



# VISIONFUSE®

## IMAGE REGISTRATION

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## 1. Introduction

This manual is designed to assist users in navigating and utilizing the Image Registration app effectively. This app is developed for advanced image processing and registration tasks.

## 2. System Requirements

To ensure smooth operation, make sure MATLAB is installed on your system with all the necessary toolboxes.

## 3. Main Functions and Features

### 1. Main interface

- UI Figure: The primary window where all image processing and registration tasks are performed.

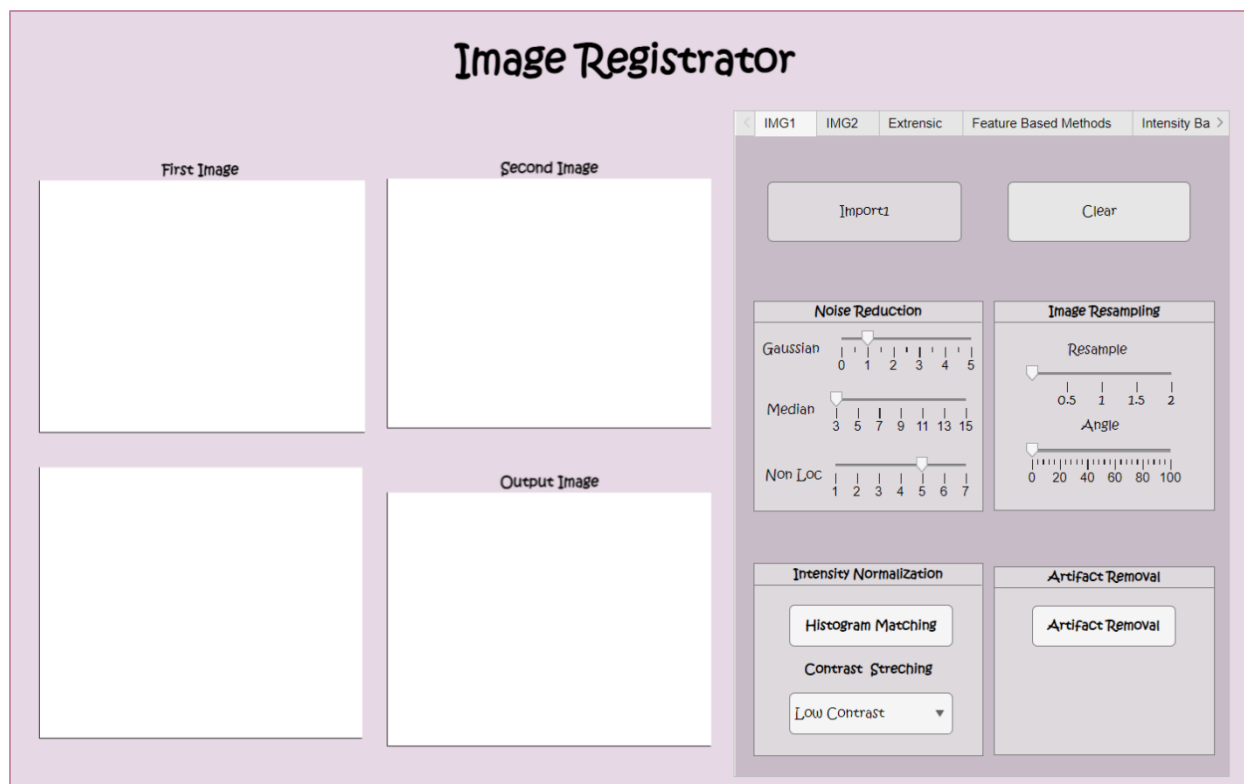


Figure 1: GUI: The Graphical User Interface

## 2. Image Import

- Import1Button & Import2Button: Use these buttons to upload the first and second images, respectively, for subsequent processing.
- Each button will take you to your directory to choose the images you want to use.
- Supported formats: the Import Buttons support for common medical image formats (DICOM, Nifti, TIFF), satellite image formats (GeoTIFF, HDF5), and general image formats (JPEG, PNG).

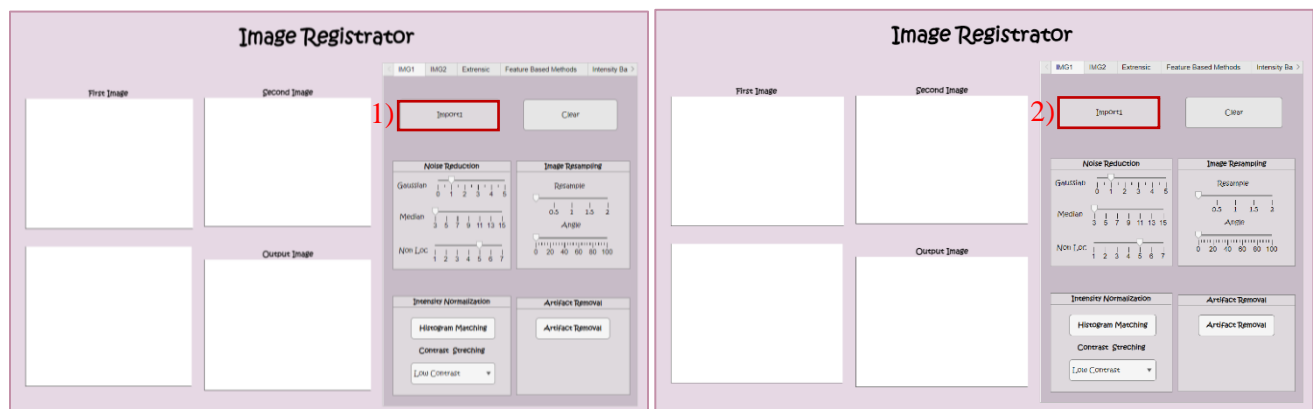


Figure 2: Import Button

## 3. Image Clearence

- Clear1Button & Clear2Button: Use these buttons to clear specific content rom the app's user interface, to reset certain elements to their default state.

