Feedback Diversity System in Wireless Communication

July 21, 2024

Abstract

This report presents the implementation and simulation of a feedback diversity system for wireless communication using MATLAB and Simulink. The system aims to improve signal reliability by selecting the stronger signal between two SISO fading channels and applying a moving average filter for noise reduction.

Contents

1 Introduction

Feedback diversity is a technique used in wireless communication to enhance signal reliability and quality by utilizing multiple transmission paths and selecting the best signal based on feedback from the receiver. This project demonstrates the implementation of a feedback diversity system using MATLAB and Simulink.

2 Project Description

The feedback diversity system enhances wireless communication by utilizing two SISO fading channels and AWGN channels. The key steps include:

1. Generating a sine wave input signal.
2. Quantizing the signal for 8-PSK modulation.
3. Modulating the signal using an 8-PSK modulator.
4. Passing the signal through SISO fading channels and AWGN channels.
5. Using a feedback diversity selector to choose the stronger signal.
6. Applying a moving average filter to smooth the selected signal.
7. Displaying the final output on a Scope.

3 Methodology

3.1 Simulink Model

The Simulink model for the feedback diversity system includes the following components:

1. **Input Signal**: A sine wave generator.
2. **Quantizer**: Converts the sine wave into discrete levels suitable for 8-PSK modulation.
3. **Modulator**: An 8-PSK modulator.
4. **Channels**: SISO fading channels and AWGN channels.

5. **Feedback Selector**: Compares the signal strengths and selects the best signal.
6. **Moving Average Filter**: Reduces noise by smoothing the signal.
7. **Output Scope**: Displays the final processed signal.

3.2 MATLAB Code

The MATLAB code generates the input signal, processes it through quantization, modulation, and filtering, and simulates the channels. The key steps include:

1. Generating a sine wave input signal.
2. Quantizing the signal for 8-PSK modulation.
3. Modulating the signal using an 8-PSK modulator.
4. Passing the signal through SISO fading channels and AWGN channels.
5. Using a feedback diversity selector to choose the stronger signal.
6. Applying a moving average filter to smooth the selected signal.
7. Displaying the final output.

Listing 1: MATLAB Code for Feedback Diversity System

```
% MATLAB Code for Feedback Diversity System
fs = 1000; % Sampling frequency
t = 0:1/fs:1-1/fs; % Time vector
f = 5; % Frequency of sine wave
x = sin(2*pi*f*t); % Sine wave

% Quantization for 8-PSK modulation
M = 8; % Modulation order
x_quantized = round((x+1)*((M-1)/2)); % Quantize the
    sine wave

% 8-PSK modulation
modulated_signal = pskmod(x_quantized, M);

% SISO Fading Channel
```

```
siso_channel = comm.SISOFlatFadingChannel('SampleRate',
    fs);
faded_signal = siso_channel(modulated_signal);

% AWGN Channel
awgn_channel = comm.AWGNChannel('NoiseMethod', 'Signal-
   to-noise ratio (SNR)', 'SNR', 20);
noisy_signal = awgn_channel(faded_signal);

% Feedback Diversity Selector (assuming selection based
    on signal power)
feedback_selector = comm.MIMOChannel('
   NumTransmitAntennas', 2, 'NumReceiveAntennas', 1);
selected_signal = feedback_selector(noisy_signal);

% Moving Average Filter
N = 10; % Window size
moving_average_filter = dsp.MovingAverage('Method', '
   Sliding-window', 'SpecifyWindowLength', true, '
   WindowLength', N);
filtered_signal = moving_average_filter(selected_signal
   );

% Output display
figure;
subplot(3,1,1);
plot(t, x);
title('Original Sine Wave');

subplot(3,1,2);
plot(t, real(modulated_signal(1:length(t))));
title('Modulated Signal');

subplot(3,1,3);
plot(t, real(filtered_signal(1:length(t))));
title('Filtered Signal');
```

4 Simulation

The simulation is performed using the Simulink model and the MATLAB code. The steps involved include:

1. Running the Simulink model.
2. Executing the MATLAB code to generate and process the signal.
3. Observing the output signals on the Scope and MATLAB plots.

5 Results

The results show the effectiveness of the feedback diversity system in improving signal reliability and quality. The output plots demonstrate the following:

1. The original sine wave signal.
2. The modulated 8-PSK signal.
3. The filtered signal after passing through the SISO fading channel, AWGN channel, feedback selector, and moving average filter.

6 Conclusion

The feedback diversity system successfully enhances wireless communication by selecting the stronger signal between two SISO fading channels and applying a moving average filter for noise reduction. The Simulink model and MATLAB code provide a comprehensive simulation of this system, demonstrating its benefits and effectiveness.

7 Contributing

Contributions to this project are welcome. Please follow the standard GitHub workflow for contributing:

1. Fork the repository.
2. Create a new branch for your feature or bugfix.
3. Commit your changes.
4. Push your changes to your fork.
5. Submit a pull request.