**IMAGE ENHANCEMENT IN MEDICAL IMAGING**

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Team B\_EHR-Imaging-Documentation-System

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## **2. Introduction**

The aim of this project is to enhance medical images using AI-based and classical image processing techniques. Medical images, such as X-rays, CT scans, and MRIs, often suffer from low contrast, noise, or artifacts that can obscure critical anatomical details. This can make diagnosis more challenging for medical professionals and can reduce the performance of computer-aided diagnostic (CAD) systems.

Image enhancement plays a vital role in medical imaging because it improves the visual quality of these images, enabling doctors and radiologists to detect abnormalities more easily and accurately. By improving contrast, reducing noise, and highlighting key structures, enhancement methods support better clinical decisions and serve as a crucial pre-processing step for downstream tasks like image segmentation, classification, and disease detection. A clear and enhanced image can ultimately lead to faster diagnosis, reduced error rates, and improved patient outcomes.

## **3. Objective of Milestone 2**

The primary objective of **Milestone 2** is to **implement and demonstrate basic image enhancement techniques on medical images**.

This milestone aims to build a foundational understanding of how various enhancement methods affect the quality and clarity of medical images. By applying techniques such as histogram equalization, CLAHE, denoising, and blurring, we can observe their impact on image contrast, sharpness, and noise levels.

**4. Methodology**

To achieve the objectives of Milestone 2, we followed a structured methodology involving dataset selection, tool setup, and the application of different enhancement techniques on medical images.

4.1 Dataset Used

We used a small set of sample medical images, primarily chest X-ray scans, taken from publicly available repositories. Some commonly used sources include:

Link : https://www.kaggle.com/datasets/tolgadincer/labeled-chest-xray-images

* NIH ChestX-ray14 Dataset — a large collection of labeled chest X-rays.
* Kaggle Medical Image Datasets — various public datasets for medical imaging tasks.

A few representative sample images were placed in the project’s data/ folder to demonstrate the enhancement techniques.

4.2 Tools & Libraries

The implementation was done using Python, leveraging widely used image processing libraries and tools:

* OpenCV — for reading images, applying filters, histogram equalization, CLAHE, and blurring operations.
* scikit-image — for additional image enhancement functions and utility routines.
* NumPy — for handling image data as arrays and performing pixel-level operations.
* Matplotlib — for visualizing the images (before and after enhancement) side by side.

4.3 Enhancement Techniques Applied

We applied the following basic image enhancement techniques:

* Histogram Equalization: Improves the overall contrast of an image by redistributing the pixel intensity values more evenly. It is useful for images that are globally dark or light.
* CLAHE (Contrast Limited Adaptive Histogram Equalization): An improved version of histogram equalization that enhances contrast locally within small regions of the image while preventing over-amplification of noise.
* Denoising: Removes random noise present in the image using the Non-Local Means algorithm, which helps preserve important edges and structures while cleaning up the background.
* Gaussian Blurring: Applies a Gaussian filter to smooth the image and reduce details. While not an enhancement technique by itself, blurring is used as a comparison baseline to understand how loss of detail affects diagnostic quality**.**

## **5. Implementation**

Enhance Medical Image() Function

import cv2

import numpy as np

import os

import matplotlib.pyplot as plt

def enhance\_medical\_image(image\_path, output\_dir="outputs"):

"""

Applies basic enhancement techniques on a medical image:

- Histogram Equalization

- CLAHE

- Denoising

- Gaussian Blurring

"""

if not os.path.exists(output\_dir):

os.makedirs(output\_dir)

img = cv2.imread(image\_path, cv2.IMREAD\_GRAYSCALE)

if img is None:

raise FileNotFoundError(f"Image not found: {image\_path}")

hist\_eq = cv2.equalizeHist(img)

clahe = cv2.createCLAHE(clipLimit=2.0, tileGridSize=(8, 8)).apply(img)

denoised = cv2.fastNlMeansDenoising(img, None, 30, 7, 21)

blurred = cv2.GaussianBlur(img, (5, 5), 0)

cv2.imwrite(os.path.join(output\_dir, "hist\_eq.png"), hist\_eq)

cv2.imwrite(os.path.join(output\_dir, "clahe.png"), clahe)

cv2.imwrite(os.path.join(output\_dir, "denoised.png"), denoised)

cv2.imwrite(os.path.join(output\_dir, "blurred.png"), blurred)

titles = ['Original', 'Hist Eq', 'CLAHE', 'Denoised', 'Blurred']

images = [img, hist\_eq, clahe, denoised, blurred]

plt.figure(figsize=(15, 5))

for i in range(len(images)):

plt.subplot(1, 5, i + 1)

plt.imshow(images[i], cmap='gray')

plt.title(titles[i])

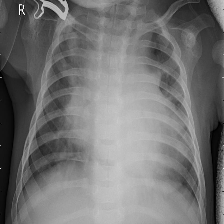
plt.axis('off')

plt.tight\_layout()

plt.show()

A x-ray of a person's chest

AI-generated content may be incorrect.**Input vs Output images**

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X-ray of a child's chest

AI-generated content may be incorrect.X-ray of a person's chest

AI-generated content may be incorrect.

## **6. Results**

• Enhanced images show improved contrast, sharpness, and visibility of key medical structures.  
• Blurred images demonstrate the opposite — they lose diagnostic details.  
**Observations:**  
• CLAHE works better than normal Histogram Equalization for highlighting localized structures.  
• Denoising effectively removes background speckle noise while preserving edges.

## 6. Results

A x-ray of a child's chest

AI-generated content may be incorrect.X-ray of a child's chest

AI-generated content may be incorrect.

## **7. Conclusion & Next Steps**

We successfully implemented basic enhancement methods on medical images in this milestone. This establishes a clean and enhanced dataset that will be used in Milestone 3, where we plan to:  
• Automate the enhancement pipeline.  
• Evaluate image quality improvements using quantitative metrics such as PSNR, SSIM, and contrast measures.

## **8. References**

OpenCV Documentation: https://docs.opencv.org/  
• scikit-image Documentation: https://scikit-image.org/  
• NIH ChestX-ray14 Dataset: https://nihcc.app.box.com/v/ChestXray-NIHCC  
• Histogram Equalization Tutorial — OpenCV  
• CLAHE explained: https://docs.opencv.org/3.4/d5/daf/tutorial\_py\_histogram\_equalization.html  
• Denoising tutorial: https://docs.opencv.org/3.4/d5/d69/tutorial\_py\_non\_local\_means.html