location on the performances of AF and DF, which are shown through simulation graphs, in section 4 a new method called adaptive relay protocol based on

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relay node location is proposed and simulation graphs are given to prove this method is useful, section 5 is created on the conclusion of the whole work.

2 SYSTEM MODEL

A simple cooperative communication system is considered in this work and simulated in matlab. Which consist of three nodes transmitting node, relay node and destination node. The source node and destination node are fixed so distance between them is constant, while relay node is moved over various points between source node and destination node, starting from near to source node to near to destination node. Signal is sent by transmitting node to destination node and relay node. The relay node performs operation of amplify and forward and decode and forward on the received signal, separately. Then operated signal at relay node is forwarded to destination, so destination will have two copies of the same signal, one direct signal (from transmitting node) and another operated signal (from relay node). Two signals are combined at the destination to get a stronger signal and then BER (bit error rate) of combined signal is calculated over fixed SNR (signal to noise ratio) value. The performance of each technique AF and DF is analyzed in terms of distance against BER. Therefore graphs generated are of distance vs. BER relation. Different graphs are generated over different SNR values to show location impact of relay node on AF and DF's performance.

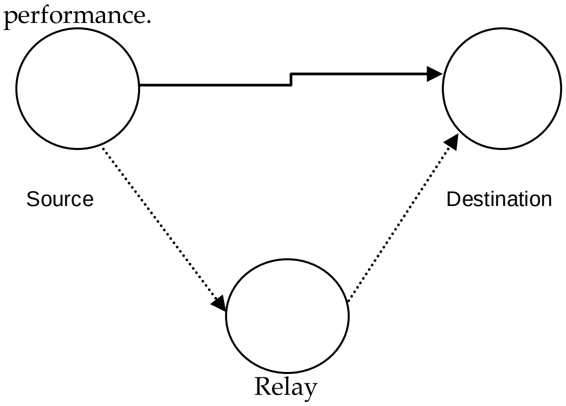

Fig. 1 Cooperative Communication System.

Where dotted lines show the distance between nodes is varying, and solid line means that nodes are fixed and distance between them is constant.

3 RELAY NODE'S LOCATION IMPACT ON AF AND DF'S PERFORMANCE

3.1 Amplify and Forward

As the name shows, the Amplify and Forward relaying technique simply amplify the signal received by the relay and forward it to the destination [3]. This method is better to use when the relay has only limited computing time and power available, or the time delay caused by the relay to perform operation on the received signal, which has to be minimized [4]. The working principal of amplify and forward relaying protocol is very simple. The signal received by the relay node must be attenuated and needs to be amplified before it can be sent again towards destination. While amplifying the received signal the noise in the signal is also amplified, this is the main drawback of this technique. Another disadvantage of this technique is that it is not able to store any information in a buffer as the processing involved is analogue but not digital.

The amount of amplification is denoted by amplification gain (β). Amplification process simply involves multiplication of amplification gain (β) with received signal. Usually amplification gain (β) is calculated through formula below.

$$\beta = \sqrt{\frac{\xi}{|h_{s,r}|^2\xi + 2\sigma_{s,r}^2}} \quad (1)$$

Where $h_{s,r}$ is the source to relay channel coefficient, $\sigma_{s,r}^2$ is source to relay variance and ξ is power of the transmitted signal.

3.2 Decode and Forward

This is the most preferred technique for processing the signal received by relay node. Working principal of decode and forward relaying protocol is closest to the one of a conventional relay. The

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working principal behind decode and forward is that the received data in relay node is decoded first and then it is transmitted to destination after re-encoding [3]. If an error correcting code is placed with source message, bit errors in received data could be corrected at the relay node. And if no error correcting code is given in source data then a checksum makes relay node capable of detecting if the received data has errors or not. Now it depends on the implementation that a message with errors should be forwarded to destination or not.

3.4 Relay Node Location Impact on AF & DF

This section will show how AF and DF's performance is affected by the location of relay node, when relay node is moved to various points from source to destination. Below are graphs generated over different SNR values.

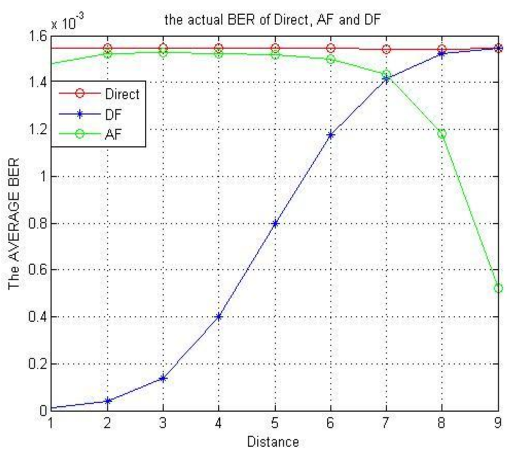

Fig.2 Distance vs. BER of direct, AF and DF at SNR 7dB.

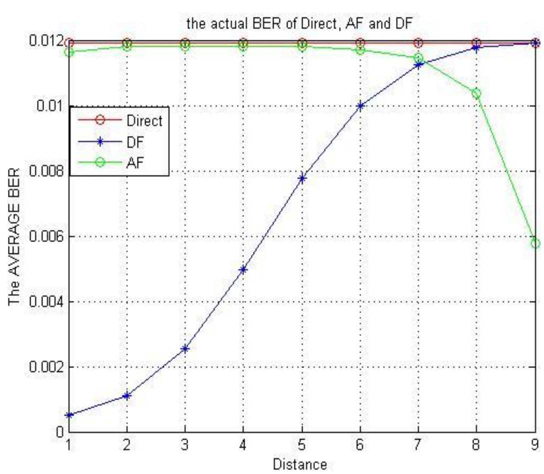

Fig.3 Distance vs. BER of direct, AF and DF at SNR 5dB.

