Experiment No: 01

Experiment Name: Write a matlab program to evalute of a 1/2-rated convolutionally encoded DS CDMA system in AWGN channel.

Objective: The objective of this experiment to evalute the performance of a 1/2-rated convolutionally encoded Direct Sequence Code Division multiple access (DS-CDMA) system over an Additive white Gaussian Noise channel using matlab simulation.

Theory:

DS-CDMA System: DS-CDMA (Direct Sequence code division multiple access) is a spread spectrum technique where each user's data is multiplied by a high-rate pseudo-random code which

Spreads the bandwidth of the signal over a wider frequency range

Let the original data sequence be $d(t)$, and the spreading code be $c(t)$. The transmitted signal $s(t)$ in DS-CDMA is

$$s(t) = d(t) \cdot c(t)$$

where

$$d(t) \in \{-1, +1\}$$
$$c(t) \in \{-1, +1\}$$

Convolutional coding:

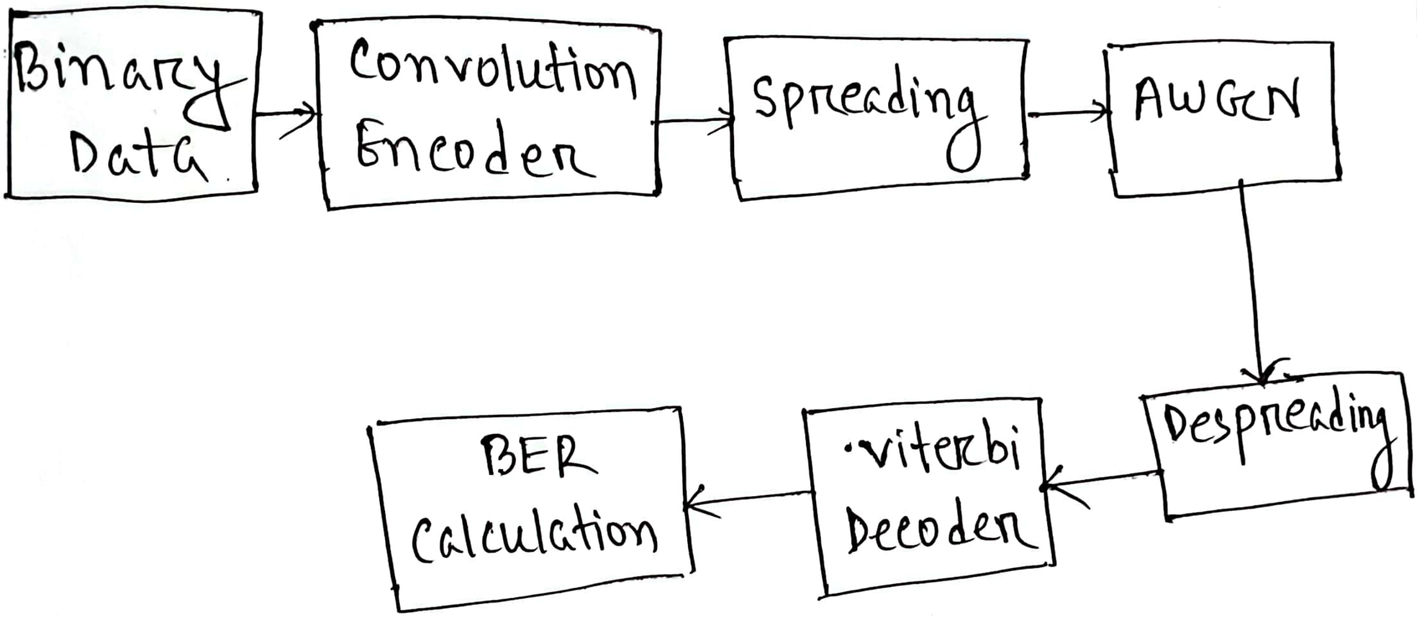
Convolutional codes are a type of error-correcting code where the output bits are generated by convolving the input bits with the code's generator polynomials.

For example, using polynomials $G_1 = 133_8$ and $G_2 = 171_8$ the encoded output can be expressed as:

$$V_1(n) = d(n) \oplus d(n-1) \oplus d(n-2)$$
$$V_2(n) = d(n) \oplus d(n-2)$$

AWGN channel: The AWGN channel introduce white Gaussian noise to the transmitted signal. used for modeling thermal noise in communication systems.

System block diagram:



Experiment No: 02

Experiment Name: Write a matlab Program to evalute performance of 1/2 rated convolutionally encodes DS CDMA system in AWGN and Rayligh fading channel.

Objective: The objective in this experiments is to evalute the bit error rate (BER) performance of a 1/2 rate convolutionally encoded direct sequence code division multiple access (DS-CDMA) system under two different channel condition.

