Efficient Detection and Combining for Cooperative Wireless Systems over Frequency Selective Channels

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Abstract - Nowadays, the advancement in wireless applications like Wifi, cellular phones and bluetooth have become an important part of daily life. But as compared to the conventional wired networks, wireless networks can provide very limited data rate because the underlying channel is unreliable in nature. The relays first need to acquire the source message for a cooperative diversity before forwarding it to the receiver. However, practical devices are basically subject to half-duplex limitation, i.e., they cannot transmit and receive signals at the meantime. In this work a cooperative relay network with relay selection modes having harmonic and maximum values of SNR without collaboration is implemented and simulated in Matlab Simulink. 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 combining procedures reported here is FRC and SNRC with no cooperation without coordination threshold Max (min (SNR)) modes and two cooperative modes DF (Detect and Forward). The joined signals are forwarded by detection method, Minimum Mean Square Error (MMSE) and Maximum Likelihood (ML) computed to reduce the bit error rate (BER) and improvement observed in the existing outcomes.

Keywords - FRC, SNRC, Frequency Selective Channel, DF, MMSE, ML.

I. INTRODUCTION

In Cooperative communication, introduction of relay channel generates few more independent paths between source and destination along with the direct link. The total communication process occurs in two stages namely broadcasting stage and cooperating stage.

- In broadcasting stage, Source sends its information to destination via a transmission medium. But due to openness of wireless network, relay and eavesdropper overhears the source information.
- In cooperating stage, Relay processes the received source signal, using one of the cooperating relaying schemes and it sends the processed signal to its legitimate receiver. At the same time jammer generates the artificial noise to reduce the channel capacity of source to eavesdropper link.

The main aspect of this cooperative communication is processing of the received source signal done by the relay. These different processing schemes at relay, leads to different cooperative relaying protocols.

Cooperative communication schemes are generally categorized into two types:

1. Fixed relaying scheme.
2. Adaptive relaying scheme.

In Fixed relaying scheme, all the resources of channel are shared between source and relay in a fixed manner. Processing at the relay differs for each protocol. In fixed amplify and forward (AF) relaying, relay simply forwards the received source signal to destination where as in fixed decode and forward (DF) relaying, relay decodes the arrived information signal, re-encode it and sends to legitimate receiver. Implementation of fixed relaying schemes is easier but the efficiency of bandwidth is low because of sharing, half of resources of channel to relay. If the source-legitimate receiver link is more, sharing half of resources to relay becomes useless since the source can send its information signal to destination directly.

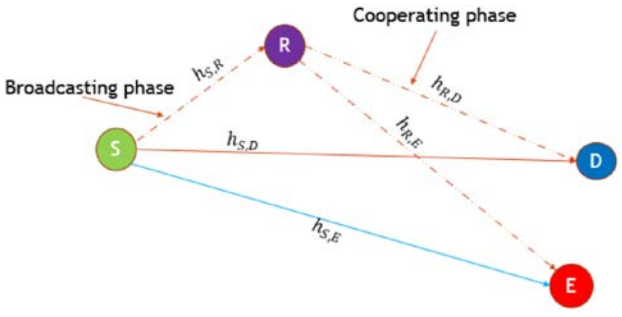

Figure 1.1 A Simplified Cooperative Model.

To overcome the limitations of fixed relaying, Adaptive relaying comp selective and incremental relaying. In selective relaying, if the SNR of the arrived signal at the helper exceeds a certain margin value it implements one of the cooperative relaying protocols and sends the processed information signal to destination. If SNR of the arrived signal at relay is less than the margin, it will be in idle position. In incremental relaying, if destination not able to

decode the message, source resends the information signal via relay.

II. FREQUENCY SELECTIVE CHANNEL MODEL

Employing different circulated relay nodes between two terminal hubs can enhance cooperative decent variety in remote relay frameworks as appeared in Part 3. Be that as it may, by and by, there is a compelling issue of synchronization between these appropriated relay hubs because of a few factors, for example, unique engendering delays and relay areas. Accordingly, the transmitted signals touch base at various time moments at the relays and recipient hub which may cause an image level synchronization issue. In this section, a novel vigorous plan for two-route transmission more than four relay nodes to utilize in cooperative relay systems with flawed synchronization between relay nodes and the two terminals is proposed.

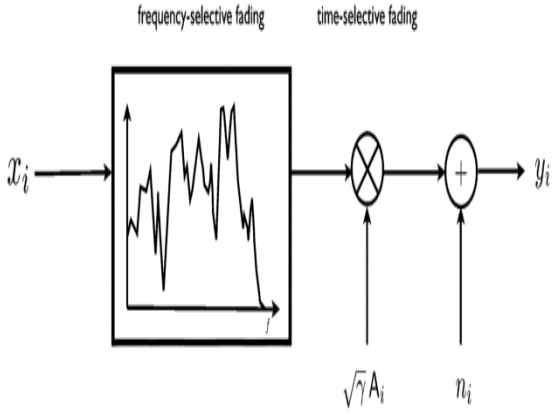

Figure 2.1 a block diagram of frequency selective channels.