As the graphs (Fig. 2 and Fig. 3) above show that DF has better performance than direct and AF, when relay node is closer to source. Gradually DF's performance is degrading, when relay node goes away from source node or it moves towards the destination node. While AF's performance is poor at the beginning, when relay node is closer to source node, once relay node starts moving towards destination node there is an improvement in AF's performance, later which outperforms DF's performance, when relay node is much closer to the destination node. The graphs above deduces that when relay node approaches and is greater than 70% of the total distance (source to destination) from source, AF outperforms DF. There is a point on the graphs, where both lines (DF and AF) cross each other, which is closer to destination. At that point performance switching occurs, which means after that point AF's performance becomes better than DF.

4 Adaptive Relay Protocol Based on Relay Node Location

This is a new method given in this work. As relay node moves between source and destination no single relaying strategy can give constant results and at some points cooperation is no more useful, so if two relaying techniques are used together could result in a better performance. According to this method a relay station will be equipped with more than one relaying strategies and relay station will be capable of switching between different relaying techniques, according to its location relative to source and destination. This could mitigate location effects on the performance, while relay is moving all around. When a relay station is loaded with more than one relaying technique and it is enough intelligent to trace its own location, and it can switch between different relaying techniques according to its location. For example if we consider a relay station which is equipped with AF and DF and it is capable of locating itself and multiplex between two relaying techniques. In such a scenario whenever relay node will be near to source it will use DF, once it goes away 70% of the total distance (source to destination) from the source, it will switch to AF. In doing so the user (source) can enjoy the benefits of cooperation throughout the whole transmission, even though relay node is moving all around. Below are graphs generated over different SNR values to show this method is useful.

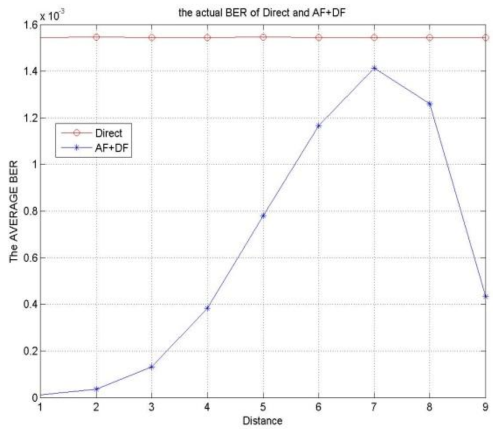

Fig.4 Distance vs. BER with adaptive relay protocol at SNR 7dB.

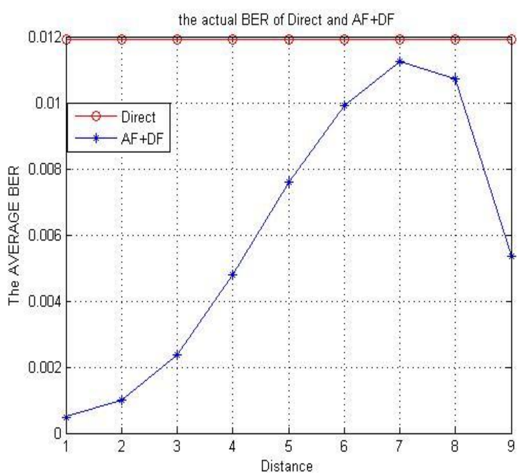

Fig.5 Distance vs. BER with adaptive relay protocol at SNR 5dB.

It can be deduced from the graphs (Fig. 4 and Fig.5) above performance line of a cooperative communication system, in which relay node is moving between source and destination and equipped with AF and DF has considerable gap from direct (non-cooperative) line, throughout the whole journey of relay node. This was not the case with a system, in which relay node is using single relaying technique. Therefore the use of adaptive relay protocol in cooperative communication system can help to reduce relay node's location impacts on overall system performance.

5 Conclusion

In this work it has been shown that location of relay node has great impact on overall performance. Different relaying techniques perform differently according to relay node location. Moreover performance of amplify and forward and decode and forward have been checked in terms of distance. Decode and forward shows good results when relay node is kept near to source, once relay node starts moving toward destination degradation in performance has been observed. While amplify and forward has better performance when relay node is much closer to destination node. Furthermore keeping distance impacts in mind a new method "*adaptive relay protocol based on Relay Node location*" has been proposed, in which a relay node has more than one relaying strategies in it and it can switch between different techniques according to its location. This method has given better performance result as compare to one with single relaying technique, when relay node moves all the way between source and destination node. Ultimate effect of this technique can help to mitigate location impact on overall performance, which can result in maintained Qos even though relay node is moving all around.

REFERENCES

[1] G.J. Foschini and M.J. Gans."On Limits of wireless Communications in a Fading Environment when Using Multiple Antennas", Wireless Personal Communications, 6:311-335, March 1998.

[2] ElzaErkip, Andrew Sendonaris, Andrej Stefanov, and BehnaamAazhang "Cooperative Communication in Wireless Systems" DIMACS Series in Discrete Mathematics and Theoretical Computer Science.

[3] A. Mahmood , Research Article "Cooperative Diversity in Wireless Networks", Journal of Engineering Science and Technology Review 3 (1) (2010) 184-187.

[4] Andreas Meier, John S, "Cooperative diversity in wireless networks", Thompson Institute for Digital Communications, School of Engineering and Electronics The University of Edinburgh, Edinburgh, EH9 3JL, UK.