**Digital Image Processing Laboratory**

Experiment Report

Experiment Title Image Restoration

Student’s Name 蒋云翔

Student’s ID 2022102330

Class 22CST

Date handed in 2024/12/10

International school, Jinan University

**A. Objectives**

(1) To know the concept of image restoration.

(2) To know basic function of image restoration in MATLAB

(3) To be able to evaluate different restoration methods and select the best one.

**B. Technique**

In this project, **N1580854213\_1.IMG**, **N1846930971\_1.IMG.jpeg**, **N1848504927\_1.IMG.jpeg**, **N1853088917\_1.IMG.jpeg** will be used to accomplish this lab by various image restoration methods.

**C. Experiment Content**

The goal of this experiment was to recover images affected by noise and remove zebra stripes. In MATLAB, we can try a variety of recovery methods to remove noise.

First, load the image file using MATLAB. Since noise may behave in a particular pattern in the frequency domain, the frequency domain features of the image can be observed using the Fourier transform. And then we compare it to the original image.图形用户界面

中度可信度描述已自动生成

Figure 1: Frequency domain features of images

By observing the frequency domain features of Fourier transform images, we can find that:

* **Original Image:**

1. Horizontal periodic streaks can be clearly seen in both images, which is known as "zebra stripe noise".
2. This noise appears as parallel lines and is usually due to periodic errors in the sensor or high-frequency noise introduced during transmission.

* **Frequency Spectrum of Image:**

1. Central highlight: corresponds to the low-frequency component of the image, indicating the overall intensity of the image or a large range of smooth changes.
2. Horizontal bright lines: These are the frequency features of fringe noise, shown in the high frequency region near the horizontal direction.

By observing the characteristics of the frequency domain, we finally decided to use low-pass filtering, high-pass filtering, and median filtering

图形用户界面, 应用程序

描述已自动生成

Figure 2: High pass Filtered image

We can observe that the application of high-pass filter to process the image is not good, this is because the high-pass filter is usually used to enhance the edge and detail of the image, it does not remove noise but may exacerbate the effect of high-frequency noise, so it is not suitable for removing zebra stripes.

图片包含 图形用户界面

描述已自动生成

Figure 3: Low Pass Filtered image

Since fringe noise is periodic high-frequency noise, low-pass filtering is a natural choice to effectively remove the effect of these horizontal bright lines. Low-pass filtering preserves low-frequency components of the image (such as background and main structure) and weakens or removes high-frequency components (such as noise).

图形用户界面, 应用程序

描述已自动生成

Figure 4: Median Filtered image

Median filtering is a simple and efficient method for noise with local characteristics such as zebra stripes. Median filtering can effectively remove noise similar to stripes by replacing the pixel value with the local median.

**D. Code structure**

The code to implement the above functions is as follows:

|  |
| --- |
| % Image Restoration Experiment  % 1. Load images  img1 = imread("C:\Users\86136\Desktop\Digital Image processing\Lab\DIP LAB\lab 5\N1580854213\_1.IMG.jpeg"); % Load the first image  img2 = imread("C:\Users\86136\Desktop\Digital Image processing\Lab\DIP LAB\lab 5\N1846930971\_1.IMG.jpeg"); % Load the second image  % 2. Display original images  figure;  subplot(2,2,1);  imshow(img1);  title('Original Image 1');  subplot(2,2,2);  imshow(img2);  title('Original Image 2');  % 3. Fourier Transform and Frequency Spectrum  fft\_img1 = fftshift(fft2(img1));  fft\_img2 = fftshift(fft2(img2));  % Display the frequency spectrum (log scale)  subplot(2,2,3);  imshow(log(1 + abs(fft\_img1)), []);  title('Frequency Spectrum of Image 1');  subplot(2,2,4);  imshow(log(1 + abs(fft\_img2)), []);  title('Frequency Spectrum of Image 2');  % 4. Low-pass Filtering (using average filter)  h\_lp = fspecial('average', [5 5]);  img\_lp\_filtered1 = imfilter(img1, h\_lp);  % Display low-pass filtered image  figure;  imshow(img\_lp\_filtered1);  title('High-pass Filtered Image 1');  % 5. High-pass Filtering (using Sobel filter)  h\_hp = fspecial('sobel');  img\_hp\_filtered1 = imfilter(img1, h\_hp);  % Display high-pass filtered image  figure;  imshow(img\_hp\_filtered1);  title('Low-pass Filtered Image 1');  % 6. Median Filtering  img\_median\_filtered1 = medfilt2(img1, [3 3]);  % Display median filtered image  figure;  imshow(img\_median\_filtered1);  title('Median Filtered Image 1');  % 7. Image Comparison and Evaluation (PSNR)  % Assuming you have the original noise-free images for PSNR calculation  % original\_img1 = imread('path\_to\_original\_image1'); % Path to the original image  % original\_img2 = imread('path\_to\_original\_image2'); % Path to the original image  % Calculate PSNR between original and filtered images  psnr\_lp = psnr(img\_lp\_filtered1, img1); % Low-pass filtered PSNR  psnr\_hp = psnr(img\_hp\_filtered1, img1); % High-pass filtered PSNR  psnr\_median = psnr(img\_median\_filtered1, img1); % Median filtered PSNR  % Display PSNR values  disp('PSNR values:');  disp(['Low-pass Filter PSNR: ', num2str(psnr\_lp)]);  disp(['High-pass Filter PSNR: ', num2str(psnr\_hp)]);  disp(['Median Filter PSNR: ', num2str(psnr\_median)]);  % 8. Conclusion and Report  % In your report, include:  % - The method you chose to recover the image.  % - Explanation of why the method was chosen.  % - Original and restored images.  % - PSNR comparison between the methods. |

**E. Conclusions**

In this experiment, we explored various image restoration techniques to remove periodic zebra stripe noise from degraded images of Saturn's satellite, Helene, captured by the Cassini spacecraft. The main objectives were to understand the concepts of image restoration, utilize MATLAB functions for processing, and evaluate the effectiveness of different restoration methods.

We applied several filtering techniques, including ***low-pass filtering, high-pass filtering, and median filtering***, to suppress the stripe noise and restore the original images. The frequency spectrum analysis revealed that the zebra stripes correspond to specific frequency components, primarily in the horizontal direction. This insight guided the selection of appropriate filters.