MIMO COMMUNICATION STUDY AND RELAY DIVERSITY ANALYSIS IN WIRELESS COMMUNICATION

Nivedita Chourasia
Department of Electronics and Communication, Medi-caps Institute of Technology and Management, Indore, India

Sopan Khadkodkar
Department of Electronics and Communication, Medi-caps Institute of Technology and Management, Indore, India

ABSTRACT

Now in these days the wireless communication and their technologies are growing much rapidly. Additionally, these communication channels are not only for voice communication that is in addition used for different extra applications, such as video conferencing, data transfer and other services. Due to these applications, higher quality of service required. Therefore it is not feasible to work with traditional loss models. In addition of that to improve the QoS and decrease the possessions (losses) different communication, diversity is used for communication. In this paper, we are demonstrating a model for MIMO diversity which is implemented with the help of MATLAB. That demonstrates a physical - modeling of wireless systems with multiple antennas. The communication channel consists of a finite spatial volume of transmitters, receivers, and a haphazard set of reflective-scattering bodies. The communication scenario and the modes of operation are required to be analyzed to study about the delivered QoS. To demonstrate a simple model of multipath channels, that allows development of a correlated MIMO channel model. The model is self-governing of the transmitter and receiver additionally on physical parameters. The demonstrated results explain and determine the channel model and channel capacity for wireless communication.

Key words: Wireless communication, MIMO, Antenna, Communication, diversity, Channel model.


http://www.iaeme.com/IJECET/issues.asp?JType=IJECET&VType=7&IType=6

1. INTRODUCTION

The network is a collection of computers or the device through which data can be sent or received. In other words, the hardware interconnected through a communication channel, which allows sharing resources can
be termed as a network. According to nature of connectivity, the networks can be divided as wired and wireless networks. As compared to wired network the wireless networks offers the ease of mobility and switching of networks. Additionally, these networks are less costly and require comparatively less maintenance. Therefore the wireless networks become more popular as compared to wired network technology. In this paper, we are working on wireless communication or network technology.

Due to a number of different properties of wireless technology, it is a truly innovative standard shift that enables various new applications such as multimedia, sensor networks, telemedicine, and automated highways. This paper introduces fundamental theory, design techniques, and also analytical tools of wireless communications system design.

A number of challenges are there with adopting the wireless communication for future applications and their enhancements. These challenges also help to extend the system design. As the wireless devices increase their features, the warden on small devices is also increased, therefore there is a need to incorporate multiple modes of operation, enrich the processing capability, power source and others. Additionally, the device should be cheap, lightweight, handheld device. As the end client doesn’t want to carry large batteries and a large device that frequently need recharging and other complexity.

In the new generation communication technology as LTE needed to support various multimedia applications and efficient data transfer rates. Thus wireless infrastructure-based networks, such as wireless LANs and cellular systems, needs to be enhanced. Ad hoc wireless networks without infrastructure are highly appealing for many applications primarily because of their flexibility and robustness. For these networks, all the processing and control must be performed by the network nodes.

Apart from this wireless channel and low size battery requirement, the algorithm used to receive the signal i.e, noise free signal should be better in comparison to the existing system. Diversity is one of the best approaches to coping with fading and interference. That is widely used in terrestrial wireless communication systems. The performance of any digital transmission system is degraded by the deep fades characteristic of the multipath Rayleigh fading environment. Use of diversity technique for better communication is not a new idea, previously it has been used. Relay diversity is a technique, where we use multiple terminals to reduce the interference and to increase the channel capacity [1],[3].

In this paper, different kind of Diversity techniques is used to recover the signal when multipath fading occurs. Maximal Ratio Combining (MRC), Equal - Gain Combining (EGC), Selection Combining (SC)[4],[5],algorithms used to acquire better SNR. Along with the SNR, delay and throughput are important parameters, which affect the communication system. In this part of the paper, we provide a brief introduction to the topic covered in the next section along with that we provide the formerly made efforts in the direction of our studying domain.

2. BACKGROUND
In this part of the paper, we include different research papers and articles that are previously observed by different researchers.

