Assignment: Implementation of Image Processing Techniques

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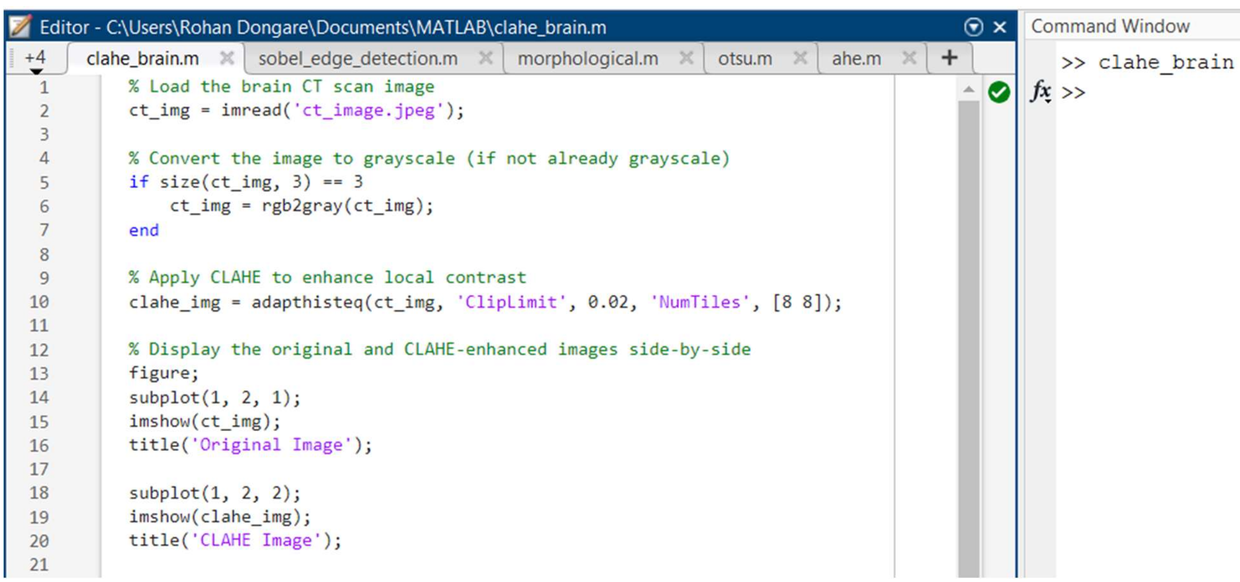
Technique Utilized 1:

In this technique, I am utilizing **Contrast Limited Adaptive Histogram Equalization (CLAHE)** for enhancing the contrast of a brain CT scan image.

