Survey on Performance of Adaptive Modulation Scheme with Cooperative Diversity in Wireless Systems

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Abstract— A common technique that is also widely used in communication systems is the Adaptive Modulation (AM). In this technique the most appropriate type of modulation is selected in addition to size of the constellation depending on the Signal to Noise Ratio (SNR) measured at the receiver side. AM technique is employed within the systems of cooperative diversity in order to obtain throughput enhancement from SNR gain. The diversity is also considered another common technique that is employed in mitigating the fading effect. Time diversity methods are not able to be employed for channels of frequency non-selective and slow fading types. The AM and cooperative diversity techniques, which are considered two common and deployed algorithms in improving the wireless communication performance. This project investigated several studies that were introduced in the literature related to these two topics. The proposed methods, concepts, outcomes and considered conditions during the implementation or derivation were also discussed and compared. Each of the studies achieved a clear improvement within the wireless communication system upon considering several criteria, such as; throughput, SNR, SE and BER.

Key words: Adaptive modulation, encoding, hoping, relay, MATLAB, COOPTARIVE DIVERSITY

I. INTRODUCTION
The cooperative diversity is considered one of the efficient techniques that occurred recently in order to achieve reliable wireless communication. This reliability is achieved by employing a relay node between the transmitter and the receiver, which in turns forward the messages again toward the concerned destination. The cooperative communication is managed by employing several protocols that were suggested and investigated by the researchers during the last years; these protocols are primarily classified into either Amplify or Forward (AF) that includes amplifying the signals before forwarding it again toward the destination and Decode and Forward (DF) that includes decoding the signals before forwarding it. The signal received at a relay is usually processed before it is forwarded to the next relay or destination node. Although there are many signals relaying protocols, the most Common ones are the amplify-and-forward (AF) and decode and-forward (DF). In a DF relaying scheme the received signal is first decoded at the relay before it is re-encoded and forwarded to the next node. In an AF relaying system, the received signal is simply amplified and forwarded to the next node. As such, AF relaying is usually considered to be simpler to implement than DF relaying and is thus better suited for wireless applications that require simple relay units.

II. RELATED WORK
A. H. Bastami and A. Olfa report that Relayed signal can be laterexploited by the destination in order to enhance the Bit Error Probability (BEP).
H. Chen, M.H. Ahmed and R. Venkatesan employed AM technique within the systems of cooperative diversity in order to obtain throughput enhancement from SNR gain.
Ö. Özdemiri and T. Stated, The best achievable performance of relayed signal occurred in Case-2, while the most power saving can be achieved in Case-1.
In 2013, According to W. Song, P. Ju, and D. Zothe wireless medium broadcast nature can be utilized through employing relay node, which in turns enhance the reception quality.
A model for cooperative ARQ and AM techniques through which the delay restrictions can be transmitted by using these two techniques from the source toward the destination was proposed by J. S. Harsini and M. Zorzi.

III. BLOCK DIAGRAM

A. Transmitter
1) Inter-leaving
Inter-leavers are designed and used in the context of characteristics of the errors that might occur when the message bits are transmitted through a noisy channel. To understand the functions of an inter-leaver understanding of error characteristics is essential. Two types are errors
concern communication system design engineer. They are burst error and random error. Interleaving is a technique for making forward error correction more robust with respect to burst errors. An interleaver permutes symbols according to a mapping. Interleaving can be useful for reducing errors caused by burst errors in a communication system.

B. Random Errors

Error locations are independent of each other. Error on one location will not affect the errors on other locations. Channels that introduce these types of errors are called channels without memory (since the channel has no knowledge of error locations since the error on location does not affect the error on another location)

C. Error Correcting Codes

An error-correcting code is an algorithm for expressing a sequence of numbers such that any errors which are introduced can be detected and corrected (within certain limitations) based on the remaining numbers. The study of error-correcting codes and the associated mathematics is known as coding theory.

Error detection is much simpler than error correction and one or more "check" digits are commonly embedded in credit card numbers in order to detect mistakes. Early space probes like Mariner used a type of error-correcting code called a block code, and more recent space probes use convolution codes. Error-correcting codes are also used in CD players, high speed modems, and cellular phones. Modems use error detection when they compute checksums, which are sums of the digits in a given transmission modulo some number. The ISBN used to identify books also incorporates a check digit.

D. Modulation

Modulation is a process of mixing a signal with a sinusoid to produce a new signal. This new signal, conceivably, will have certain benefits over an un-modulated signal, f(t) = A sin(ot + p). We can see that this sinusoid has 3 parameters that can be altered, to affect the shape of the graph. The first term, A, is called the magnitude, or amplitude of the sinusoid. The next term, Q, is known as the frequency, and the last term, p, is known as the phase angle. All 3 parameters can be altered to transmit data. The sinusoidal signal that is used in the modulation is known as the carrier signal, or simply "the carrier". The signal that is used in modulating the carrier signal (or sinusoidal signal) is known as the "data signal" or the "message signal". It is important to notice that a simple sinusoidal carrier contains no information of its own. In other words we can say that modulation is used because some data signals are not always suitable for direct transmission, but the modulated signal may be more suitable.