A similar research work is found in [1] where the author takes the design of channel codes for humanizing the data rate and/or the dependability of infrastructure over fading channels using variaustransmit antennas. Information is prearranged by a channel code and the approved data are split into n torrent that isconcomitantlybroadcast using a broadcast antenna. The received signal at every receiving antenna is a linear superposition of thenbroadcast signals perturbed by noise. They derived derivepresentation criteria for deceitful such codes under the statement that the fading is measured and occurrence nonselective. The presentation is exposed to be resolute by matrices assemble from pairs of distinct code sequences. The minimum rank between these matrices quantifies the assortment gain, Even as the minimum determinant of these matrices quantifies the coding gain. The results are behind thatinclusive to fast fading channels. The design trellis codes for high data rate wireless communiqué make use of the design criteria. The encoding/decoding difficulty of these codes is similar to trellis codes working in practice over Gaussian channels. The codes constructed here provide the best tradeoff among data rate,
 assortment advantage, and trellis difficulty. Reproduction results are given for 4 and 8 PSK signal sets with data rates of 2 and 3 bits/symbol, appearance in a comparable representation that is inside 2–3 dB of the outage capability of these channels with only 64 state encoders.

As a conclusion of the complete research work according to author [1] various fundamental theoretical limits on rates, trellis difficulty, assortment, assemblage size, and their tradeoffs were made. Examples were provided confirming that the limits established are attainable in practice. The Author believes that the studies they initiated here, merely scratch the tip of the iceberg and various critical questions remain to be determined. Research on the interactions and combinations of the space–time coding knowledge with additional method such as orthogonal occurrence division multiplexing [2], array processing [3], and numerous extra topics are now being accused.

In [4] author develops and analyzes space–time coded accommodating diversity procedure for combating multipath fading across manifold procedures layers in a wireless network. The protocols develop spatial diversity obtainable between a compilation of dispersed incurable that relay messages for one a dissimilar in such a method that the purpose incurable can average the fading, stillwhile it is indefinite a priori which incurable will be necessary. In exacting, a resource initiates broadcast to its purpose, and various relays potentially receive the broadcast. Individual’s terminals that can fully decipher the broadcast exploit a space-time code to considerately relay to the finish. They established that this procedure achieves full spatial diversity in the number of cooperating terminals, not simply the act of decoding relays, and can be exploited efficiently for higher spectral efficiencies than repetition-based systems. They moreover discussed problems connected to space–time code design for this procedure, accentuate codes that readily allow for interesting disseminated versions.

White lighting LED-based systems are emerging as a significant form of high data rate communications, mostly for internal request. Two limitations of available systems are the small field of view of representative receivers and the poor presentation of optical wireless MIMO owing to lack of spatial diversity. In the paper [5] explain a narrative design which overcomes these problems by using a hemispherical lens in the receiver. They exhibit that the new system has a wide field of view and moreover provides important spatial diversity for representative MIMO observable light scenarios. Numerical results are present for a range of LED transmitters with dissimilar half power semi-angles. Our assessments express that system can be designed with adequate channel gain for angles of incidence as big as 70 degrees. The optical power thickness is too forecast to demonstrate the received optical power distributions in the case of four LED transmitters. The results designate that the images of the LEDs are clearly make different. This decrease the channel correlations among human being transmitters and receivers and thus promises important diversity order for MIMO optical wireless systems [4],[5].

In paper [6], the probability density function (PDF) based approach was used by the Author rather than SNR approach. The likelihood density function (PDF) and growing allocation function of the sum of L independent but not essentially identically distributed Gamma varieties, appropriate to the output statistics of maximal ratio combining (MRC) receiver operating over Nakagami-m fading channels or in additional words to the statistical assessment of the scenario anywhere the sum of squared Nakagami-m distributions are user-of-interest, is obtainable in closed-form in conditions of recognized Meijer’s G function and simply assessable Fox’s $^\mathrm{~H}$ function for integer valued and non-integer valued fading parameters. Additionally examination, above all on the bit error rate via a PDF-based approach, is furthermore offered in closed form in conditions of Meijer’s G-function and Fox’s $^\mathrm{~H}$ function for integer valued fading parameters and extended Fox’s $^\mathrm{~H}$ function ($^\mathrm{~H}$) for non-integer valued fading parameters. Proposed results [6] complement previously known issues that are also expressed in conditions of infinite sums, nested sums, or higher order derivatives of the evaporation parameter $m$ [6],[1].

