# **Final Project Report**

*Ultrasound Image Denoising and Feature Enhancement* *By Aakash Balamurugan*

## **1. Objective**

The objective of this project is to denoise and enhance ultrasound medical images using various image processing techniques in MATLAB.  
The goal is to improve image clarity and feature visibility, which is critical for accurate medical diagnosis and assessment.

## **2. Tools Used**

* MATLAB Online
* Image Processing Toolbox

## **3. Methodology**

### **3.1. Image Loading and Preparation**

* A real-world echocardiogram ultrasound image (ultrasound\_image.jpeg) was used.
* The image was converted to grayscale for consistent processing.

### **3.2. Denoising Techniques**

* **Median Filtering**: Applied a 3×3 kernel median filter to reduce salt-and-pepper noise.
* **Wiener Filtering**: Applied a 5×5 local adaptive Wiener filter to remove noise while preserving edges.
* **Anisotropic Diffusion Filtering**: Applied anisotropic diffusion to reduce speckle noise while maintaining important structures.

### **3.3. Feature Enhancement Techniques**

* **Histogram Equalization**: Enhanced image contrast by redistributing pixel intensity values.
* **Contrast Adjustment**: Improved dynamic range and brightness to highlight features.
* **Laplacian Edge Enhancement**: Applied a Laplacian filter to sharpen and accentuate anatomical boundaries.

### **3.4. Quantitative Evaluation**

* **Peak Signal-to-Noise Ratio (PSNR)** was used to measure noise reduction.
* **Structural Similarity Index (SSIM)** was used to measure preservation of image structure.

## **4. Results**

### **4.1. Denoising Results**

*(Insert Figure 1: showing Original, Median Filtered, Wiener Filtered, Anisotropic Diffusion Filtered images side-by-side.)*

### **4.2. Enhancement Results**

*(Insert Figure 2: showing Anisotropic Diffusion, Histogram Equalized, Contrast Adjusted, and Laplacian Enhanced images side-by-side.)*

### **4.3. Quantitative Evaluation Results**

| **Method** | **PSNR (dB)** | **SSIM** |
| --- | --- | --- |
| Median Filter | 36.15 | 0.9785 |
| Wiener Filter | 37.19 | 0.9521 |
| Anisotropic Filter | 36.03 | 0.9522 |

## **5. Conclusion**

This project successfully enhanced the clarity of an ultrasound image by applying a series of denoising and enhancement techniques in MATLAB.  
 The **Wiener Filter** achieved the highest **PSNR** (37.19 dB), indicating it was the most effective at reducing noise, while the **Median Filter** achieved the highest **SSIM** (0.9785), demonstrating the best structural preservation.  
 These results highlight the trade-off between noise reduction and feature preservation in biomedical imaging.  
 In clinical applications, enhancing ultrasound image clarity can significantly aid in the early detection of abnormalities such as valve defects and soft tissue irregularities.