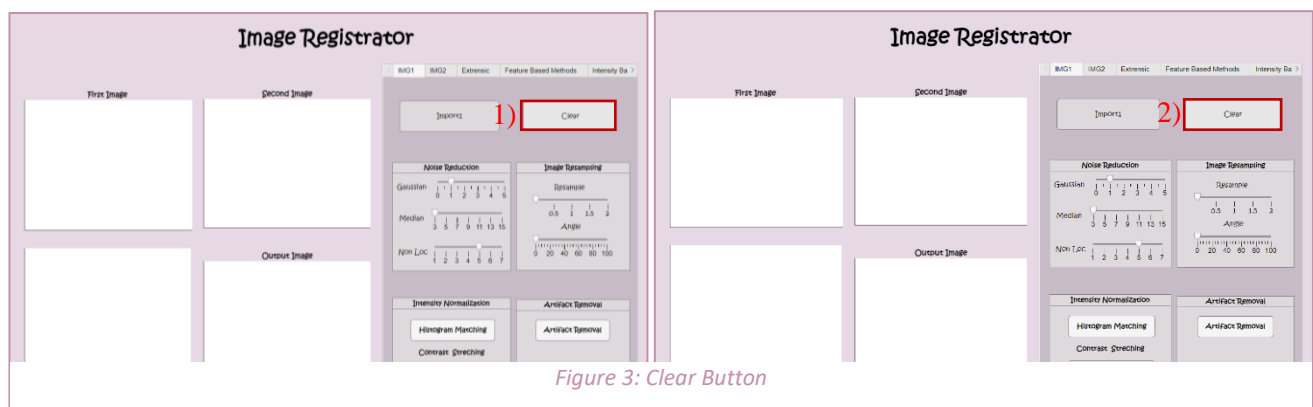


Figure 3: Clear Button

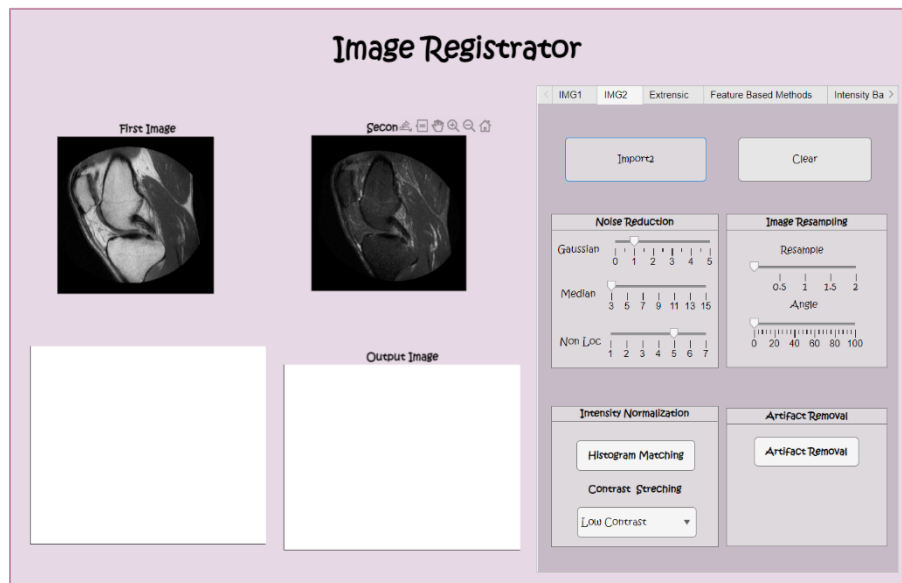


Figure 4: Image Imported

#### 4. Image Processing Tabs

Each tab in the app serves a unique function:

##### IMG1 & IMG2 Tabs

In each tab you will find the import button for the image with the preprocessing settings you can apply in it.

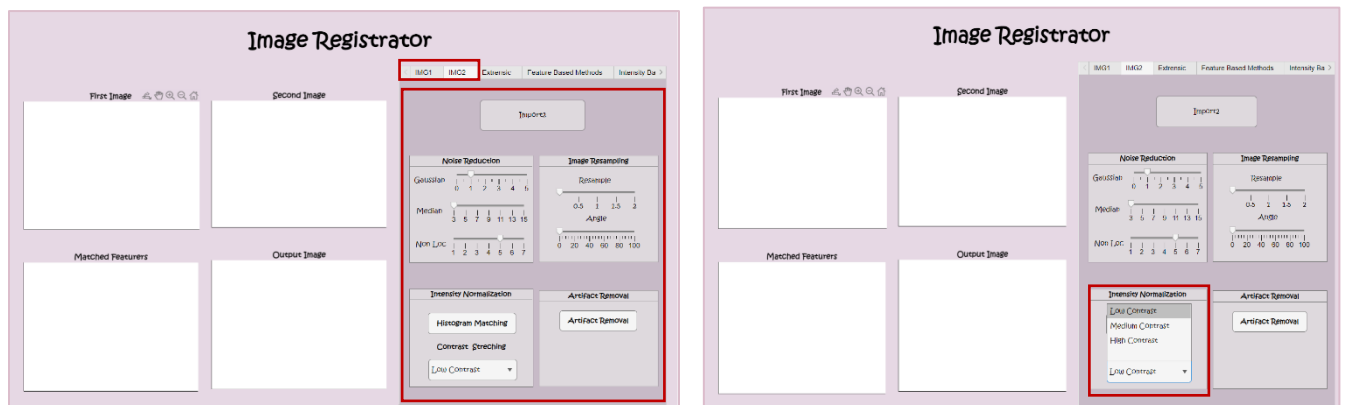


Figure 5: Pre-Processing Tab

- Noise Reduction Panel: Adjust noise reduction parameters using different methods:
  - Gaussian Filtering: a way to blur your image slightly, it smooths out the rough edges.
  - Median Filtering: picks the most common (median) colour or brightness from a small area in your image and uses it to replace noisy spots.
  - Non-Local Means: find differences that look like noise, they blend these areas to match their surroundings better.
- Intensity Normalization Panel: Modify image intensity.
  - Histogram Matching: It adjusts the brightness and contrast of your image to match a reference image.
  - Contrast Stretching: Adjusts the darkest and brightest parts of your image, making dark areas lighter and bright areas darker. You can choose between high, medium, and low contrast see figure 5.
- Image Resampling Panel: Resample and rotate images.
- Artifact Removal Panel: Remove unwanted artifacts from images.