To minimize the intersymbol obstruction and added substance noise impacts, the equalizer coefficients can be optimized utilizing the minimum mean squared error (MMSE) paradigm. At the point when the SNR has hoisted values the MMSE equalizer fills in as Zero Compelling does, however when the SNR has bring down qualities, the way that MMSE equalizer considers the noise and signal fluctuation, makes to not amplify the noise as Zero Constraining does,

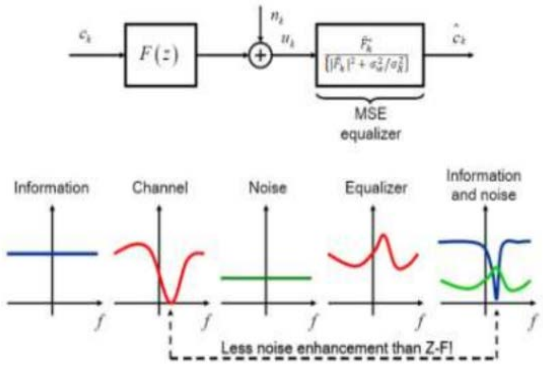

Figure 2.2 MMSE Equalizer.

As it can be found in the Fig,2.2 when the Signal to Noise Proportion (SNR) has high esteems, the MMSE equalizer fills in as the Zero Constraining does, yet for whatever remains of qualities that SNR can take, the MMSE equalizer works better in terms of mutilation.

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 noise and distortions during transmission. The same thing kept in mind the a cooperative relay system is proposed in this work. This is brief here the block diagram of the proposed cooperative relay selection scheme with detect and forward relay mode followed by combining technique Fixed Ratio Combining (FRC) and Signal to Noise Ratio Combining(SNRC). To reduce the effects of errors detection algorithms are applied which are maximum likelihood (ML), minimum mean square error (MMSE) and without detection. 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.

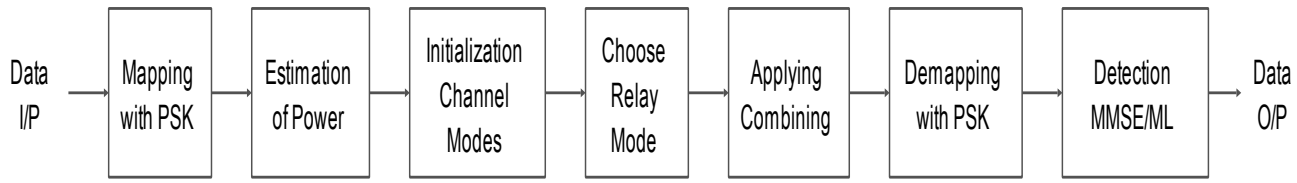

Figure 3.1 Block Diagram of Proposed Methodology.

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 Detect and Forward 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) and non-linear (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.

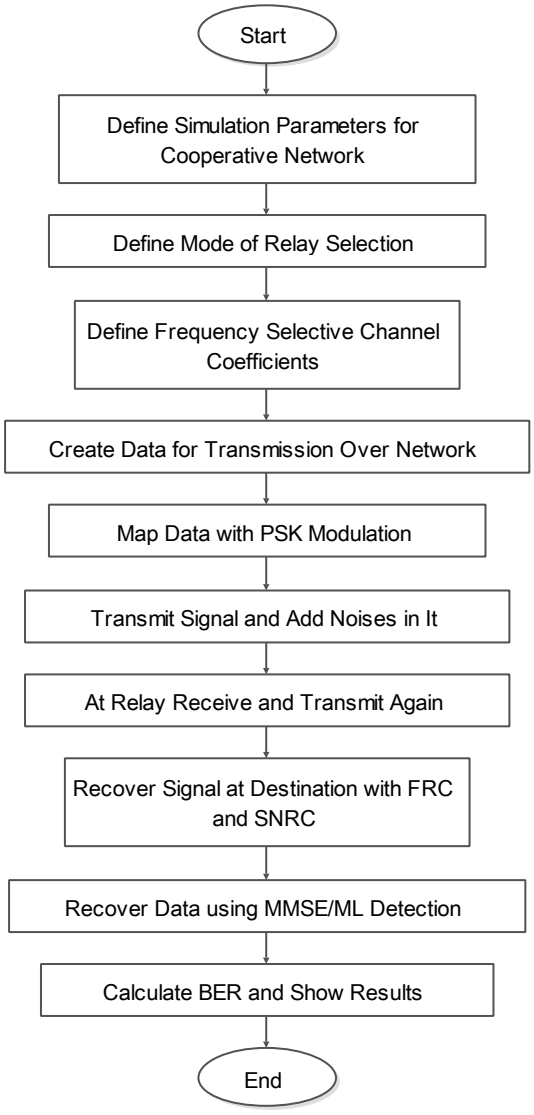

Figure 3.2 Flow Chart of Proposed Methodology.

After receiving the information signal from the source, relay uses cooperating relaying schemes to process the signal. Elemental cooperating relaying schemes to transmit the information signal to the destination are Decode and Forward (DF) and Amplify and Forward (AF). In addition to these two relaying schemes, combing Cooperative is used by the relay, to produce artificial interference to confound the eavesdropper. To combine the benefits of both DF and AF.