E. Channel

1) Rayleigh Fading channel

The delays associated with different signal paths in a multipath fading channel change in an unpredictable manner and can only be characterized statistically. When there are a large number of paths, the central limit theorem can be applied to model the time-variant impulse response of the channel as a complex-valued Gaussian random process. When the impulse response is modeled as a zero mean complex-valued Gaussian process, the channel is said to be a Rayleigh fading channel.

The model behind Rician fading is similar to that for Rayleigh fading, except that in Rician fading a strong dominant component is present. This dominant component can for instance be the line-of-sight wave. The article gives a quick overview of a simple statistical multipath channel model called Rayleigh fading channel model. We assume a quasi-static flat fading Rayleigh channel, with coherence time $T_c$. For a flat fading channel, the fading coefficients $h_{ij}$ remain constant within a frame of length $T_c$ time slots and change into new ones from frame to frame. Also, we assume uncorrelated path gains (the distance between two antennas is more than half of the wavelength) which vary

$$ R_{xy} = \mathbb{E}(s[k]y^T) $$

is the cross correlation between received sequence and input sequence and

$$ R_{yy} = \mathbb{E}(y y^T) $$

is the auto-correlation of the received sequence.

For solving the Minimum Mean Square Error (MMSE) criterion, we need to find a set of coefficients $C$ which minimizes $\mathbb{E}(s[k]|y)$. Differentiation with respect to $c$ and equating to 0,

$$ \frac{\partial}{\partial c} \mathbb{E}(s[k]|y) = 0 $$

Simplifying,

$$ R_{xy} = \mathbb{E}(s[k]y^T) = h^T \mathbb{E}(s[k]y) = h^T \mathbb{E}(s[k]s^T) $$

$$ R_{yy} = \mathbb{E}(y y^T) $$

$$ = \mathbb{E}(h[k]s[k]s^T) + \mathbb{E}(h[k]n[k]s^T) + \mathbb{E}(h[k]s[k]n^T) + \mathbb{E}(n[k]n^T) $$

Note:

1) $\mathbb{E}(s[k]) = 0$ is the variance of the input signal?
2) $\mathbb{E}(s[k]s^T) = 0$ (As there is no correlation between input signal and noise)

Section headings are numbered 1. AAA, 2. BBB, etc. in 14 pt. bold “Small Caps” Times New Roman font with a 6 pt. line spacing following. Subsection headings are numbered 1.1. XXX, 1.2. YYY, etc. in 12 pt. bold Times New Roman font with a 6pt line spacing following.

F. Co-operative communication

Co-operative communication means it uses the relay in between the transmitter and receiver as shown below. Relay maybe two types AF relay and DF relay.

![Fig. 2: Co-Operative communication](https://example.com/fig2.png)

G. Software description

1) MATLAB (R2013)

MATLAB is a programming language developed by Math Works. It started out as a matrix programming language.
where linear algebra programming was simple. It can be run both under interactive sessions and as a batch job.

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPADSymbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science, and economics. MATLAB is widely used in academic and research institutions as well as industrial enterprises.

### H. Advantages
1. Better Performance
2. Provides robust features for classification.
3. Reliable.
4. Provide convenient service.

### I. Applications
1. Wireless Local Area Networks (LANs).
2. Digital Televisions Transmission (European and Australian standards).
3. ADSL (asymmetric digital subscriber loop), for high speed data transmission along existing telephone lines.
4. May be used in future Mobile communication.
6. It is used in CodeDivision Multiple Access (CDMA).

### IV. Conclusions
In this paper, we have reviewed the cooperative communication is managed by employing several protocols that were suggested and investigated by the researchers during the last years; these protocols are primarily classified into either Amplify or Forward (AF) that includes amplifying the signals before forwarding it again toward the destination and Decode and Forward (DF) that includes decoding the signals before forwarding it. The signal received at a relay is usually processed before it is forwarded to the next relay or destination node. Although there are many signals relaying protocols, the most Common ones are the amplify-and-forward (AF) and decode-and-forward (DF). In a DF relaying scheme the received signal is first decoded at the relay before it is re-encoded and Forwarded to the next node. In an AF relaying system, the received signal is simply amplified and forwarded to the next node. As such, AF relaying is usually considered to be simpler to implement than DF relaying and is thus better suited for wireless applications that require simple relay units.

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