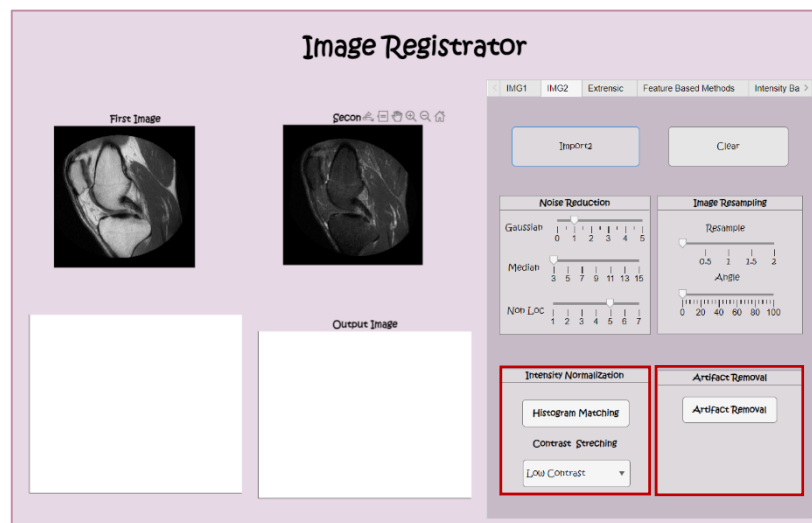


Figure 6: Pre-processing

## 5. Extrinsic Tab:

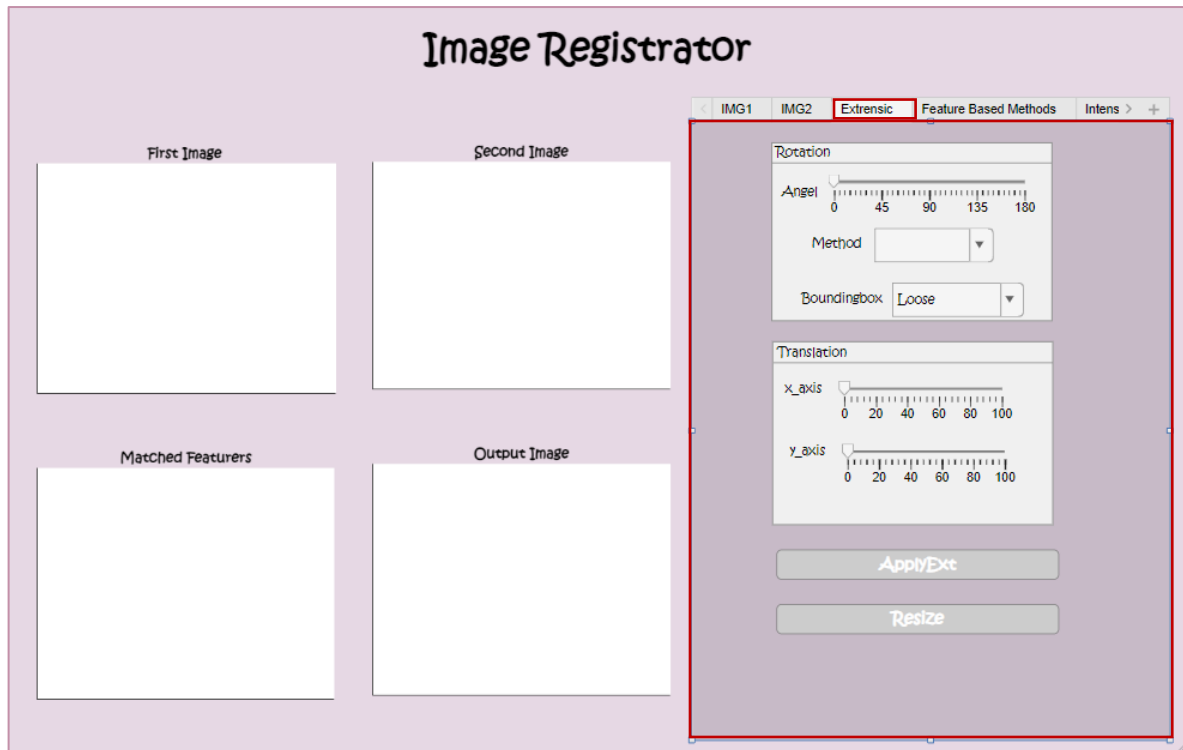


Figure 7: Extrinsic Tab

- Rotation Panel: Controls to rotate the image where you can choose the method and the binding-box:

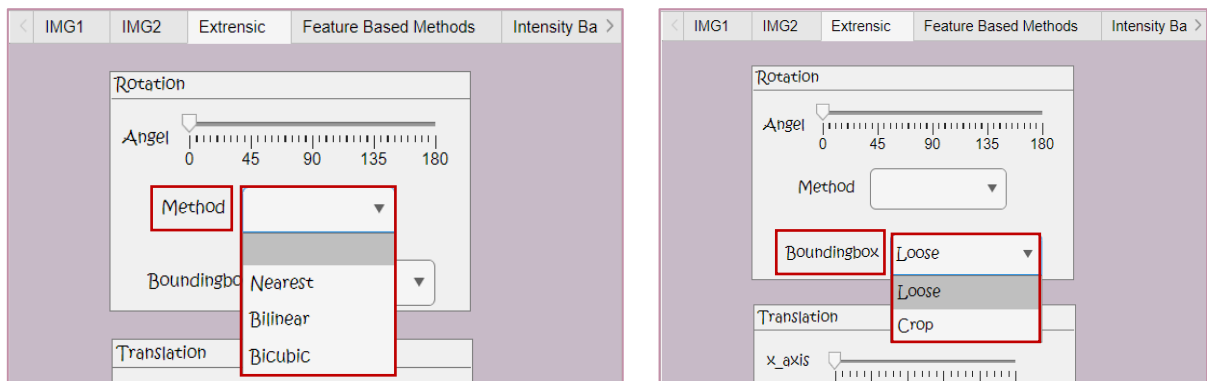


Figure 8: Rotation Panel

- Nearest for basic and fast rotation.
- Bilinear for a smoother turn.

- Bicubic for the highest quality rotation.
- Choose between Loose to keep the entire image in view or Crop to maintain the original size with some cropping.
- Translation Panel: Adjust image translation on X and Y axis.
- ApplyExt Button: After you choose the preferred extrinsic parameters, click on it to Apply extrinsic transformations.
- Resize Button: Resize the second image according to the first image.

