WIRELESS IMAGE TRANSMISSION

Language/Tools used: MATLAB
Name: Mounika Imadabathuni
Roll no: 23WH1A0492

1.Abstract:

This project demonstrates the simulation of a wireless image transmission system using MATLAB. An image is converted into a binary data stream, modulated using QPSK, transmitted through a noisy wireless channel, and reconstructed at the receiver. The effects of noise on image quality are analyzed using Bit Error Rate (BER) vs Signal-to-Noise Ratio (SNR) plots. This project integrates MATLAB basics, image processing, signal processing, and wireless communications concepts.

2.Introduction:

- Digital communication plays a vital role in multimedia transmission. Images sent over wireless channels are affected by noise and fading, which degrade quality. MATLAB provides an effective platform to simulate such systems and study their performance.

- This project aims to build a simulation where an image is transmitted using Quadrature Phase Shift Keying (QPSK) modulation over an Additive White Gaussian Noise (AWGN) channel, and the received image is reconstructed and compared with the original.

3.System Design:

3.1. Image Preprocessing

In this step, a grayscale image is loaded and resized to reduce processing complexity. The pixel values are converted into an 8-bit binary format and arranged as a serial bitstream, preparing the data for digital transmission.

```
img = imread('cameraman.tif');
img_resized = imresize(img, [128 128]);
img_bin = de2bi(img_resized(:), 8, 'left-msb');
bitstream = img_bin(:);
```

3.2.QPSK Modulation

The bitstream is grouped into pairs and mapped into QPSK symbols. QPSK (Quadrature Phase Shift Keying) is chosen because it balances efficiency and robustness. The modulated signal is now ready to be transmitted through the wireless channel.

```
M = 4;

symbols = bi2de(reshape(bitstream, log2(M), []).','left-msb');

tx_sig = pskmod(symbols, M, pi/4);

SNR_dB = 0:5:30;

ber = zeros(size(SNR_dB));
```

3.3.Wireless Channel and Demodulation

The modulated signal passes through an **AWGN (Additive White Gaussian Noise)** channel for different SNR values. At the receiver, the signal is demodulated, and the bitstream is reconstructed. The received image is then rebuilt, and the Bit Error Rate (BER) is calculated for performance evaluation.

```
for i = 1:length(SNR_dB)
    rx_sig = awgn(tx_sig, SNR_dB(i), 'measured');
    rx_sym = pskdemod(rx_sig, M, pi/4);
    rx_bits = de2bi(rx_sym, log2(M), 'left-msb');
    rx_bitstream = rx_bits(:);
    [~, ber(i)] = biterr(bitstream, rx_bitstream);

    rx_pixels = bi2de(reshape(rx_bitstream, 8, []).','left-msb');
    rx_img = reshape(uint8(rx_pixels), size(img_resized));
end
```

3.4.Results & Performance Analysis

Finally, the results are visualized. A **BER vs. SNR curve** is plotted, showing that BER decreases as SNR increases. Side-by-side image comparison illustrates how the received image quality improves significantly at higher SNR values.

```
figure; semilogy(SNR_dB, ber, '-o');
xlabel('SNR (dB)'); ylabel('BER');
title('BER vs SNR for QPSK Image Transmission'); grid on;

figure;
subplot(1,2,1); imshow(img_resized); title('Original Image');
subplot(1,2,2); imshow(rx_img);
title(['Received Image at ', num2str(SNR_dB(end)), ' dB']);
```

4.Results

1. At **low SNR (0–5 dB)**, the received image is highly distorted due to noise, and BER is very high.

2. At **moderate SNR (10–20 dB)**, the image quality improves and BER reduces noticeably.

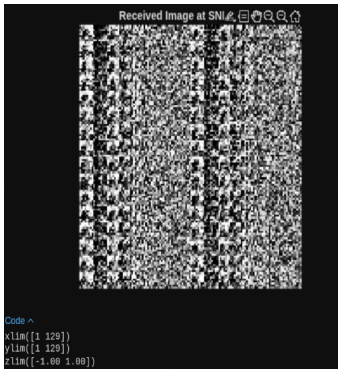
3. At **high SNR (25–30 dB)**, the received image is almost identical to the original, with very low BER.

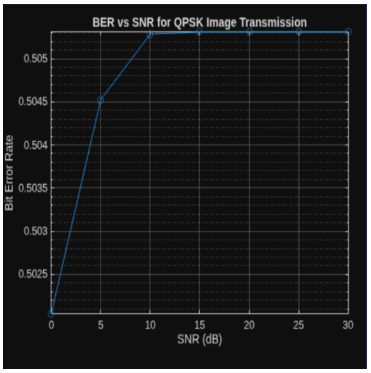
4. The **BER vs. SNR curve** confirms the inverse relation: as SNR increases, BER decreases exponentially.

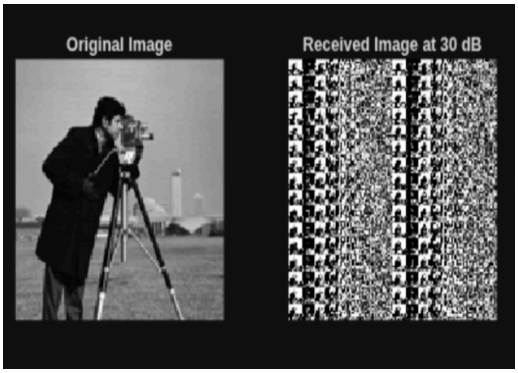
5.Applications

- Satellite image transmission
- Telemedicine (remote medical imaging)
- Military & surveillance communication
- Multimedia sharing in mobile networks
- Wireless sensor networks & IoT

6.Output Images







7.Conclusion

The project successfully simulates wireless image transmission in MATLAB. The results show that image quality improves as SNR increases, confirming that noise significantly affects wireless communication performance. This project demonstrates practical applications of MATLAB in digital communications by combining fundamentals of image processing, signal processing, and wireless communications.

8.References

MathWorks – *MATLAB Documentation: Image Processing Toolbox*.
https://www.mathworks.com/help/images/

MathWorks – *Communications Toolbox Documentation*.
https://www.mathworks.com/help/comm/

Proakis, J. G., & Salehi, M. – *Digital Communications*, McGraw-Hill Education, 5th Edition.

Sklar, B. – *Digital Communications: Fundamentals and Applications*, 2nd Edition, Prentice Hall.

TutorialsPoint – *MATLAB Programming Basics*.
https://www.tutorialspoint.com/matlab/index.htm