ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 4, April 2016

A Review of impact of relay over diversity combining in a deeply faded channel

Aditi Shah, Apoorva Gangwar,Dr. Sonika Singh ,Ajay Mathew, Sandeep Sharma

Department of Electronics and communication, DIT University Dehradun

ABSTRACT

. When a signal propagates through a wireless channel, it experiences random fluctuations in time if the transmitter, receiver, or surrounding objects are moving, due to changing reflections and attenuation. Thus, the characteristics of the channel appear to change randomly with time, which makes it difficult to design reliable systems with guaranteed performance. Also path loss(fading) at higher frequencies is larger.Diversity scheme which refers to a method for improving the reliability of a message signal by using two or more communication channels with different characteristics.

INTRODUCTION

In wireless communications, fading is deviation of the attenuation that a carrier-modulated telecommunication signal experiences over certain propagation media. The fading may vary with time, geographical position and/or radio frequency, and is often modeled as a random process. A fading channel is a communication channel that experiences fading. In wireless systems, fading may either be due to path loss variance with distance ,multipath propagation and/or shadowing

Types of Fading :

Large Scale Vs Small Scale Fading:

Large-scale fading represents the average signal power attenuation or path loss due to motion over large areas. This phenomenon is affected by prominent terrain contours (hills, forests, billboards, clumps of buildings, etc.) between the transmitter and receiver. The receiver is often represented as being "shadowed" by such prominences.The statistics of large-scale fading provide a way of computing an estimate of path loss as a function of distance.

Small-scale fading refers to the dramatic changes in signal amplitude and phase that can be experienced as a result of small changes (as small as a half-wavelength) in the spatial separation between a receiver and transmitter.Small-scale fading manifests itself in two mechanisms, namely, time-spreading of the signal (or signal dispersion) and time-variant behavior of the channel. Small-scale fading is also called Rayleigh fading.

Slow Vs Fast Fading

Slow fading arises when the coherence time of the channel is large relative to the delay constraint of the channel. In this regime, the amplitude and phase change imposed by the channel can be considered roughly constant over the period of use.

.

IMPROVEMENTS:

The effects of fading can be combated by using diversity. Diversity can be achieved in time, frequency, or space. Common techniques used to overcome signal fading include:

- Diversity reception and transmission
- MIMO
- OFDM
- Rake receivers
- Space–time codes

Diversity

Both Rayleigh fading and log normal shadowing induce a very large power penalty on the performance of modulation over wireless channels.

One of the most powerful techniques to mitigate the effects of fading is to use **diversity-combining** of independently fading signal paths. Diversity-combining uses the fact that independent signal paths have a low probability of experiencing deep fades simultaneously. Thus, the idea behind diversity is to send the same data over independent fading paths. These independent paths are combined in some way such that the fading of the resultant signal is reduced. By selecting the antenna with the strongest signal, called **selection combining**, we obtain a much better signal than if we just had one antenna.

Diversity techniques that mitigate the effect of multipath fading are called **micro-diversity.** Diversity to mitigate the effects of shadowing from buildings and objects is called **macro-diversity.** Macro-diversity is generally implemented by combining signals received by several base stations or access points. This requires coordination among the different base stations or access points. Such coordination is implemented as part of the networking protocols in infrastructure-based wireless networks.

Diversity types :

The following classes of diversity schemes can be identified:

- **Time diversity**: Time diversity is achieved by transmitting the same signal at different times, where the time difference is greater than the channel coherence time (the inverse of the channel Doppler spread). Time diversity does not require increased transmit power, but it does decrease the data rate since data is repeated in the diversity time slots rather than sending new data in these time slots. Time diversity can also be achieved through coding and interleaving.

- **Frequency diversity**: Frequency diversity is achieved by transmitting the same narrowband signal at different carrier frequencies, where the carriers are separated by the coherence bandwidth of the channel. This technique requires additional transmit power to send the signal over multiple frequency bands. Examples include:
  - OFDM modulation in combination with subcarrier interleaving and forward error correction.
  - Spread spectrum, for example frequency hopping or DS-CDMA.