## 6. Feature-Based Methods Tab

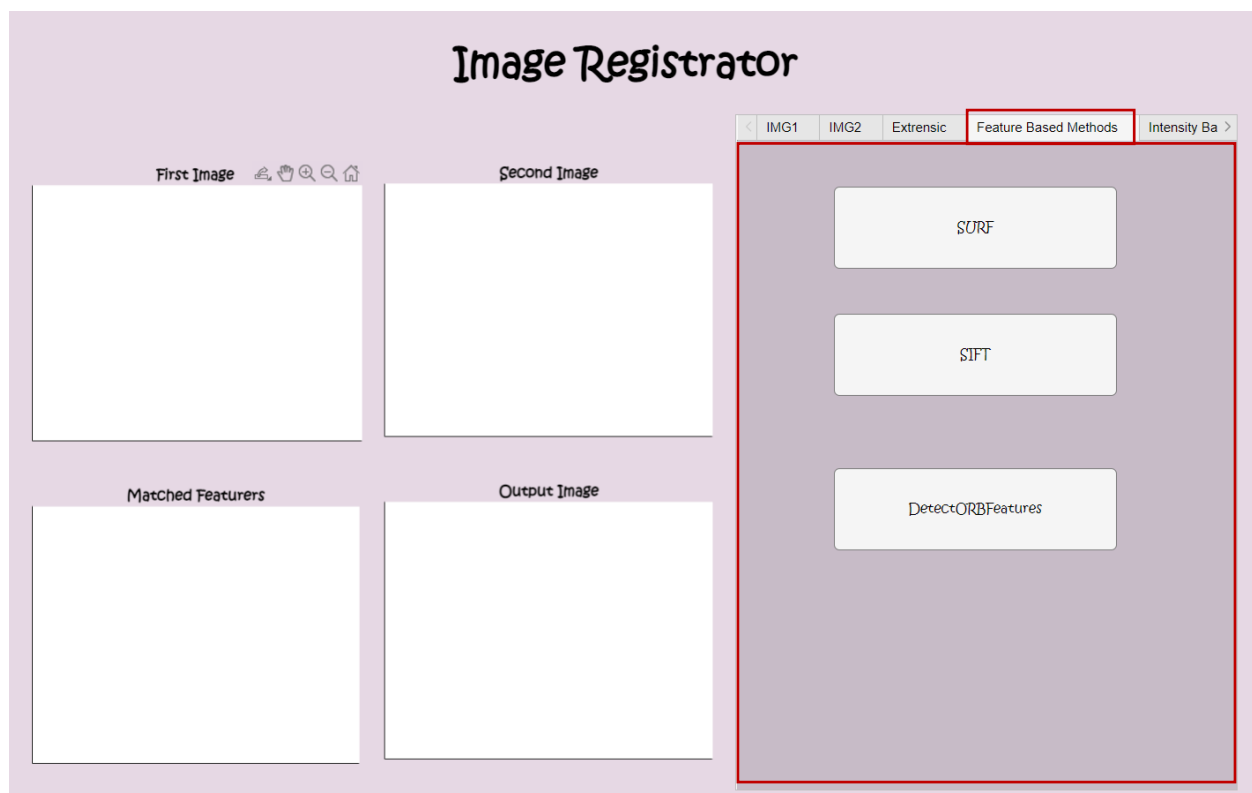


Figure 9: Feature Based Methods



- SURF, SIFT, ORB Buttons: Detect features using various algorithms.
  - SURF (Speeded Up Robust Features): rapidly identifies and matches important points or features in images, such as corners and edges. It's efficient in handling image scaling and rotation, making it useful for object recognition and 3D reconstruction.
- SURF features can be used for tasks like estimating the geometric transformation needed to align one image with another.



Figure 10: SURF

- SIFT (Scale-Invariant Feature Transform): is designed to detect and describe local features in images, regardless of scale or orientation changes. It's robust against variations in illumination, noise, and minor changes in the viewpoint, often used in image stitching and object detection.