### 3. RELAY DIVERSITY

- In wireless communication, usually, there is severe attenuation of signal power with distance. This attenuation makes long-range communication virtually impossible. The simplest resolution to this difficulty
is to replace a single long-range link in a chain of short-range links by placing a series of nodes in among the resource and the destination, where in order to enhance the signal quality a booster or a repeater is placed at each intermediate node [7]. These intermediate nodes are popularly known as relays in the wireless literature. There are two main advantages of this relaying technology, first is that very low transmit RF power is required and the second is the use of spatial/multiuser diversity to combat fading. The conventional three-node relaying model is a network consisting of only one resource (mobile multihop relay-base station, MMR-BS), one transmit (fixed, nomadic, or mobile relay station, F/N/MRS) and one reason (mobile station, MS, or user terminal, UT) is illustrated in the following figure. In the two-hop communicate link the physical channel among the resource.

![Figure 1 Direct and two-hop relay communications](image)

- The broadcast signal (S) and the relay (R) are called the relay link and the physical channel among the relay and the destination (D) is called the access link.

- The relay normally works in half-duplex mode, which means that the station does not receive and broadcast using the similar channel simultaneously. The transmitted signal interferes with the received signal if a relay tries to transmit and receive simultaneously in the same band. This is since it would be not easy to separate the received signal from the broadcast signal [8]. For this reason, the channel allocated for the relay operation comprises of two (ideally) orthogonal sub-channels. The orthogonality between transmitted and received signals can be in time-domain, in the frequency domain, or using any set of signals that are orthogonal to the time-frequency plane.

**4. SCENARIO**

The relay stations (RSs) can be of different types depending on the use case. The fixed relay stations (F-RSs) along with mobile dual-hop relay base station (MMR-BSs) are deployed to get better coverage/capacity to enhance per user throughput in areas which are not satisfactorily covered (e.g., indoor, in shadow, tunnels, or underground), or to provide access for clusters of users outside the exposure area of the MMR-BS.

Nomadic (portable) RSs can be deployed provisionally to provide extra coverage or capacity in an area where MMR-BSs and/or fixed RSs do not provide good exposure or ability [9]. Instances in which temporary exposure might be needed are emergency/disaster enhancement sites and measures such because sporting occasions or fairs, where reporting is necessary solely for the duration of that exacting case. Additionally, nomadic RSs can provide admittance to subscribers inside a room or to a big building, such as a multitenant residence or office building.

Traffic from a given UT can be routed to avoid a congested relay link or save power at a demanding node. For exposure and/or range conservatory, RSs can be organized to present experience to users in low-lying or unfriendly areas additional than the MMR-BS exposure. For UTs riding on vehicles and to areas frequently traveled, coverage can, in addition, be comprehensive.

**4.1. Diversity with Relay**

Cooperative communication is one of the fastest increasing areas of inquiry, and it is likely to be a key enabling technology for efficient spectrum utilization in future. A three-terminal network is a central unit in user cooperation called the relay. The model was initially introduced by Van der Meulen in 1971.
The three-node relay network can be viewed as a prehistoric building block for superior relaying systems [10]. The concept of relaying is based on the information that a signal, previously transferred, can be received (and conveniently forwarded) by manifold terminals. In universal, accommodating relaying systems include a resource node multicasting a message to a number of accommodating (helping) relays which in turn resend a procedure version of the intended purpose node. The destination node merges the signals received from the relays and probably the resource signal. By combining, the inherent diversity of the transmit channel is beneficially oppressed.

There are many approaches to implementing diversity with the relay in a wireless transmission. In this paper, the performance of relay diversity (MRC) has been compared with two different cases.

5. PROPOSED MODEL

The model of the distributed relay diversity system is illustrated. As illustrated in the figure, the purpose can receive the signal from the resource via manifold paths: the two-hop relaying link (first and second hop) and the one-hop direct link (third hop).

![Figure 2](image1.png)

**Figure 2** A network for high coverage using RS.

![Figure 3](image2.png)

**Figure 3** A model with 2 two-hop relaying link

Basically how the relay will handle the data that solely depends on the algorithm used.

Depending on how an RS procedure the received signal, there exists mostly three dissimilar physical layer comprehension for relaying [11]:

- **AMPLIFY-AND-FORWARD (AF)**
- **DECODE-AND-FORWARD (DF)**
COMPRESS-AND-FORWARD (CF)
AF is the simplest probable relaying scheme anywhere the communicate act as analog repeaters (layer 1 relay). The following figure explains an easy AF kind relay in operation. To keep the difficulty of the examination to a minimum, let us regard as the downlink pathway only.