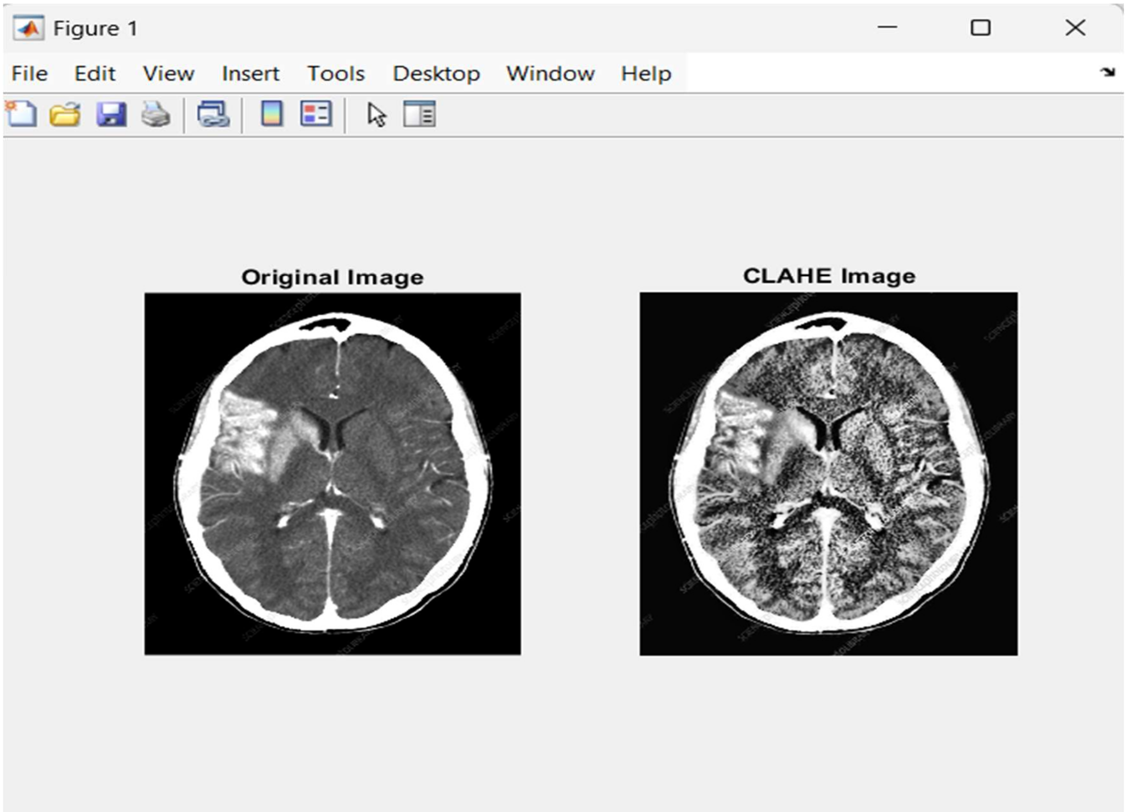
Rationale for Using the Technique:

CLAHE was chosen for its ability to improve the local contrast of an image, which is crucial for visualizing details in medical imaging. Traditional histogram equalization may not be effective for all areas of the image, as it can enhance noise in uniform regions. CLAHE addresses this by applying contrast enhancement in localized regions of the image, thus preserving the overall quality and reducing the amplification of noise.

Results and Outcomes:




```matlab
% Load the brain CT scan image
ct_img = imread('ct_image.jpeg');

% Convert the image to grayscale (if not already grayscale)
if size(ct_img, 3) == 3
    ct_img = rgb2gray(ct_img);
end

% Apply CLAHE to enhance local contrast
clahe_img = adapthisteq(ct_img, 'ClipLimit', 0.02, 'NumTiles', [8 8]);

% Display the original and CLAHE-enhanced images side-by-side
figure;
subplot(1, 2, 1);
imshow(ct_img);
title('Original Image');

subplot(1, 2, 2);
imshow(clahe_img);
title('CLAHE Image');
```



