Image Noise Reduction Using Singular Value Decomposition (SVD)

Methodology

Task 1: Load and Display Grayscale Image

In this task, we load an image of our choice into MATLAB, convert it to grayscale, and plot the initial grayscale image.

Task 2: Add Three Types of Noise

We add three types of noise to the grayscale image: Gaussian, salt and pepper, and speckle noise. The noisy images are then displayed.

Task 3: Singular Value Decomposition and Cumulative Singular Values

For each noisy image, we perform Singular Value Decomposition (SVD) to obtain the singular values. We calculate the cumulative sum of singular values and visualize the results.

Task 4: Image Reconstruction and RMSE Calculation

We reconstruct the noisy images using different numbers of singular values and calculate the Root Mean Square Error (RMSE) between the reconstructed and original grayscale image. The RMSE values are plotted against the number of singular values considered.

Task 5: Finding the Optimal Number of Singular Values

We analyze the RMSE plots to determine the optimal number of singular values for noise reduction in each case and record these optimal values.

Task 6: Image Compression

We calculate the compression ratio for each noisy image using the optimal number of singular values. This metric indicates how much the image has been compressed while maintaining quality.

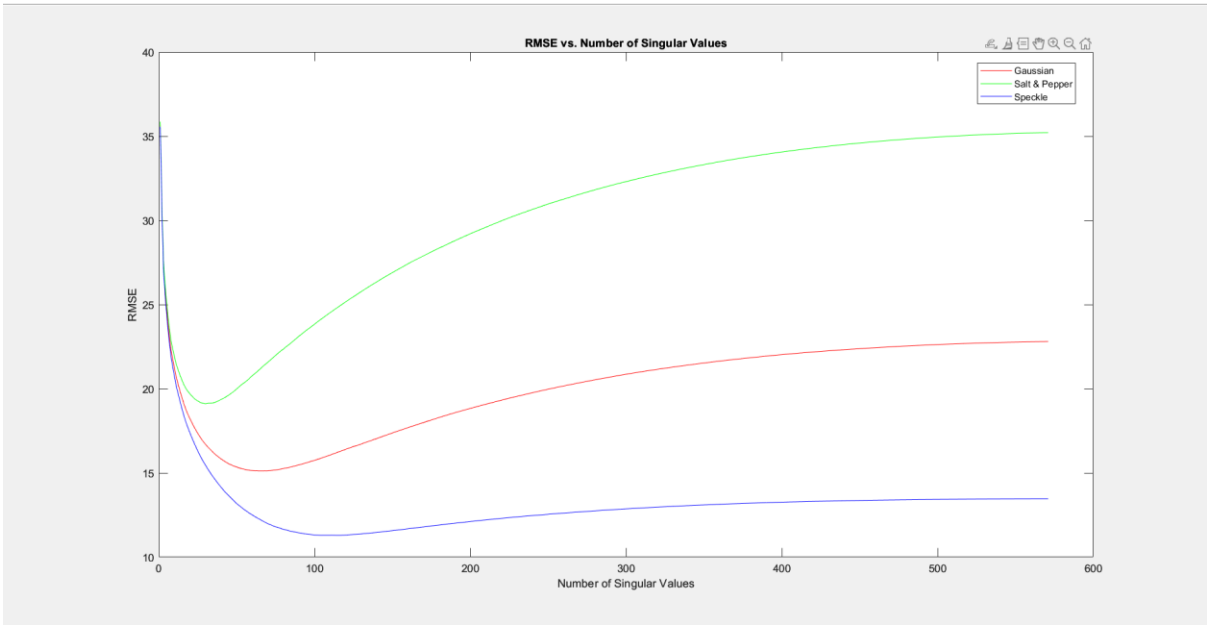
Results

Task 3: Cumulative Singular Values

Below are the Noisy Images.

Task 4: RMSE vs. Number of Singular Values

The RMSE values plotted against the number of singular values considered for each noise type illustrate...



RMSE vs. Number of Singular Values

Task 5: Optimal Number of Singular Values

The optimal number of singular values for each noise type is as follows:

Optimal Singular Values for Gaussian Noise: 66

Optimal Singular Values for Salt & Pepper Noise: 30

Optimal Singular Values for Speckle Noise: 115

Task 6: Image Compression

The compression ratios for each noise type, using the optimal number of singular values, are as follows:

Compression Ratio for Gaussian Noise: 17.88

Compression Ratio for Salt & Pepper Noise: 8.80

Compression Ratio for Speckle Noise: 29.99

Discussion

In this study, we explored the application of Singular Value Decomposition (SVD) for image noise reduction. The analysis of cumulative singular values and RMSE plots allowed us to determine the optimal number of singular values for noise reduction. Additionally, we calculated the compression ratios to assess the level of image compression achieved.