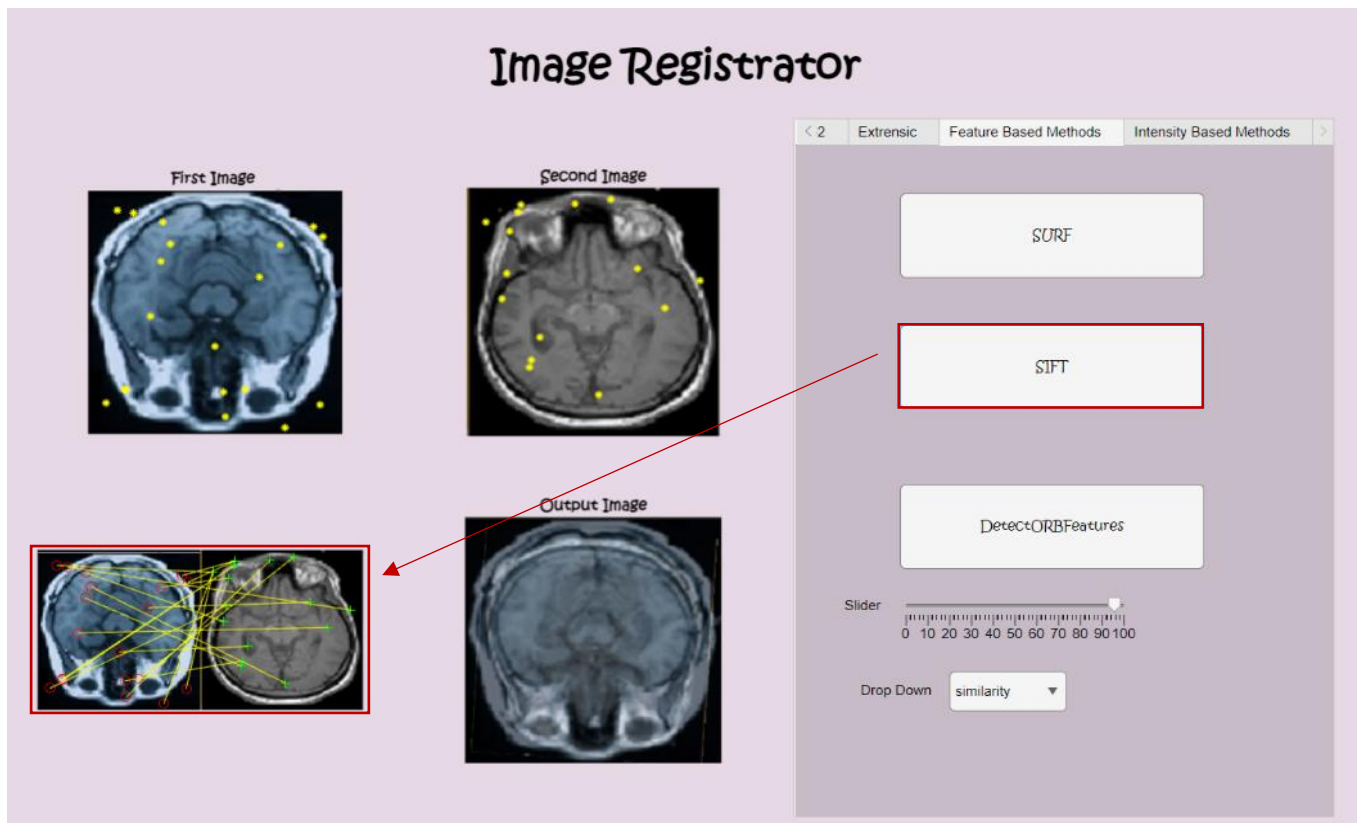


Figure 11:SIFT

- ORB (Oriented FAST and Rotated BRIEF): combines fast key point detection and a robust descriptor for efficient matching. It's particularly useful for real-time applications, offering good performance in varying lighting and viewpoint conditions, commonly employed in tracking and navigation.