Theory: Direct sequence code division multiple access (RDS-CDMA) is are spread spectrum technique in which each bit of data is multiplied by a high-rate pseduRandom noise (PN) sequence called a chip sequence. If the spreading sequence has a

L, the Processing gain (G_P) is given by

$$G_P = \frac{\text{chip rate}}{\text{Data rate}} = L$$

Convolutional encoding is a form of forward error correction (FEC) that introduce redundancy in the transmitted signal. A (1/2) rate convolutional code produces two output bits for every input bit data effectively doubling the data.

In digital communication system, the noise is commonly modled by an AWGN channel, where the received signal $r(t)$ is:

$$r(t) = s(t) + n(t)$$

Here $s(t)$ is the transmitted signal and $n(t)$ is additive white Guassian noise

Rayleigh fading channels on the other hand

$$r(t) = h(t) \cdot s(t) + n(t)$$

and $$BER = \frac{\text{Number of bits errors}}{\text{Total transmitted bits}}$$

Experiment No: 03

Experiment Name: Write a Matlab Program to evalute Performance of a 1/2-rated Convolutionally encoded DS CDMA system in AWGN and Rician fading channel.

Objective: The objectives of this experiment is to evalute the performance of a 1/2 rated convolutionally encoded DS-CDMA system under two different wireless channel condition. the additive Gaussian Noise (AWGN) channel and the rician fading channel.

Theory: DS-CDMA is Direct Sequence Code Division Multiple Access & Spread Spectrum technique where user data is multiplied by a high rate pseudo noise (PN) code before transmission.

Mathematically, the transmitted signal is

$$s(t) = d(t) \cdot c(t)$$

where, $d(t)$ is the binary data signal (± 1)

$c(t)$ is the spreading code (± 1, typically a PN sequence)

Convolutional Encoding: Convolutional Encoding add redundancy to the original data to enable error correction at the receiver

For example:

Generator polynomials: $G_1 = 133_8$, $G_2 = 171_8$

Now, $v_1(n) = d(n) \oplus d(n-1) \oplus \cdots$

$v_2(n) = d(n) \oplus d(n-2) \oplus \cdots$

AWGN channel: The additive white Gaussian noise channel introduces white noise with constant power spectral density.

$$r(t) = s(t) + n(t)$$

Rician Fading channel : The Rician fading channel models wireless environments where there is a dominant Line-of-Sight (LOS) path along with multiple scattered paths

$$r(t) = h(t) \cdot s(t) + n(t)$$

where, $h(t)$ is the Rician fading coefficient

$n(t)$ is Gaussian noise

BER Evaluation : To access system performance the bit error rate is calculated by comparing the transmitted data with the decoded data at the receiver of varying E_b/N_0 values.

$$BER = \frac{\text{Number of Bit Errors}}{\text{Total Transmitted Bits}}$$

Experiment No: 04

Experiment Name: Write a matlab Program to study the Performance of a differentially encoded OQPSK based wireless Communication system.

Objective: The objective of this experiment is to simulated and analyze the Bit Error Rate Performance of a differentially Encoded Offset Quadrature phase shift keying (OQPSK) based wireless communication system using matlab.

Theory:

OQPSK: Offset QPSK is a variation of QPSK where the Q component is delayed by half a symbol period relative to the component. It ensure that I and Q component do not change simultaneously mathmetically OQPSK represented by

$$s(t) = I(t) \cdot \cos(2\pi f_c t) + Q(t - T_s/2) \cdot \sin(2\pi f_c t)$$

where,

$I(t)$ and $Q(t)$ are pulse-shaped binary data

T_s is the symbol period

f_c is the carrier frequency

Differential Encoding: Differential encoding is used to overcome the phase ambiguity at the receiver.

Let the input bit be b_n, and output differentially encoded phase be θ_n:

$$\theta_n = \theta_{n-1} + \Delta\theta_n$$

AWGN channel: The additive white Gaussian Noise (AWGN) channel introduces random noise with Gaussian distribution

$$r(t) = s(t) + n(t)$$

Differential detection: At the receiver non-coherent differential detection compares the phase difference between consecutive symbols.

$$\Delta\theta = \arg(r_n \cdot r_{n-1}^{*})$$

BER Performance: The system's performance is measured using bit error Rate as a function of E_b/N_0

$$BER = \frac{\text{Number of Error}}{\text{Total transmitted Bits}}$$

Experiment No: 05 :

Experiment Name: Develop a Matlab source to simulate an Interleaved FEC encoded wireless Communication System with implementation of BPSK digital modulation technique. Show at least three wave from generated at different section of the simulated system.

Objective: The objective of this simulation is to develop a wireless communication system model that incorporates

i) Forward Error Correction encoding
ii) Interleaving
iii) BPSK digital modulation

Theory: FEC is a technique where redundant bits are added to the transmitted data so that the receiver can detect and correct errors without needing retransmission

$$output = d(n) * g_1 + d(n) * g_2$$

Interleaving rearrange the order of encoded bits to spread out potential burst errors. It increases the effectiveness of error correction by making error appear random instead of clustered.

