CT Reconstruction

Xinyan Liu, 2044332, xliu87@cougarnet.uh.edu,

Department of Computer Science, Undergraduate

Lujia Wu, 1854803, lwu20@cougarnet.uh.edu,

Department of Computer Science, Undergraduate

Yihui Lin(Vincent Lin), 2006325, ylin59@cougarnet.uh.edu,

Department of Computer Science, Undergraduate

Wei Yan, 1774112, wyan6@cougarnet.uh.edu,

Department of Computer Science, Undergraduate

University of Houston

COSC 4372 Medical Imaging

Dr. Nikolaos Tsekos

Dec 10th, 2022

Introduction

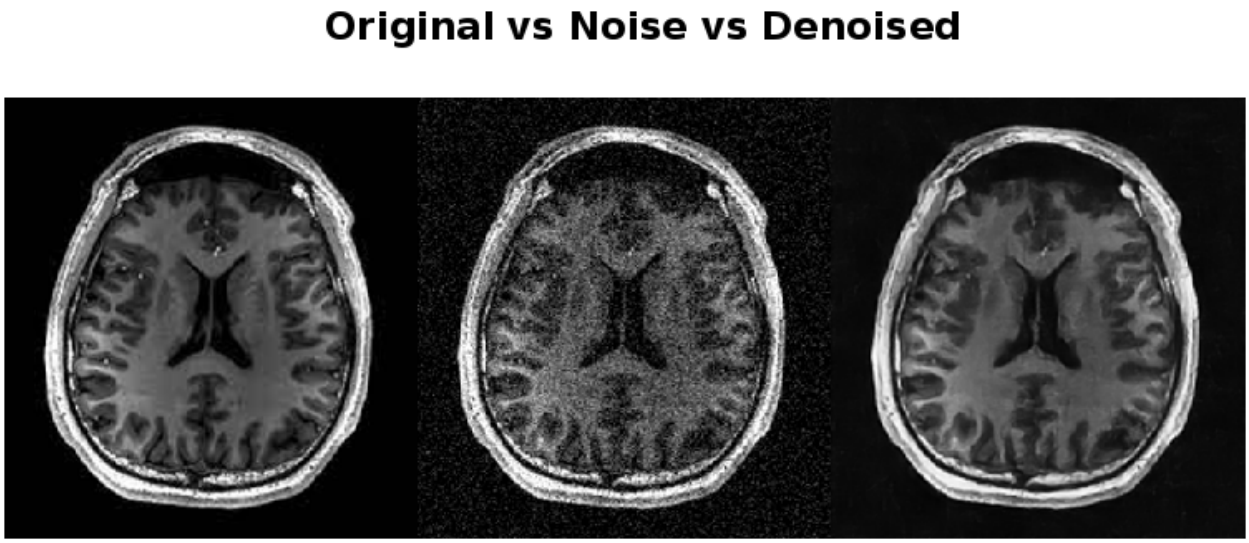
CT imaging diagnosis is to scan the patient's lesion with a scanner to obtain multi-level images of the lesion, and then the doctor makes a diagnosis of the patient's condition based on the results of the imaging examination. As a three-dimensional scanning method, CT image plays an important role in the diagnosis of many diseases. CT is easy to operate, and patients will not feel pain. Image reconstruction in CT is a mathematical process that generates tomographic images from X-ray projection data acquired at many different angles around the patient. Because it has a dramatic effect on image quality, it can also affect radiation dose, so reconstruction with improved image quality translates into a reduction in radiation dose. Of course, we want to do this without sacrificing image accuracy and spatial resolution.