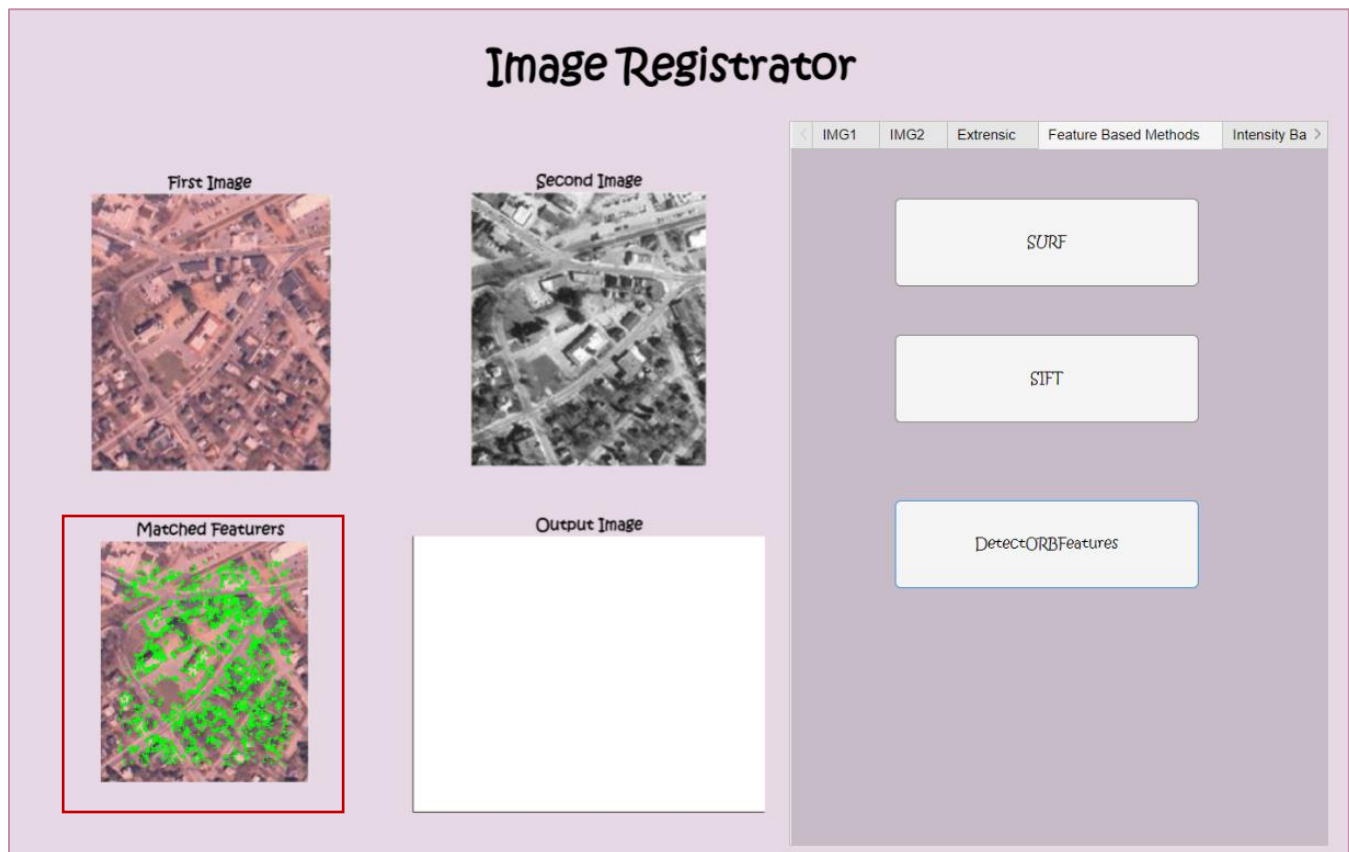


Figure 12:ORB

## 7. Intensity-Based Methods Tab

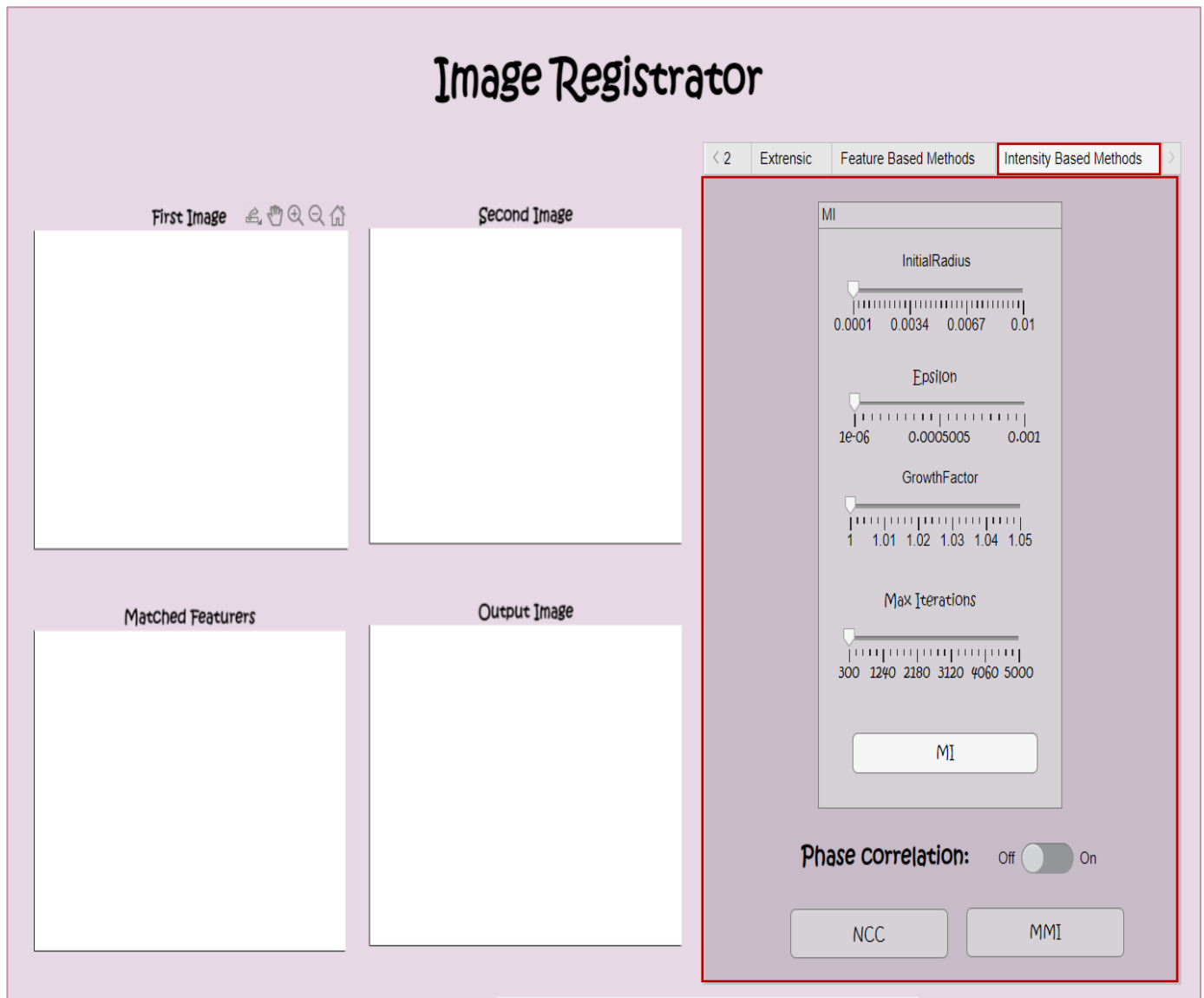


Figure 13: Intensity-Based Methods Tab

- **MI Panel (Mutual Information-Based Registration)** The MI Panel uses Mutual Information, a measure that captures the statistical dependency between images, to align them accurately. This method excels in registering images from different modalities, like matching a CT scan to an MRI.

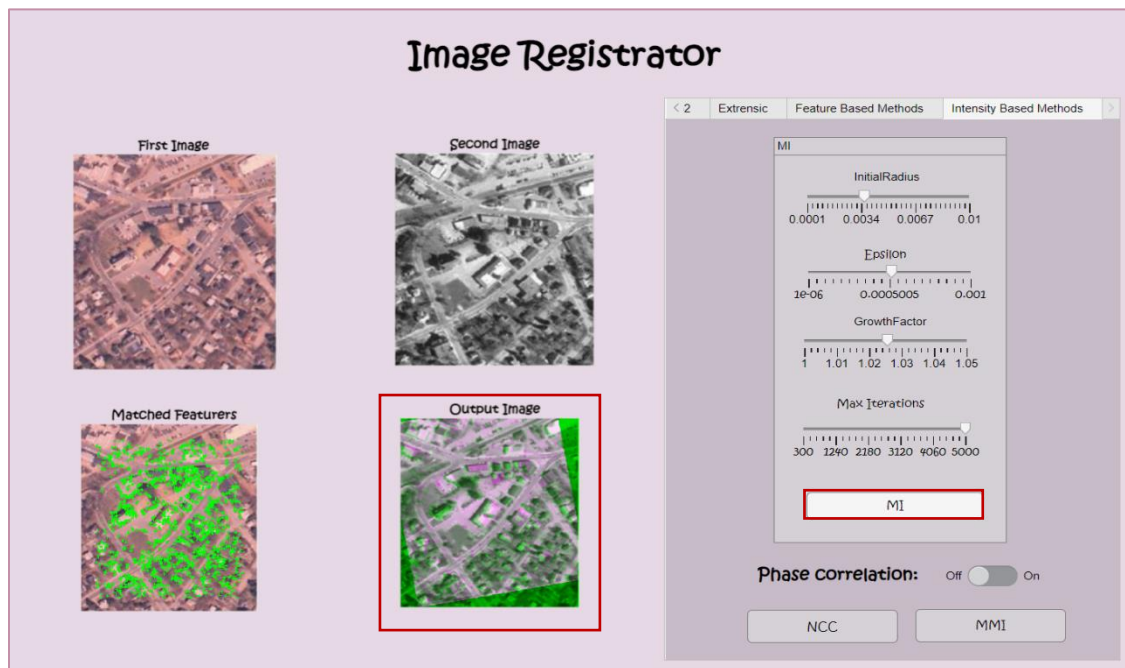


Figure 14:MI Panel

- MMI Button (Modified Mutual Information)

Modified Mutual Information is an enhanced version of MI, offering improved registration accuracy, especially in the presence of noise or varying image intensities. It's well-suited for aligning medical images where precision is critical.