- **Space diversity**: The signal is transmitted over several different propagation paths. It can be achieved by antenna diversity using multiple transmitter antennas (transmit diversity) and/or multiple receiving antennas (reception diversity). In the latter case, a diversity combining technique is applied before further signal processing takes place. A special case is phased antenna arrays, which also can be used for beam-forming, MIMO channels and Space time coding (STC)

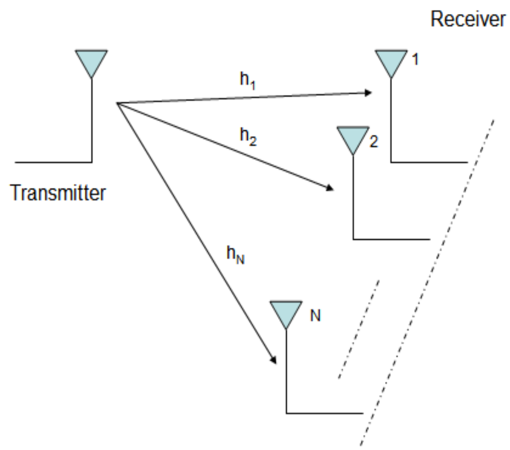
- .**Polarization diversity**: Multiple versions of a signal are transmitted and received via antennas with different polarization. A diversity combining technique is applied on the receiver side.

- **Multiuser diversity**: Multiuser diversity is obtained by opportunistic user scheduling at either the transmitter or the receiver. Opportunistic user scheduling is as follows: the transmit selects the best user among candidate receivers according to the qualities of each channel between the transmitter and each receiver. In FDD systems, a receiver must feedback the channel quality information to the transmitter with the limited level of resolution.

- **Cooperative diversity**: Achieves antenna diversity gain by using the cooperation of distributed antennas belonging to each node.

- **Directional diversity**: Directional antennas provide angle, or directional, diversity by restricting the receive antenna beam-width to a given angle. In the extreme, if the angle is very small then at most one of the multipath rays will fall within the receive beam-width, so there is no multipath fading from multiple rays

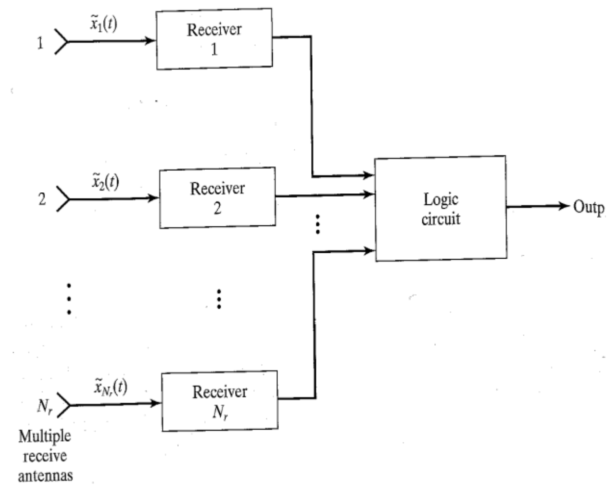
- **Diversity combining :**
- Diversity combining is the technique applied to combine the multiple received signals of a diversity reception device into a single improved signal.



-
- **Fig: Receiver diversity in a wireless link**

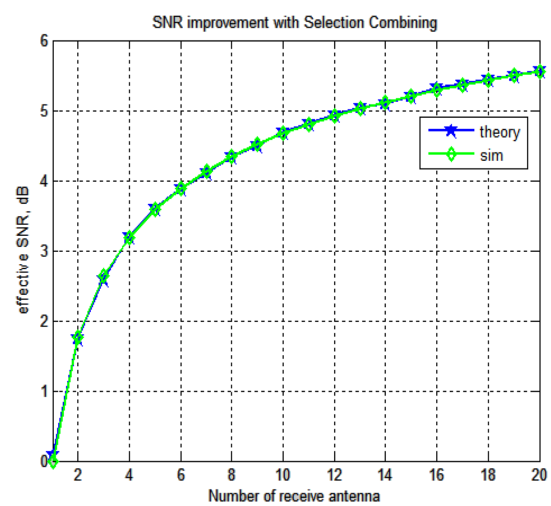
- **Various combining techniques :**
- There are various diversity combining techniques which are used and can be distinguished as following:
- Selection Combining **:**

- Consider a scenario where we have a single antenna for transmission and multiple antennas at the receiver (as shown in the Fig 1.2).At the receiver we have now N copies of the same transmitted symbol. Which then poses the problem – how to effectively combine them to reliably recover the data.
- **Selection diversity** approach is one way out – With **selection diversity**, the receiver selects the antenna with the highest received signal power and ignore observations from the other antennas.



