POWER ALLOCATION AND ECHO CANCELLATION ANALYSIS FOR COOPERATIVE MIMO-OFDMA CHANNEL

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ABSTRACT

Multiple Inputs and Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM) system have the potential to attain high capability on the propagation setting. The reduction of power consumption in co-operative multiuser OFDMA systems is a great challenge in multipath environment. The power distribution among multi users in relay path has more complexity when compared to that of the shortest path. Subcarrier resource allocation move toward is the main interest in this paper, it is a method that is based upon the nodes that are able to transmit as well as receive on adjacent OFDM subcarriers at the same time. In this particular approach there will be a performance trade off in realistic conditions as adjacent subcarriers will not be totally isolated and readily available on the receiving subcarriers that are adjacent to those that are transmitting and there will be no interference. In this paper we look into the performance of such cooperative OFDMA systems under realistic conditions and relay path of cooperative communication on different modulations like 16QAM, 64QAM, 128QAM AND 256QAM using power consumptions for this propose we proposed a transceiver structure to reduce the interference between transmitting subcarriers as well as at the receiving subcarriers. Its performance can be stated terms of signal to interference and noise ratio (SINR) and is evaluated by both analysis and simulation and it is incorporated into a recently proposed cooperation strategy for OFDMA systems to examine its performance under the realistic structure.

Keywords: MIMO-OFDM, Subcarrier Analysis, Modulation Process, Interference Analysis and Power Consumption.

INTRODUCTION

Cooperative multiple-input multiple-output technology permit a wireless Network to coordinate among distributed antennas and deliver the good extended performance gains the same as those provided by standard MIMO systems. The random failing nature of wireless channel has drawn several researchers to propose new techniques to extend the variety order of the wireless system by increasing the transmission of the signal over by self-employed failing methods. By combining the signals received from completely at various methods at the receiver consequences in an additional reliable system. Cooperative diversity could be a technique that uses alternative relaying terminals to attain diversity gain. Number of dynamic resource allocation algorithms are basically considered as a part of the literature for the downlink of non-cooperative multiuser OFDMA systems [1-4]. The advantages of MIMO systems have been broadly accepted to an amount that can boldly transmit diversity methods and they have been incorporated into wireless standards. Transmit diversity is clearly advantageous on a cellular base station; but it may not be possible for other practical scenarios. Due to the reason of cost, size, or hardware limitation, a wireless agent may not be able to support multiple transmit antennas.

Cooperative Communication

Cooperative communication is one of the new communication technologies which allow multiple transmitters as well as receivers to work together in a cluster to transfer data transmission, and such group of clusters to a great extent will improve the transmission excellence by using cooperative diversity. In a conventional cooperation system [5] each and every cooperating devices are using orthogonal channels to get relay path from different
communication channels for justifying co channel interference and to overcome transmission collision, by doing this process so we would radically reduce the efficiency of the bandwidth. One way to attempt this problem is to use wireless network coding, in such a way that different messages are neatly shared to a cooperating device for data relaying and to save the channel using.

Fig 1: Cooperative Communication Block

MIMO wireless technology to supply enlarged link capability and spectral strength that is combined with improved link responsibility exploitation what were predecessor seen as interference methods. MIMO (multiple inputs, multiple outputs) is a one type of the antenna technology used in wireless communications, within which multiple antennas cover up to a unit area used at each the supply (transmitter) and also the destination (receiver). The antennas at every end of the communications circuit area division are combined to reduce errors and optimize the knowledge speed. MIMO is one in all of many sorts of antenna technology, the others being are as SISO, SIMO and MISO.

**SISO System**

The simple selection of link that is said in MIMO systems is SISO. SISO is stated as Single Input Single Output [6]. This system uses only a single antenna to transmit to the output and there will be a single antenna to receive the signals. And its construction is simple to design, no problem in the diversity. This can be effectively used in a communicating radio channel.

Fig 2: SISO System

**SIMO System**

The SIMO or Single Input Multiple Output version of MIMO happens wherever the transmitter encompasses a single antenna and therefore the receiver has multiple antennas. This can be conjointly called receiving diversity. it's usually accustomed change a receiver system that receives signals from variety of freelance sources to combat the consequences of attenuation. It is been used for several years with radio emission listening / receiving stations to combat the consequences of part attenuation and interference.