An incorrectly detected symbol at the relay station will have a fifty percent probability of also being incorrectly detected at the destination. This stands in contrast with the equal ration combing in a system using AAF. Instead of detecting the symbol at the relay, it is amplified and transmitted to the sender

IV. SIMULATION RESULTS

In this section the simulation results of the proposed system utilizing different cooperative modes and Various Relay Selection Modes and the optimum BER is achieved using minimum mean square error(MMSE) and maximum likelihood (ML) detection. Also a combination of different combining methods and diversity protocols are analyzed to illustrate their potential benefits. The detected signals at the receiver side from various cooperative modes are than combined using Fixed Ratio Combining (FRC) and Signal to Noise Ratio Combining (SNRC) and outcomes are given in below figures.

The simulation of proposed algorithm has completed in Matlab and simulated in Matlab Simulink. The simulation waveforms of proposed algorithm has visualized on Matlab Scope. In Figure 4.1 BER Vs SNR Curves using Relay Selection and without Detection has shown. In Figure 4.2 BER Vs SNR Curves using Relay Selection and MMSE Detection curve has shown. BER Vs SNR Curves using Relay Selection and ML Detection has shown in Figure. 4.3.

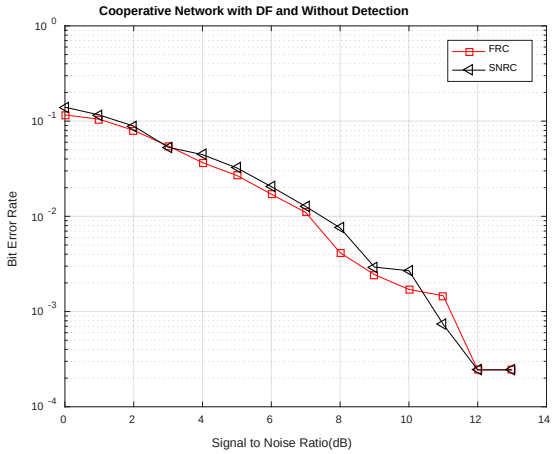

Figure 4.1 BER Vs SNR Curves using Relay Selection and without Detection

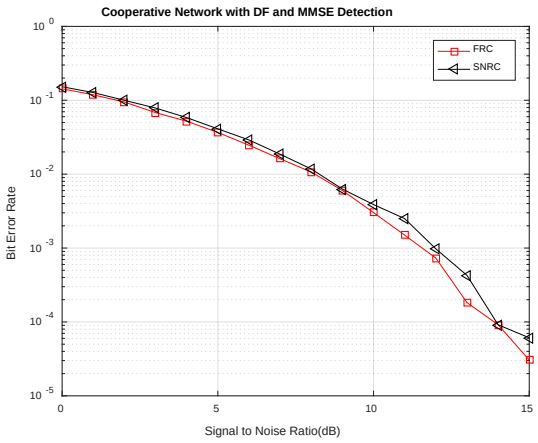

Figure 4.2 BER Vs SNR Curves using Relay Selection and MMSE Detection

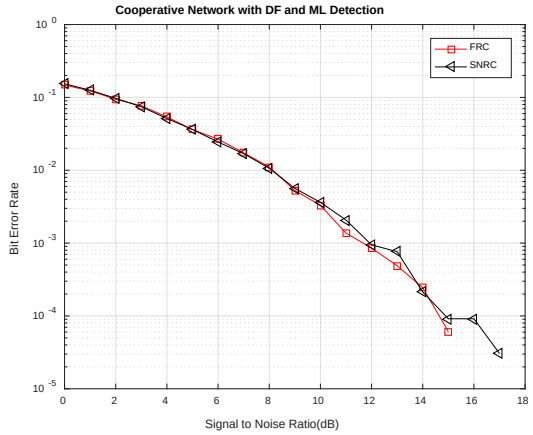

Figure 4.3 BER Vs SNR Curves using Relay Selection and ML Detection

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

V. CONCLUSION AND FUTURE SCOPE

This investigation, focus on study and analysis of cooperative communication systems with wireless network protocols. From the simulation results we can say that the results of the proposed approach is better with the Fixed Ratio Combining (FRC) and Signal to Noise Ratio Combining(SNRC) using Detect and Forward (AF) followed by detection algorithms MMSE and ML using No Collaboration Threshold Harmonic (SNR) relay mode and MRC combining technique with DF cooperative mode followed by MMSE and ML detection using Collaboration threshold Max (min (SNR)) relay mode. It can be concluded from simulation results proposed system has better BER performance compared to existing work. For further enhancement in the existing system the application of digital filtering with more efficient detection algorithms make system more robust and error free.

For a large wireless network, the relaying channels are precious resources and may not meet the needs of all users. Our study demonstrated that, network dynamics could be exploited to use cooperative diversity more flexibly.

All the relaying schemes are analyzed only for single eavesdropper case. Hence further work can be extended to multiple eavesdropper environments.

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