Image Processing Techniques Applied to MRI Image

Assignment BID-21001

1. Introduction

This report presents the application of various image processing techniques to an MRI image of the knee. The goal is to enhance the image for better visualization and analysis. The techniques applied include contrast enhancement, histogram equalization, noise reduction, edge detection, and image sharpening. Each technique is discussed in terms of its purpose and effect on the image.

2. Image Processing Techniques

2.1. Image Loading and Grayscale Conversion

The MRI image was loaded and converted to grayscale. This step is essential as it simplifies the processing by reducing the image to a single channel, which is particularly useful for subsequent image enhancement techniques.

2.2. Contrast Enhancement

Technique: imadjust
Purpose: Contrast enhancement adjusts the intensity values of the image to improve the visibility of details. It stretches the histogram of the image to span the full range of intensity values, thus enhancing the contrast.
Result: The contrast-enhanced image exhibits improved differentiation between various tissue types and structures in the MRI image.

2.3. Histogram Equalization

Technique: histeq
Purpose: Histogram equalization improves the contrast of an image by redistributing the intensity values. It aims to achieve a uniform distribution of intensities, making the features in the image more discernible.
Result: The histogram-equalized image shows enhanced contrast and better-defined features, which can assist in the identification of subtle details.

2.4. Noise Reduction

Technique: Median Filtering (medfilt2)
Purpose: Median filtering is a non-linear technique used to reduce noise while preserving edges. It works by replacing each pixel value with the median value of the pixels in a specified neighborhood.
Result: The median-filtered image demonstrates a reduction in noise, leading to a cleaner and more refined visual representation of the structures within the MRI.

2.5. Edge Detection

Technique: Sobel Operator (edge with 'sobel' method)
Purpose: Edge detection identifies and highlights the boundaries of structures within the image. The Sobel operator is used here to detect edges by calculating the gradient magnitude of the image.
Result: The edge-detected image highlights the outlines of structures, which can be valuable for diagnosing and analyzing the anatomical features present in the MRI.

2.6. Image Sharpening

Technique: Unsharp Masking (imsharpen)
Purpose: Image sharpening enhances the details and edges by increasing the contrast of the pixels. Unsharp masking applies a high-pass filter to the image to accentuate fine details.
Result: The sharpened image shows clearer and more pronounced details, which can aid in more accurate interpretation and analysis of the MRI.

3. Results

The processed images were displayed in a figure with subplots for visual comparison. Each image processing technique was applied sequentially, and the results were evaluated based on the enhancement and clarity provided:

- Original Grayscale Image: Shows the unprocessed MRI image.
- Contrast Enhanced Image: Displays improved contrast.
- Histogram Equalized Image: Shows a more uniformly distributed intensity range.
- Median Filtered Image: Demonstrates reduced noise.
- Edge Detection (Sobel): Highlights structural boundaries.
- Sharpened Image: Shows enhanced fine details.

4. Conclusion

The application of these image processing techniques has significantly enhanced the MRI image, making it easier to analyze and interpret. Each technique contributed to improving different aspects of the image, such as contrast, clarity, and detail. This comprehensive approach allows for better visualization of anatomical features, which is crucial for diagnostic and research purposes.