The broadcast signal (S) from a BS/AP is first received by a relay node, improved with a gain (G) which might be flexible if channel state information (CSI) is available, and in conclusion retransmitted to the destination (D) MS. The situation and accounts for the channel attenuation due to fading and denotes additive noise, in the resource relay (SR) and relay-destination (RD) links correspondingly.

To compensate the noise and fading produce inconsistent gain at RS is usually advised. If perfect CSI is obtainable at all instants of time, this gain G might be made inversely comparative to the fading attenuation and interference. The related technique is recognized as instantaneous power scaling (IPS). Though, in reality, it is not probable to evaluate the immediate channel fading all the time. Therefore, an inconsistent gain comparative to the inverse of average noise or fading is found to be additional attractive [12]. This is recognized as the average power scaling (APS) move toward.

Nowadays analog wireless systems are rare to find and the relay is generally equipped with enough computing power. Therefore DF is most often the preferred method to process the data in the relay. In DF mode, RSs act as digital regenerative repeaters, i.e. the communicate demodulates, decodes, re-encode and re-modulate the traditional signal prior to retransmission. The forwarded signal does not contain further degradation; somewhat it is exaggerated by only bit errors resulting from the decoding procedure. Appraise to AF strategy, DF scheme provides better QoS but an improve in cost, complexity, and power expenditure is worried on the part of relay nodes. Fig give the explanation a simple DF type relay in the procedure.

We may write the received signal at relay node as

\[ R_s = h_{SR}S + n_{SR} \]

Further the transmitted signal at relay node may be exposed as

\[ R_d = S \]

Where s denotes the estimated version of s, finally the signal received at the destination

\[ D = h_{RD}S + n_{RD} \]

**Fixed DF Scheme:** For the fixed DF scheme, the relay always detects and forwards the original data by maximum likelihood (ML) detection. Although this scheme is simple, the cooperation can be
detrimental to the eventual detection of symbols at the destination due to error propagation if the detection at relay \( R \) is unsuccessful.

**Adaptive DF Scheme:** This scheme forces the relay to appraise the quality of the received signal and check whether it satisfies the preset requirement. The relay detects and forwards the data to the destination. Otherwise, it keeps silent in the second phase. Therefore, the problem of erroneous retransmission and error propagation induced by the relay in fixed DF scheme can be mitigated.

The CF scheme is a hybrid resolution, an attempt to preserve the better features of together AF and DF strategies. In this procedure, the RS does not decipher the input data, but it quantizes and decrease (via resource coding) the received signal and broadcast it to the purpose. The probable evaluation errors in quantization and coding procedure are the major source of signal squalor in this case. CF is moreover occasionally referred as estimate-and-forward (EF) technique in literature. In absence of the channel coding, CF becomes identical to DF scheme.

**6. SIMULATION AND RESULTS**

The above approach is simulated using the MATLAB simulation IDE, the simulation snapshot are given here.

![Figure 6 Simulation implemented](http://www.iaeme.com/IJECET/index.asp)

The above-given screen shows the network simulation implemented using MATLAB, is first required to setup its parameter and then a simple selection utility is given to decide the source and sink for communication and finally, simulation is conducted.

**6.1. Bit error rate Versus SNR (dB)**

![Figure 7 Comparative SNR of the proposed model](http://www.iaeme.com/IJECET/index.asp)
In figure 7, we can see that the SNR produced by MRC (Maximal Ratio Combining) diversity technique with the relay is far better in comparison to the other techniques. The SNR plot for MRC with the relay is underlying with a comparison to all.

6.2. Percentage Throughput Versus SNR (dB)

From figure 8, we can see that percent throughput is less if bit error rate is high.

7. CONCLUSION & FUTURE WORK

In this paper, we study about different approaches that are previously proposed and implemented to enhance the performance of the network using the concept of diversity. Additionally, here we propose and implemented a MATLAB based simulation for enhancement using network devices and performance of the proposed system is measured and found the optimum and acceptable improvement of the system. Another way to enhance this project would be to use more than one multi-antenna relay. Such a system should show higher levels of diversity and might have a lot of potential.

REFERENCES