Fig 3: SIMO System
SIMO has the advantage and it is moderately simple to implement although it is having some disadvantages in the process that is desirable within the receiver, services offered by SIMO is also quite acceptable in several applications, however wherever the receiver is found in a very mobile device like a mobile phone telephone set, the amount of process can also be strictly controlled by price, battery drain and size.

**MISO System**

MISO is furthermore termed as transmit diversity. During the case, constant information is transmitted redundantly from the two transmitting antennas. The receiver is then able to receive the optimum signal that it will then use to receive or extract the individual information.

**ECHO CANCELLATION**

Echo cancellation[12] is an enabling technology in the case of voice over packet. If one person is speaking at the same time as the other listens and they talk back and forward. Echo suppressor is to determine which one is in the primary direction and that allows the channel to go forward. While in the reverse channel condition, it places shrinking to obstruct or "suppress" any of the signals on the basis of assumption that the received signal is echo. Logically, such a device is not perfect. There are some cases where the both ends are made in active, and while in the other cases where one end replies faster than that of an echo suppressor can switch instructions to keep the echo signal attenuated but allows the remote conversationalist to reply without any attenuation. Echo is nothing but it is the sound of your own voice that is reverberating in the handset receiver while you are in a
conversation. If the echo's amplitude level seems to be low, then it goes to unnoticed state, and it will not make any problem or disturbance in the conversation; On the other hand, if the echo intermission exceeds within the region of 25 milliseconds, it is can be capable of being heard to the speaker. It first involves in identifying the beginning transmitted signal that is going to reappears, with some amount time delay, in the transmitted or received signal. This echo cancellation can be done by using sub-carrier based duplexing method.

In this paper our interest lies in the study of performance of cooperative OFDMA systems under subcarrier-based duplexing[11] and in the practical tradeoffs / limitations in the realistic configurations [12]. To perform this kind of situation we will be using a transceiver structure that is going to utilize the baseband echo cancellation to restrain the interference between the transmitting as well as at the receiving subcarriers. The performance of this transceiver can be demonstrated with the help of analysis as well as in computer simulation, and it is possible to achieve subcarrier-based duplexing in short-range as well as in low-transmit-power communication systems (e.g., 802.11a/g systems) with the help of suspicious design. This scheme is then incorporated into the cooperation strategy of [13] to investigate its performance under realistic conditions. It is revealed that even though the performance of the cooperative network is corrupted due to the residual interference imposed on the receiving subcarriers by the transmitting subcarriers, but it still performs better when compared to that of the conventional cooperation schemes.

**SUBSYSTEM IMPERFECTIONS**

Fig. 6 shows per subcarrier echo cancellation SINR of the second stage for unusual ADC resolutions. It is noticed that SINR$_{SC,s2}$ increases approximately linearly with the resolution of ADC when the its resolution is less than 12bit, and that of the 1bit increment of ADC resolution, then ADC improves SINR$_{SC,s2}$ by an order of 6dB, which then coincides with the analysis of quantization noise. On the other hand, as the resolution of ADC is going on ever-increasing, then this improvement will turn out to be a smaller amount of significant. This is due to the fact that when the ADC resolution is near to the ground or low, thus the quantization error is going to dominate the effects of other additional subsystem imperfections as well as it will determines the output SINR; as the accuracy of ADC is keeps on increasing, the power of the quantization noise is going to decrease, it will effects the other additional subsystem imperfections that will come into the picture. Fig. 6 shows the SINR$_{SC,s2}$ performance for different levels of phase noise by concurrently varying the values. It can be seen that the effect of phase noise on SINR$_{SC,s2}$ is comparable to with the intention of the quantization noise.