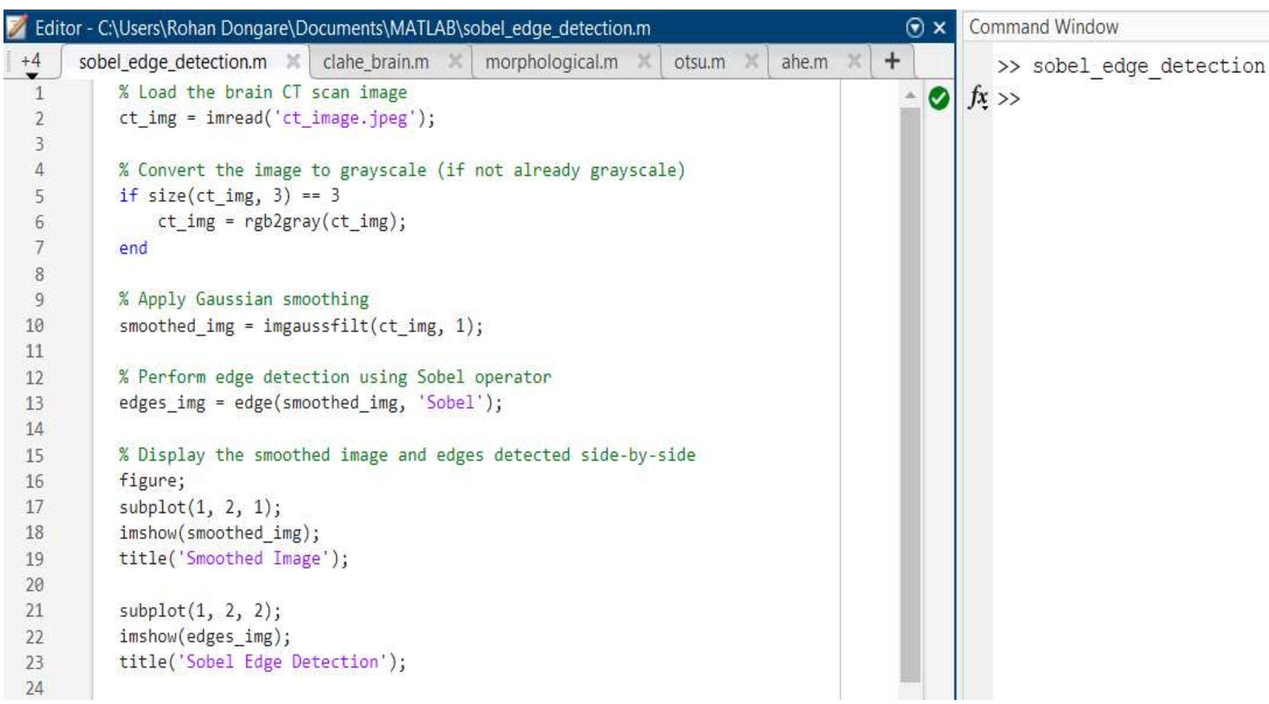
The application of CLAHE resulted in a noticeable improvement in the visibility of structural details within the brain CT scan image. The enhanced image displayed more distinct contrast in areas that were previously difficult to differentiate. This enhancement facilitates better analysis and interpretation of the image, particularly for detecting subtle features that are critical in medical diagnostics. The side-by-side comparison of the original and CLAHE-enhanced images clearly shows the effectiveness of the technique in improving local contrast.

Technique Utilized 2:

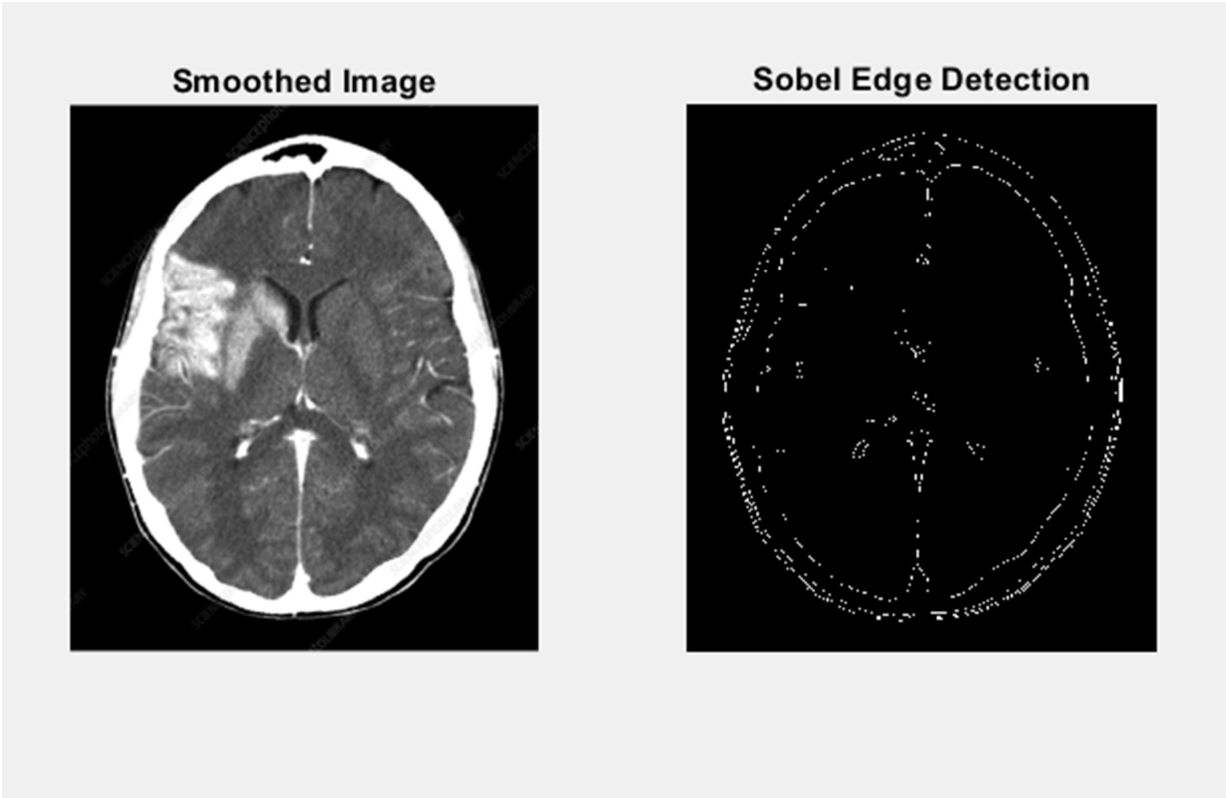
In this technique, I am utilizing **Gaussian Smoothing** followed by **Sobel Edge Detection** for processing and analyzing a brain CT scan image.