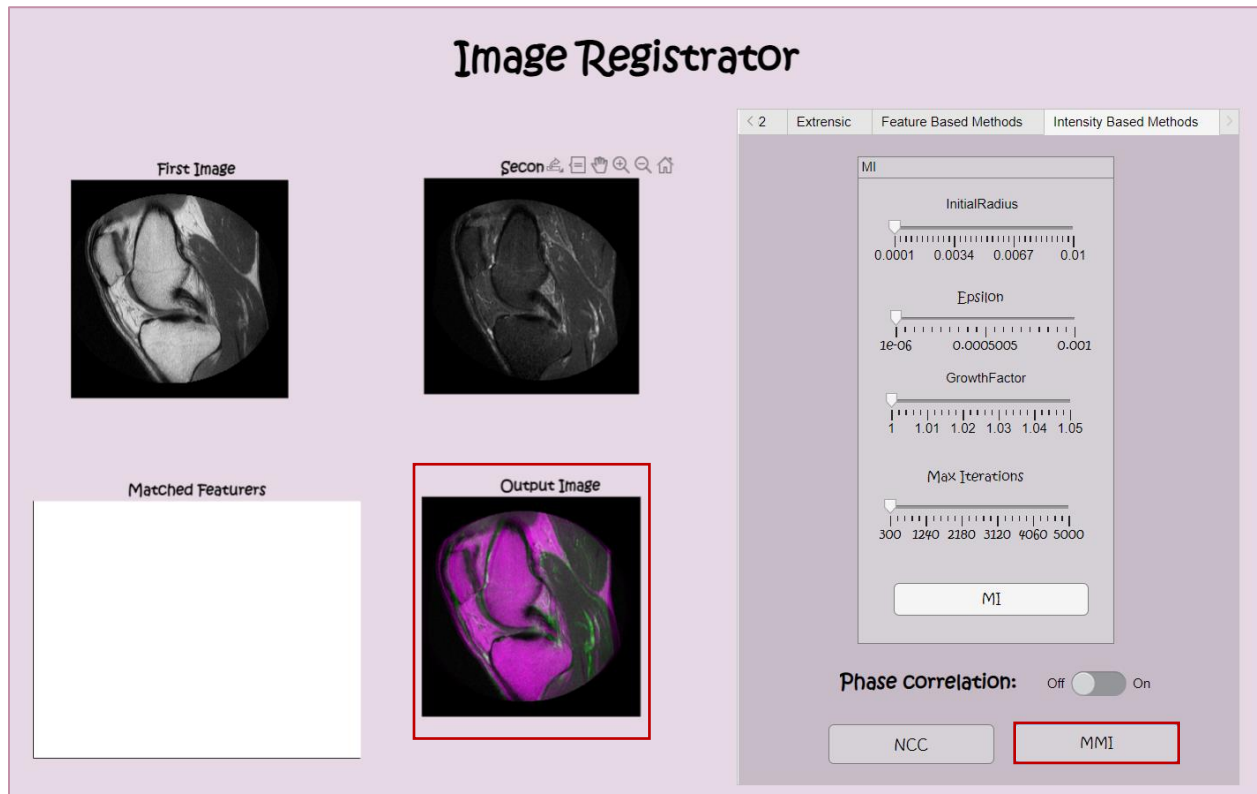


Figure 15:MMI Button

- NCC Button (Normalized Cross-Correlation)

Normalized Cross-Correlation quantifies the similarity between two images, adjusting for changes in lighting or exposure. It's highly effective in template matching and alignment tasks, ensuring consistent brightness and contrast.

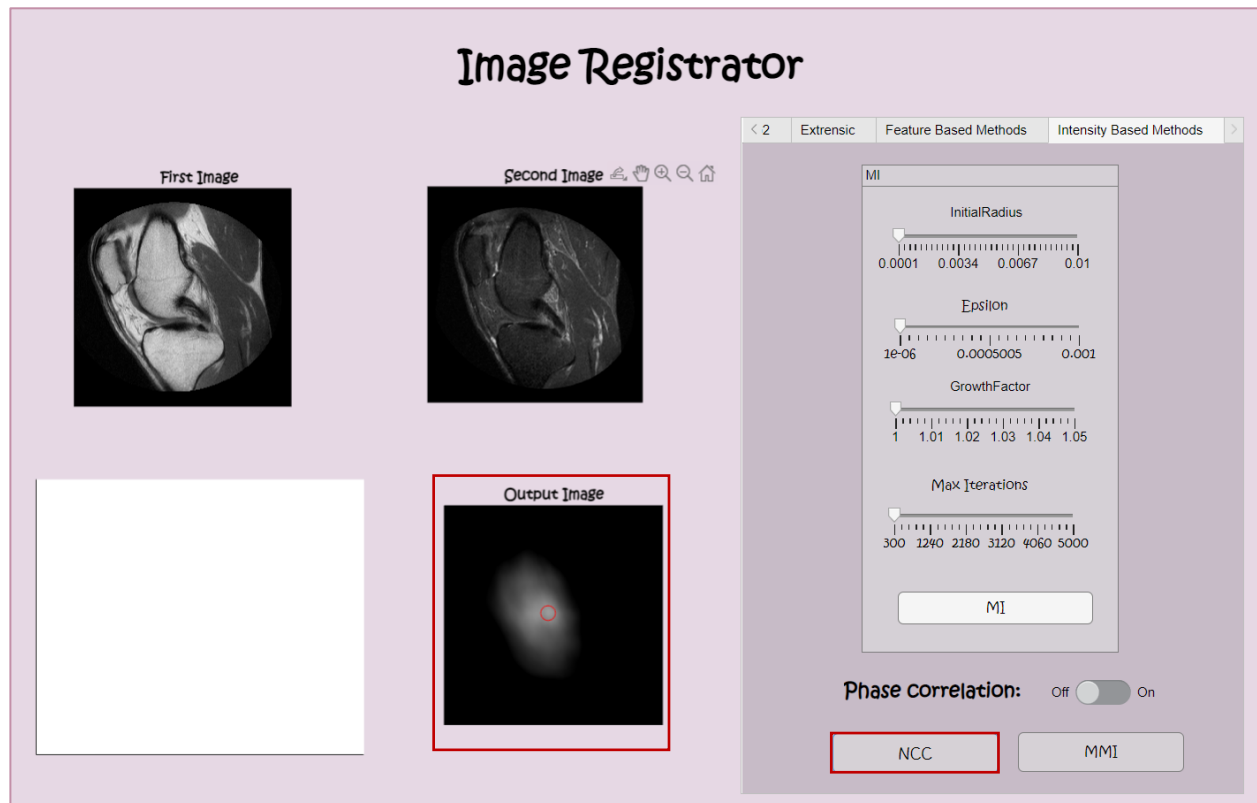


Figure 16:NCC

- Phase Correlation Switch

Phase Correlation utilizes frequency domain analysis for rapid and precise alignment of images. This feature is particularly useful in detecting subtle shifts and rotations, commonly used in satellite imaging and motion tracking.