Binary phase shift keying (BPSK) is a digital modulation scheme where each bit is represented by a different phase of the carrier:

$$s(t) = \sqrt{2E_b} \cdot \cos(2\pi f_c t + \pi b)$$

where $b = 0 \Rightarrow 0°$
$b = 1 \Rightarrow 180°$
$0 \rightarrow +1$
$1 \rightarrow -1$

Three important signal stages are visualized

1) Original message Bits (binary signal)

2) BPSK modulated signal

3) Received signal (after AWGN)

Experiment no:06

Experiment name: Develop a matlab source to simulate an Interleaved FEC encoded wireless communication system. with implementation of QPSK digital modulation technique. show at least three waveforms generated at different sections of the simulated system

Objective: The objective of this experiment is to simulate a wireless communication system that uses Forward Error Correction (FEC) with interleaving, and applies Quadrature phase shift keying (QPSK) as the digital modulation technique.

Theory: FEC is used to detect and correct bit errors at the receiver without retransmission. A common FEC technique is convolutional coding, which uses shift registers and generator polynomials to encode data with redundancy we know that,

Encoded bits = f(current bit, previous bits)

Interleaving is a technique that reorders the bits to spread out burst error across time making them appear as random errors.

Quadrature phase shift keying (QPSK) maps every two bits to one of four distinct phases of a carrier signal.

The four QPSK symbols are:

00 → +1 + j1

01 → −1 + j1

11 → −1 − j1

10 → +1 − j1

the transmitted QPSK signal is:

$$s(t) = \sqrt{\frac{2E_b}{T}}\left[I(t)\cos(2\pi f_c t) - Q(t)\sin(2\pi f_c t)\right]$$

where,

$I(t)$, $Q(t)$ are in-phase and quadrature components

E_b is bit energy

f_c is carrier frequency

Experiment No: 07

Experiment Name: Develop a matlab source to simulate an Interleaved FEC encoded wireless communication system with implementation of 4-QAM digital modulation technique. show at least three waveforms generated at different sections of the simulated.

Objective: The objective of this simulation to analyze the performance of a wireless communication system that employs:

i) Forward Error Correction
ii) Interleaving, and
iii) 4-QAM digital modulation.

Theory:

Forward Error Correction: FEC improves the reliability of data transmission by introducing controlled redundancy. A widely used FEC method is convolutional coding, which uses shift registers and generator polynomials to output. encoded data.

Interleaving: Interleaving is a bit rearrangement Process but combats burst error. Instead of sending bits in order, interleaving spreads them across time so that consecutive bits are less.

4-QAM modulation: 4-QAM also called QPSK, uses two carriers (I and Q) to transmit two bits per symbol. The modulation maps 2-bit symbol to one of four constellation points

00 → $-1-j1$
01 → $-1+j1$
10 → $+1-j1$
11 → $+1+j1$

The transmitted signal is

$$s(t) = I(t) \cdot \cos(2\pi f_c t) + Q(t) \cdot \sin(2\pi f_c t)$$

where, $I(t)$ and $Q(t)$ are the in-phase and quadrature amplitudes

f_c is the carrier frequency

Experiment No: 08

Experiment Name: Develop a matlab source to simulate an Interleaved FEC encoded wireless communication system with implementation of 16-QAM digital modulation technique. show at least three waveforms generated at different sections of the simulated ~~signal~~ system.

Objective: The objective of this simulation is to design and evaluate a wireless communication system that uses:

i) Forward Error Correction coding
ii) Interleaving
iii) 16-QAM
iv) AWGN channel.

Theory :

Forward Error Correction (FEC):

FEC adds redundant bits to the transmitted data two allow the receiver to detect and correct errors with the need for retransmission.

$$\text{Number of output bits} = \text{Input bits} \times \frac{1}{\text{code rate}}$$

Interleaving: Interleaving helps mitigate burst errors by rearrangement the sequence of codded bits before transmission.

i) Block Interval
ii) Deinterleaver.

16-QAM modulation: 16-QAM modulation is a digital modulation technique that combines amplitude and phase modulation. Each symbol in 16-QAM represent 4 bits

For Example,

$0000 \rightarrow -3-3j$
$0001 \rightarrow -3-1j$
$1111 \rightarrow +3+3j$
......

The modulated signal can be expressed as:

$$s(t) = I(t) \cdot \cos(2\pi f_c t) + Q(t) \cdot \sin(2\pi f_c t)$$

where:

$I(t), Q(t) \in \{\pm 1, \pm 3\}$
f_c is the frequency

AWGN channel: The Additive white Gaussian Noise (AWGN) channel Gaussian noise to the transmitted signal:

$$r(t) = s(t) + n(t)$$

where $n(t)$ is Gaussian noise with zero mean and variance $N_0/2$.