Rationale for Using the Technique:

1. **Gaussian Smoothing**: This technique was chosen to reduce noise and smooth the image. Gaussian smoothing helps in diminishing the impact of high-frequency noise while preserving important structures within the image. This is crucial for preparing the image for edge detection, as it ensures that the detected edges are more accurate and less affected by noise.
2. **Sobel Edge Detection**: Sobel edge detection was applied to highlight the edges within the image. The Sobel operator is effective in detecting edges by computing the gradient of the image intensity at each pixel. This technique is particularly useful for identifying boundaries and transitions within the CT scan, which are important for further analysis or diagnostic purposes.




```
% Load the brain CT scan image
ct_img = imread('ct_image.jpeg');

% Convert the image to grayscale (if not already grayscale)
if size(ct_img, 3) == 3
    ct_img = rgb2gray(ct_img);
end

% Apply Gaussian smoothing
smoothed_img = imgaussfilt(ct_img, 1);

% Perform edge detection using Sobel operator
edges_img = edge(smoothed_img, 'Sobel');

% Display the smoothed image and edges detected side-by-side
figure;
subplot(1, 2, 1);
imshow(smoothed_img);
title('Smoothed Image');

subplot(1, 2, 2);
imshow(edges_img);
title('Sobel Edge Detection');

```



Results and Outcomes:

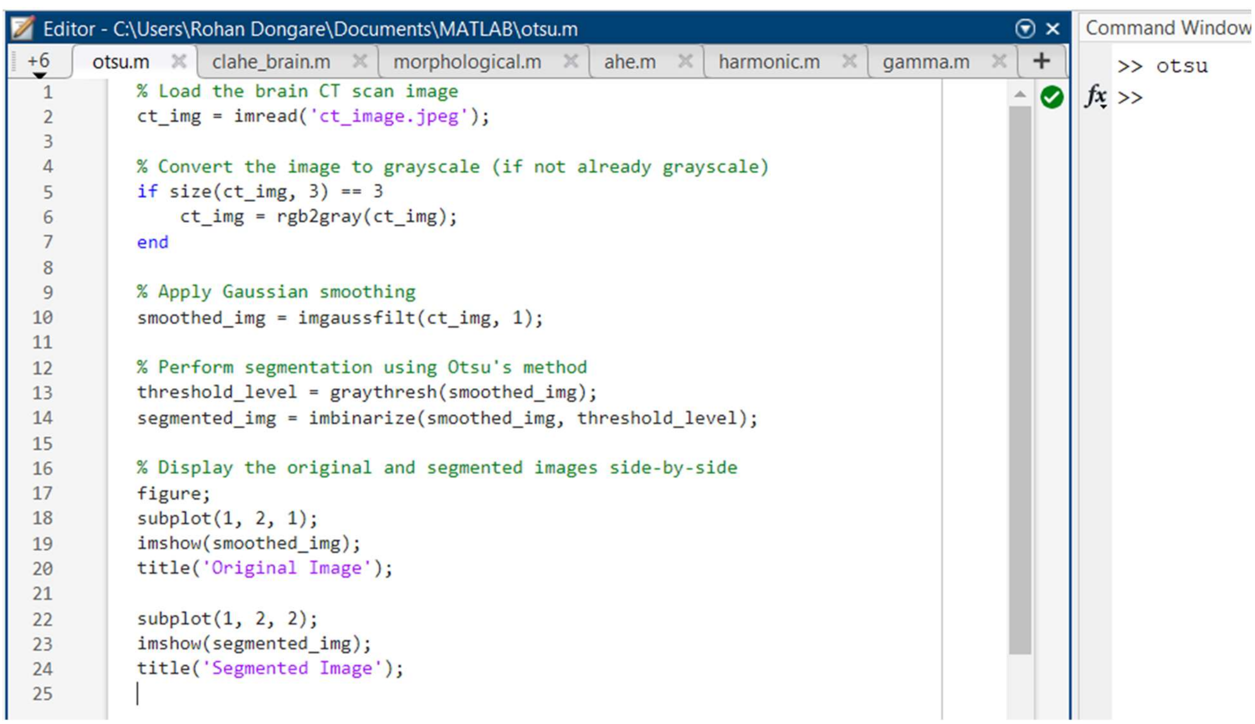
The application of Gaussian smoothing resulted in a cleaner image with reduced noise, which facilitated more accurate edge detection. The Sobel edge detection algorithm successfully identified and highlighted the edges within the brain CT scan image, making it easier to discern structural boundaries and features. The side-by-side comparison of the smoothed image and the edge-detected image demonstrates the effectiveness of these techniques in enhancing the clarity of critical features and aiding in the analysis of the CT scan.

Technique Utilized 3:

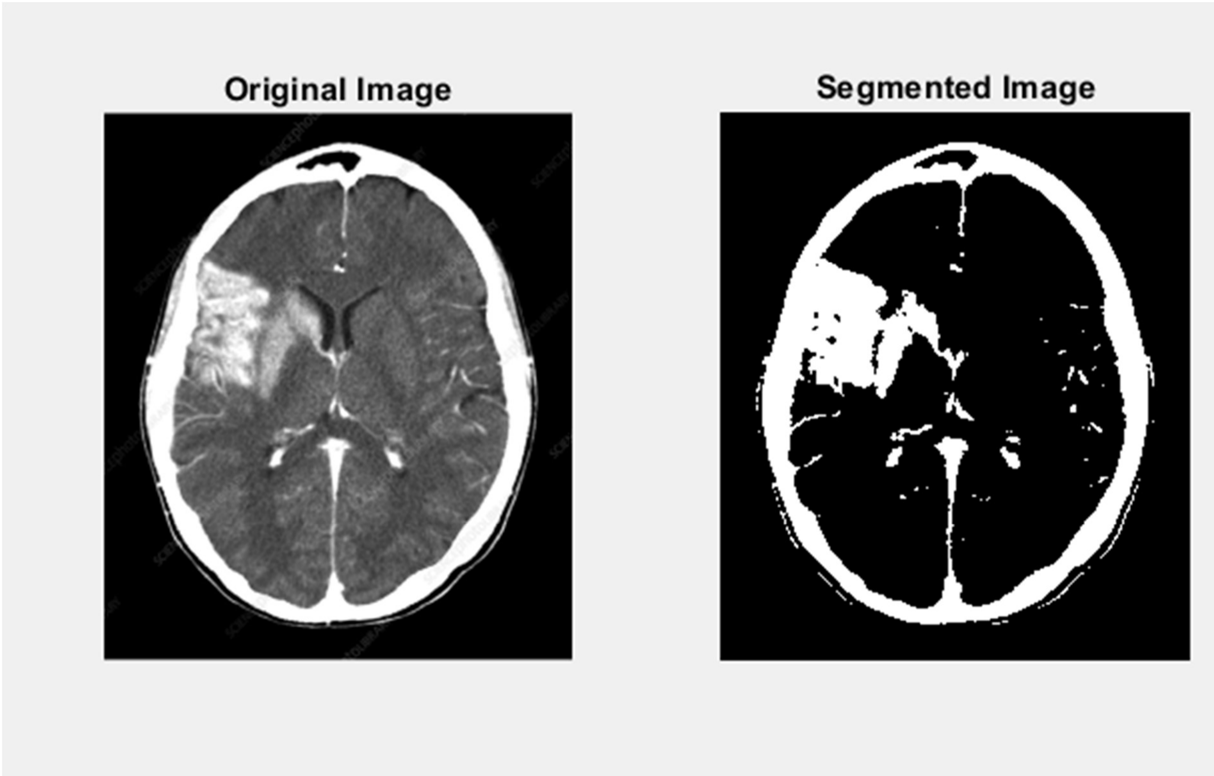
In this technique, I am utilizing **Gaussian Smoothing** followed by **Otsu's Method for Image Segmentation** for analyzing a brain CT scan image.

Rationale for Using the Technique:

1. **Gaussian Smoothing**: This technique was applied to reduce noise and smooth the image. Smoothing is essential for preparing the image for accurate segmentation, as it helps in mitigating noise and minor variations that could otherwise lead to inaccurate segmentation results.
2. **Otsu's Method for Image Segmentation**: Otsu's method was chosen for its effectiveness in automatically determining the optimal threshold for binarizing the image. This method calculates a threshold that minimizes the intra-class variance of the pixel values, thus achieving a robust separation of the foreground and background. This is particularly useful for segmenting regions of interest within medical images, such as different tissues or anomalies.




```matlab
% Load the brain CT scan image
ct_img = imread('ct_image.jpeg');

% Convert the image to grayscale (if not already grayscale)
if size(ct_img, 3) == 3
    ct_img = rgb2gray(ct_img);
end

% Apply Gaussian smoothing
smoothed_img = imgaussfilt(ct_img, 1);

% Perform segmentation using Otsu's method
threshold_level = graythresh(smoothed_img);
segmented_img = imbinarize(smoothed_img, threshold_level);

% Display the original and segmented images side-by-side
figure;
subplot(1, 2, 1);
imshow(smoothed_img);
title('Original Image');

subplot(1, 2, 2);
imshow(segmented_img);
title('Segmented Image');
```



Results and Outcomes:

The Gaussian smoothing process resulted in a cleaner image with reduced noise, which facilitated more effective segmentation. The application of Otsu's method successfully segmented the image into distinct regions based on intensity levels. The side-by-side comparison of the smoothed image and the segmented image demonstrates the effectiveness of these techniques in improving image quality and highlighting relevant features for further analysis.