![Fig 6: Performance of the proposed transceiver for different levels of phase noise (interleaved subcarrier assignment)](image-url)
When the data rates of user 1 and user 2 varies while d10 is fixed to be 50m. It can be seen that the difference between the power consumption of DF cooperation in the ideal case and that in the realistic case increases with the data rate [8-10]. The reason is that the transmit power of user 1 increases with the data rate, therefore more interference is generated to the data streams from user 2 to user 1, and user 2 needs to scale up its transmit power in order to compensate for the SINR loss. As the data rate increases, the extra transmit power required by user 2 also increases, thus the total power consumption of optimal DF cooperation will finally exceed that of AF&DF cooperation and that of no cooperation. This technique which was based on the analysis of the capacity of a three- node network consisting of a source, a relay and a receiver has the assumption that all nodes operate in the same band. Therefore the system could be decomposed into a broadcast channel with respect to the source and a multipath access channel with respect to the destination. The relays whole and sole purpose is to help main channel, in the work on the relay channel but in cooperative communication, he total system resources are fixed, and users act both as information sources and as relays. In spite of indisputability of the historical importance of the first work on relay channel, recent work in cooperation has taken a somewhat different emphasis. To enable cooperation among users, different relaying techniques could be employed depending on the relative user location, channel conditions, and transceiver complexity. These are methods that define how data is processed at the relays before onward transmission to the destination. There are different types of cooperative communication strategies which would be outlined. These include the Amplify and Forward (AAF) and Decode and Forward.

Amplify-and-forward strategy (AAF)

This is a simple cooperative signaling method where each user receives a noisy version of the signal transmitted by its partner amplifies it and retransmits to the base station. The base receives two independently faded versions of the signal and combines them in order to make better decisions on information sent by the user and partner, and makes a final decision on the transmitted bit. This method achieves diversity order of two, which is the best possible outcome at high SNR.
Decode-and-forward strategy (DAF)

This approach follows that the relay station decodes the received signal coming from the source node; it then re-encodes the incoming signal and forwards it to the destination station. It is the most often preferred method to process data in the relay since there is no amplified noise in the signal sent because it will re-decodes the data will sending it back[20], in this method a user attempts to detect the partner’s bits and then retransmits the detected bits. The partners may be assigned mutually by the base station, or via some other technique. For the purposes of this tutorial we consider two users partnering with each other, but in reality the only important factor is that each user has a partner that provides a second (diversity) data path. The easiest way to visualize this is via pairs, but it is also possible to achieve the same effect via other partnership topologies that remove the strict constraint of pairing. Again, consider the case of a single relay. The simplest algorithm described below again divides transmissions into two blocks of equal duration, one block for the source transmission and one block for the relay transmission.

Performance of the proposed transceiver for echo cancellation

In principle, the SI waveform can be perfectly regenerated at the receiver since the transmit data is known inside the device. Thus, again in principle, SI can be perfectly cancelled in the receiver path. The orthogonality between subcarriers is moderately vanished in OFDM systems the reason behind is due to the non-ideal characteristics of dissimilar subsystems, resulting in the signal outflow between the subcarriers otherwise it is due to the inter-carrier interference. When a user is working in the subcarrier-based duplexing mode, due to the massive differentiation in the power of the transmitting signal and preferred signal, the outcome of ICI on the receiving Sub-carriers could be important, the subsystem imperfections that are important to consider and it includes carrier frequency offset, time synchronization, quantization error of Analog / Digital Converter, nonlinearity of Power Amplifier, I/Q imbalance and Phase Noise of Local Oscillator.

AF and DF Relay Path on Cooperative Communication

AF and DF abovementioned and are often called as fixed cooperation modes because the relay nodes, for all time they will participates in cooperative communication there is no matter in the sense that what the channel transmission individuality are. For example, consider a half duplex mode, in that the data transmission rate and the operation of the utilization of degrees of freedom are going to decrease. This indicates that when to cooperate is a dangerous issue. Merely when the characteristic value is attainment to have the greater value than the threshold value, then the cooperative communication is implemented; or else, the source node will get the direct transmission data all over again. Hence, the main reason in selection of nodes is the conditions based upon the of source-relay channel. In the case of incremental modes, the feedback of the destination node determines that whether the direct transmission is successful or not. Then if the data are correctly detected, then the source node will send new data; otherwise, the relay node will participate in the cooperative communication process. Thus this process is done corresponding by adding redundancy mechanism and retransmission mechanism in the relay transmission.

RESULTS AND DISCUSSION

In order to align the phases of the received signals, we need phase synchronization between the relays, i.e., the two relays require a global phase reference. The cooperative MRC scheme serves two users at the same time and
has full rate transmission for each receiver. This is achieved without using additional resources or exchanging channel knowledge and data between different relays.