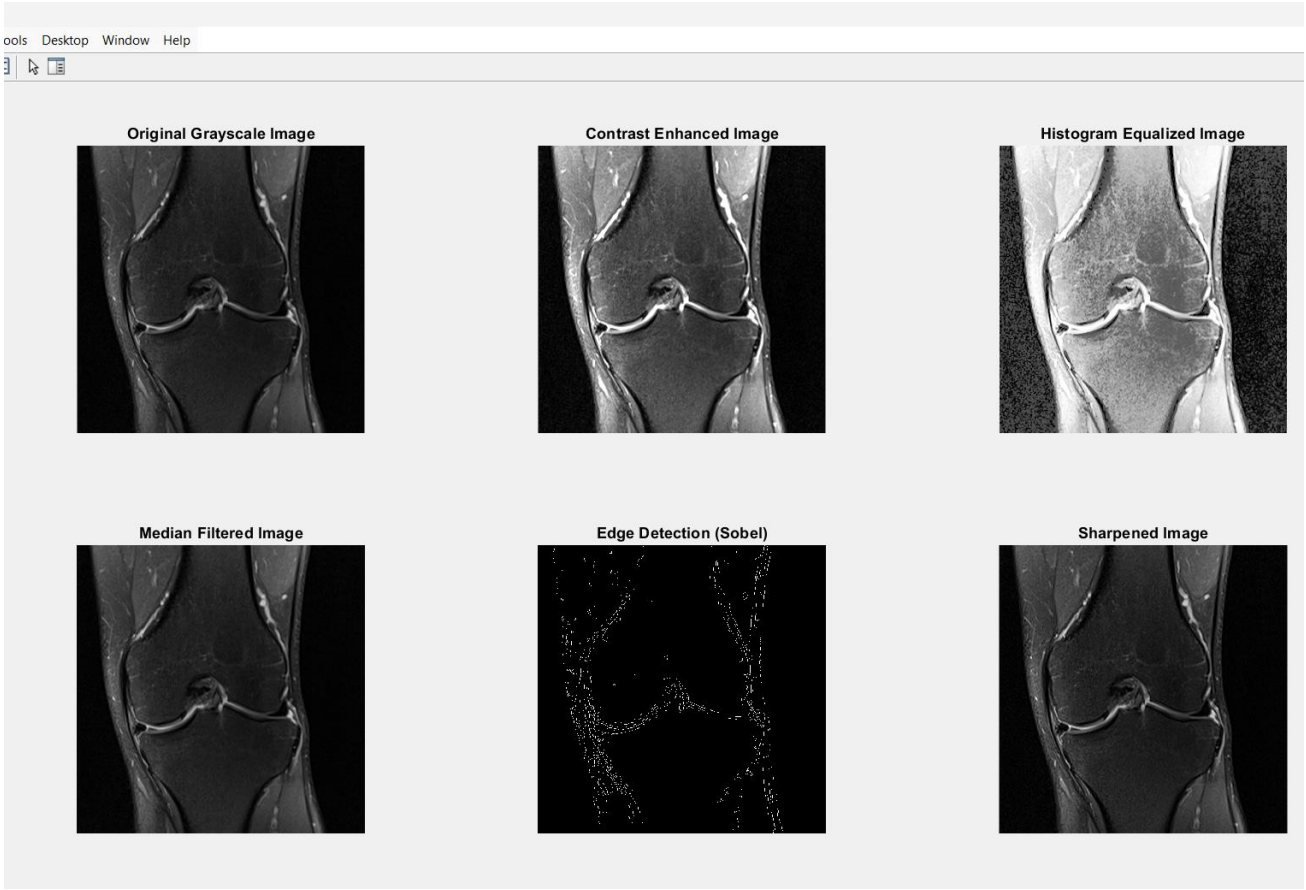
CODE:

Editor - C:\Users\hiadi\OneDrive\Desktop\bid\dip\assignment.m

assignment.m

```
% Load the image
img = imread('C:\Users\hiadi\OneDrive\Desktop\bid\dip\knee mri.png');

% Convert to grayscale
if size(img, 3) == 3
    gray_img = rgb2gray(img);
else
    gray_img = img;
end

% 1. Contrast Enhancement using imadjust
adjusted_img = imadjust(gray_img);

% 2. Histogram Equalization
equalized_img = histeq(gray_img);

% 3. Noise Reduction using Median Filter
median_filtered_img = medfilt2(gray_img, [3 3]);

% 4. Edge Detection using Sobel operator
edges_img = edge(gray_img, 'sobel');

% 5. Image Sharpening using Unsharp Masking
sharpened_img = imsharpen(gray_img, 'Radius', 2, 'Amount', 1);

% Displaying all results in a single figure
figure;

subplot(2, 3, 1); imshow(gray_img);
title('Original Grayscale Image');

subplot(2, 3, 2); imshow(adjusted_img);
title('Contrast Enhanced Image');

subplot(2, 3, 3); imshow(equalized_img);
title('Histogram Equalized Image');

subplot(2, 3, 4); imshow(median_filtered_img);
title('Median Filtered Image');

subplot(2, 3, 5); imshow(edges_img);
title('Edge Detection (Sobel)');

subplot(2, 3, 6); imshow(sharpened_img);
title('Sharpened Image');
```

OUTPUT:


ools Desktop Window Help
Original Grayscale Image
Contrast Enhanced Image
Histogram Equalized Image
Median Filtered Image
Edge Detection (Sobel)
Sharpened Image