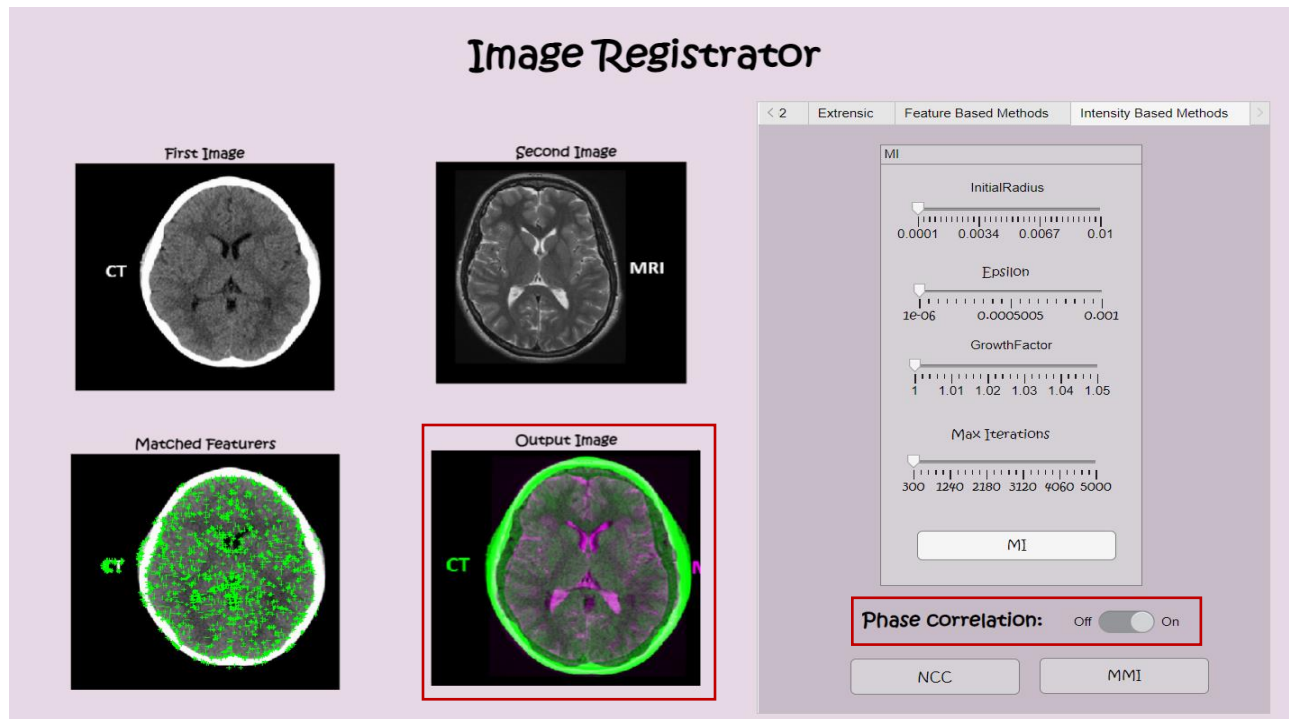


Figure 17:Phase Correlation



## 8. Image Display

- UIAxes (1-4): Displays the original, processed, and resultant images.

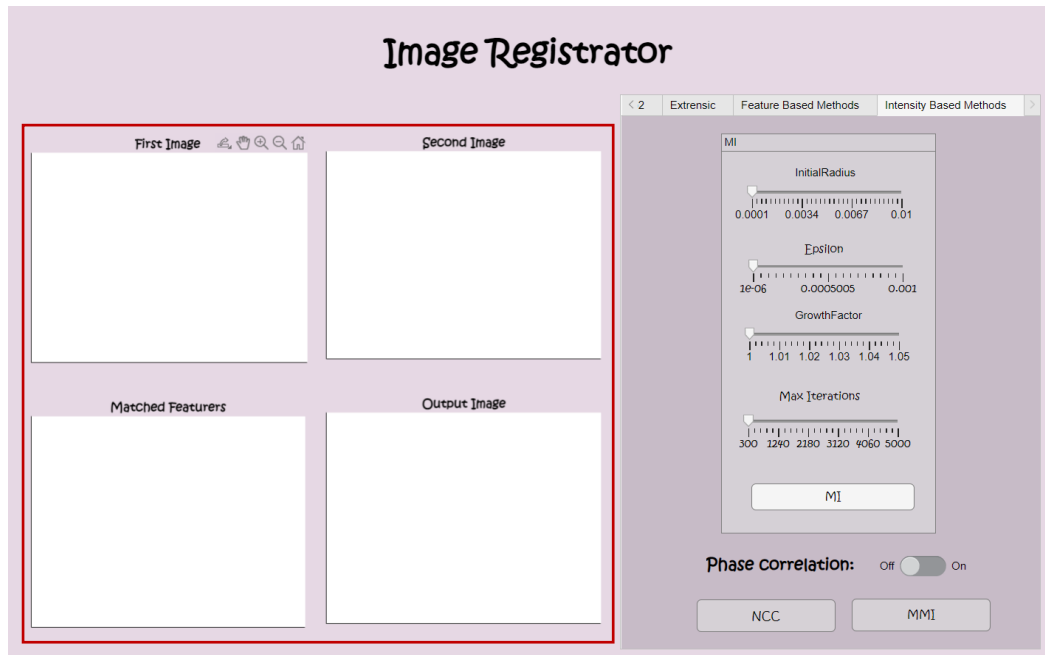


Figure 18: Display Axes