![Graph](image1.png)

**Fig 10: Performance of the proposed transceiver with localized subcarrier allocation Iteration**

The method that involves in the use of a single of all purpose devices is to deploy a network services that results in design complications which then results in inefficient use of battery power causing short battery life [15]. Users can ease off the load on the network and in turn increase the capacity and battery life for their devices by cooperative communications in such situations. The echo canceller is an adaptive transversal filter that adaptively learns the response of the hybrid, and generates a replica of that response which is subtracted from the hybrid output to yield an echo-free received signal [11].

![Graph](image2.png)

**Fig 11: Total Power consumption of 2-user cooperative OFDMA system for different data rates**

Fig.11, Shown that the overall power consumption of optimal DF cooperation will exceed that of AF&DF cooperation as the data rate of user 3 keeps increasing due to stronger interference between Tx and Rx subcarriers at the relay node. Therefore, we conclude that under realistic configurations the optimal DF cooperation scheme performs better than the conventional schemes when the system parameters are properly chosen.

QAM: Quadrature Amplitude Modulation or QAM is a form of modulation which is widely used for modulating data signals onto a carrier and it is used for radio communications. Quadrature amplitude modulation (QAM) is both an analog as well as a digital modulation scheme. It conveys two analog message signals, otherwise two digital bit streams, by means of changing the modulations of the amplitudes of two carrier waves, QAM is
generally used because; it offers advantages in excess of additional forms of data modulation techniques such as PSK, FSK. Quadrature Amplitude Modulation is nothing but one kind of a signal in which is having the two carriers that are shifted in phase by 90 degrees are then modulated and the resultant output is having the combination of both the amplitude as well as phase variations.

It is possible to transmit more bits per symbol, if the energy of the constellation diagram is to remains the similar / equal, then the points on the constellation will be nearer together and the transmission seems to be more vulnerable to noise, this results in a higher bit error rate than that of the lower order QAM variants. In this way there is a balancing between the obtaining of the higher data rates and maintaining an acceptable bit error rate for any radio communications system [14]. QAM Modulations like: 16/64/128/256-QAM, in 16-QAM signal alphabet is the set \( \Delta 16 = \{ \pm 1 \pm j, \pm 3 \pm j, \pm 1 \pm 3j, \pm 3 \pm 3j \} \) without any loss of generalization, we assume that the transmitted symbol to be in the first quadrant; \( X \in \{ 1+j, 3+j, 1+3j, 3+3j \} \). Just as with the QPSK case, the correct decision probability can be written as a product of the error function. To send data, the transmitter varies the amplitude and phase of a carrier signal. In QAM64 there are 64 possible combinations of amplitude and phase for each period of time, or symbol, of the carrier [14]. With QAM256 there are 256 possible combinations in the same period - thus increasing the data capacity fourfold but making it more difficult for the receiver to discriminate between each signal.

![Fig 12: Power consumption for different QAM Modulations in Realistic conditions](image1)

![Fig 13: Power consumption versus bit rate in No cooperation, AF & DF, DF in realistic and DF in Ideal condition](image2)

From the above two graph shown that the transmission bit rate is increased and power consumption reduced by increasing the levels of QAM modulation techniques as 64-QAM, 128-QAM and 256- QAM modulations. In
each level of QAM modulation we have achieved the decrement in power consumption for the DF cooperation under realistic conditions compared with the non-cooperative condition. By using above comparison we investigated the sub-carrier based duplexing in terms of different QAM modulation techniques performance of cooperative communication OFDMA systems with BER can play an important role to decrease the power consumption.

CONCLUSION

Cooperative communication in OFDMA systems has been shown to significantly improve wireless system performance. In this project a particular subcarrier resource allocation approach investigated. To perform the investigation we proposed a transceiver structure so that the system tradeoffs and limitations of this approach could be understood. The performance of the transceiver was evaluated by both analysis and computer simulation and it was shown that the non-ideal characteristics of subsystems will limit the achievable SINR. From this observation, we obtained a good improvement in reduction of power consumption particularly in relay network. To achieve this, we use different levels of QAM modulations (16- QAM, 64-QAM, 128-QAM and 256). By using these levels of QAM, we improved the data rates and decrease the bit error rates. Finally, we compared all these results by MATLAB computer simulations.

REFERENCES

[10] Marzetta TL. Non cooperative cellular wireless with unlimited numbers of base station antennas