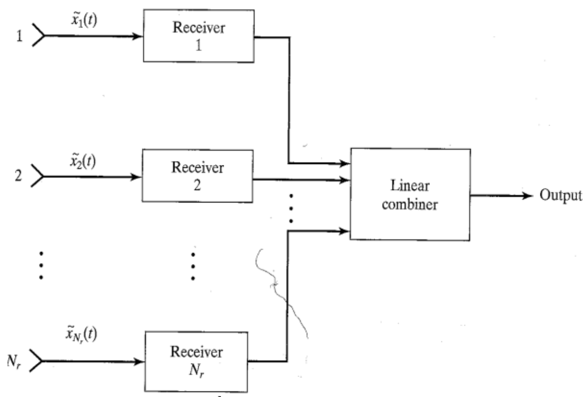
-
- **Fig 1.1** Block diagram of Selection Combining ,using N_r receive antennas

- The improvement in SNR with increase of number of receiving antennas in selection combining can be realized with the following matlab simulation graph.



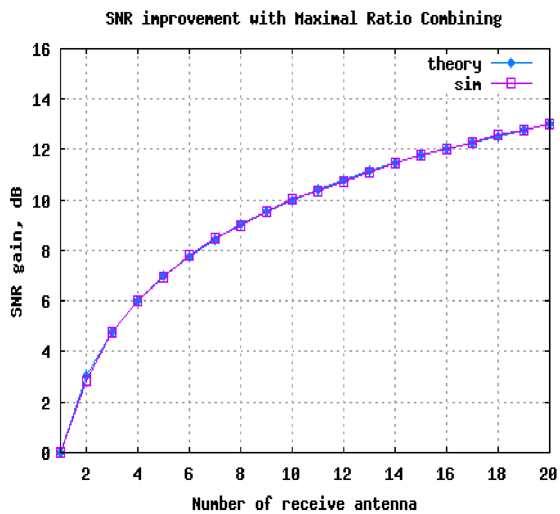
- **Fig 1.2** SNR improvement with Selection Combining
- Maximal-ratio combining**:**
- From a performance point of view SC is not optimum as it ignores the information available from all the diversity branches except branch that produces the largest instantaneous power of its own demodulated signal.This limitation is mitigated by the MRC.The maximum-ratio combiner consists of Nr linear receiver,followed by a linear

combiner.The output is a weighted sum of all branches. It is often used in large phased-array systems: The received signals are weighted with respect to their SNR and then summed. The resulting SNR yields$\sum_{i=1}^{N} SNR_k$ where SNR_k is SNR of the



received k^{th}signal.

- The improvement in SNR with increase of number of receiving antennas in selection combining can be realized with the matlab simulation graph .



-
- **Fig 1.3** M.R.C. using Nr receive antennas
  Fig 1.4 SNR improvement using MRC
- Equal Gain Combining :
- Here actually all the received signals are summed coherently.In this combining techniqueon the i^{th}receive antenna, equalization is performed at the receiver by dividing the received symbol $y_i$by the apriori known phase ofh_i.The channel $h_i$is represented in polar form as$|h_i|e^{j\theta_i}$. The decoded symbol is the sum of the phase compensated channel from all the receive antennas.

Switched combining:

- The receiver switches to another signal when the currently selected signal drops below a predefined threshold. This is a less efficient technique than selection combining.
- Sometimes more than one combining technique is used – for example, lucky imaging uses selection combining to choose (typically) the best 10% images, followed by equal-gain combining of the selected images.
- Other signal combination techniques have been designed for noise reduction and have found applications in single molecule biophysics, chemo-metrics among other disciplines.

CONCLUSION

Fading can cause poor performance in a communication system because it can result in a loss of signal power without reducing the power of the noise. This signal loss can be over some or all of the signal bandwidth. Fading can also be a problem as it changes over time: communication systems are often designed to adapt to such impairments, but the fading can change faster than the adaptations can be made. In such cases, the probability of experiencing a fade (and associated bit errors as the signal-to-noise ratio drops) on the channel becomes the limiting factor in the link's performances.

REFERENCES

1. Journal Of theoretical and Applied Information Technology-“Diversity Schemes for Wireless Communication”.

2. M.O.Hasna and M.S.Alouini, “ End-to-End Performance of Transmission Systems With Relays Over Rayleigh-Fading Channels”, Member, IEEE Transactions on wireless communication,vol.2,no. 6, november 2003,pp. 1126-1131.

3. http://dsplog.com

4. Pravin W. Raut, Dr. S.L. Badjate “DIVERSITY TECHNIQUES FOR WIRELESS COMMUNICATION”,INTERNATIONAL JOURNAL OF ADVANCED RESEARCH INENGINEERING AND TECHNOLOGY (IJARET).

5. Simon Haykin and Michael Moher, Modern Wireless Communications , Pearson Education, 2005.

6. “Fading Mitigation in Wireless Communication using Conventional Diversity Combining Schemes”:Syed Ahmad Ali Shah,M.Saad Bin Ilyas and M.U. Hashmi