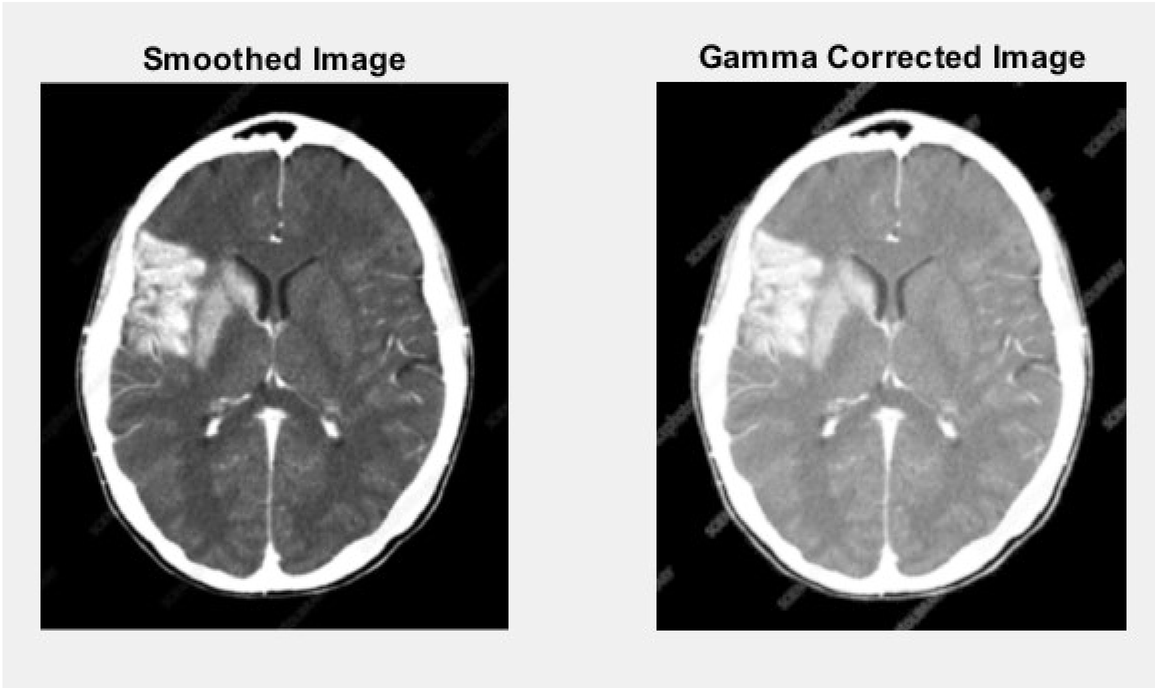
Technique Utilized 4:

In this technique, I am utilizing **Gaussian Smoothing** followed by **Gamma Correction** for enhancing the quality of a brain CT scan image.

Rationale for Using the Technique:

1. **Gaussian Smoothing**: This technique was employed to reduce noise and smooth the image. Gaussian smoothing helps to eliminate minor fluctuations and noise, making the subsequent processing steps more effective. By applying a Gaussian filter with a standard deviation of 2, the image becomes less noisy and more suitable for further enhancement.
2. **Gamma Correction**: Gamma correction was applied to adjust the brightness and contrast of the image. By using a gamma value of 0.5, the technique enhances the visibility of features in both dark and bright areas of the image. Gamma correction is useful for correcting the non-linear relationship between the pixel values and the perceived intensity, thereby improving the image's overall clarity and detail.

```matlab
% Load the brain CT scan image
ct_img = imread('ct_image.jpeg');

% Convert the image to grayscale (if not already grayscale)
if size(ct_img, 3) == 3
    ct_img = rgb2gray(ct_img);
end

% Apply Gaussian smoothing
smoothed_img = imgaussfilt(ct_img, 2);

% Perform gamma correction
gama = 0.5; % Adjust gamma value as needed
gamma_corrected_img = imadjust(smoothed_img, [], [], gama);

% Display the smoothed and gamma-corrected images side-by-side
figure;
subplot(1, 2, 1);
imshow(smoothed_img);
title('Smoothed Image');

subplot(1, 2, 2);
imshow(gamma_corrected_img);
title('Gamma Corrected Image');
```



Results and Outcomes:

The Gaussian smoothing resulted in a less noisy image, which improved the effectiveness of the gamma correction. The gamma-corrected image displayed enhanced contrast and detail, particularly in the darker regions. The side-by-side comparison of the smoothed image and the gamma-corrected image illustrates the benefits of these techniques in improving image quality and making important features more discernible.