Method

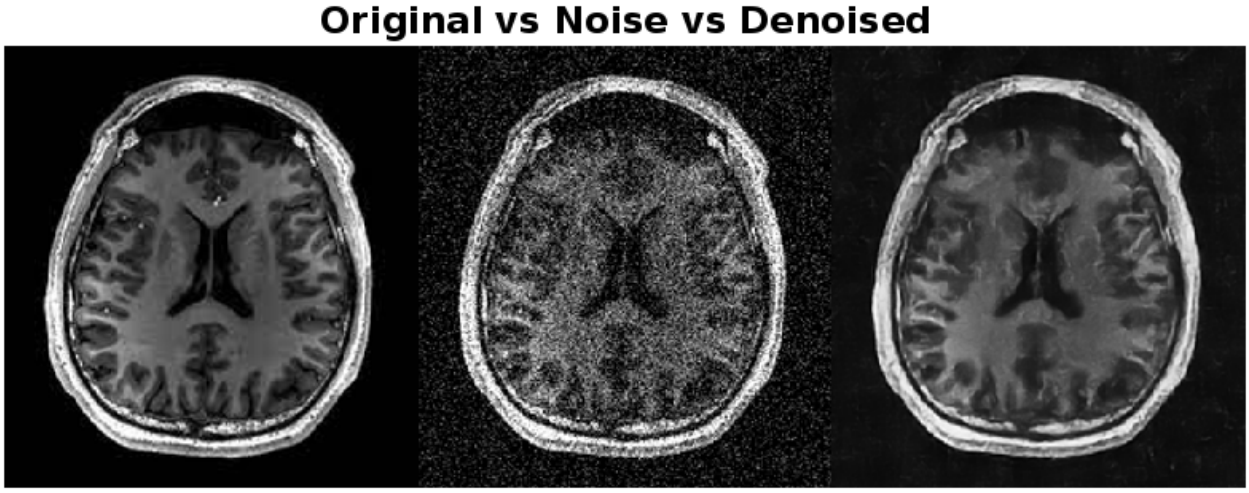
As we mentioned in our project proposal. We used two main function toolboxes in matlab, Image Processing Toolbox and Deep Learning Toolbox. Image Processing Toolbox provides a comprehensive set of reference standard algorithms and workflow applications for image processing, analysis, visualization, and algorithm development. You can use deep learning and traditional image processing techniques for image segmentation, image enhancement, denoising, geometric transformation, and image registration. Deep Learning Toolbox provides a framework for designing and implementing deep neural networks using algorithms, pre training models, and applications. We used imnoise() function to add noises to our image. After that we pretrained denoising convolutional neural network. The purpose of the CNN network is to minimize the mean square error between the denoised CT image and the normal CT image. Finally, we used denoiseImage() function to get our final output image, and now we can compare

the output image and the original image to see the accuracy of our work. The output image should be similar as the original image to show that our work is effective.

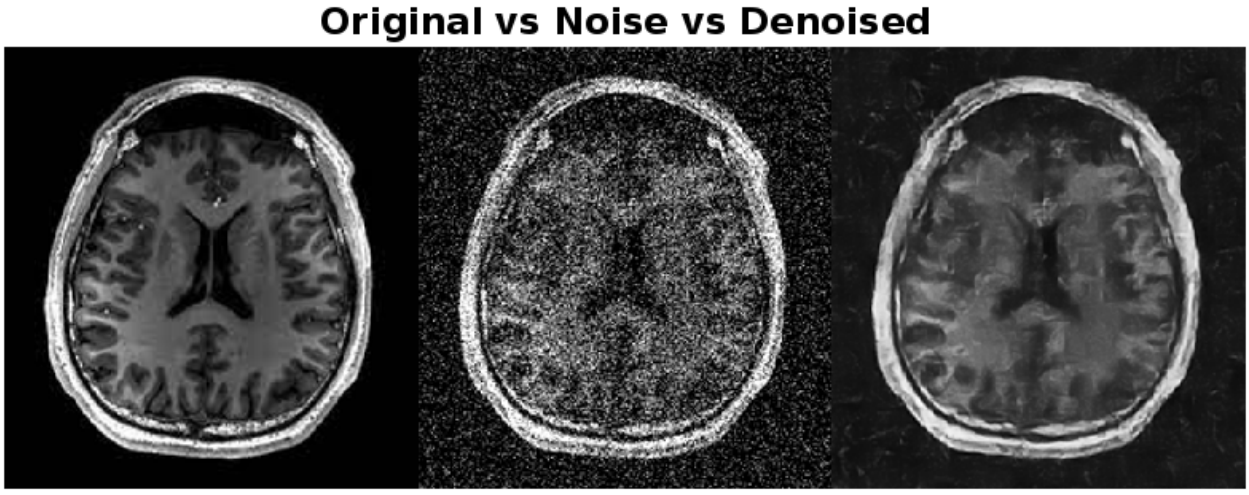
Results and Discussion



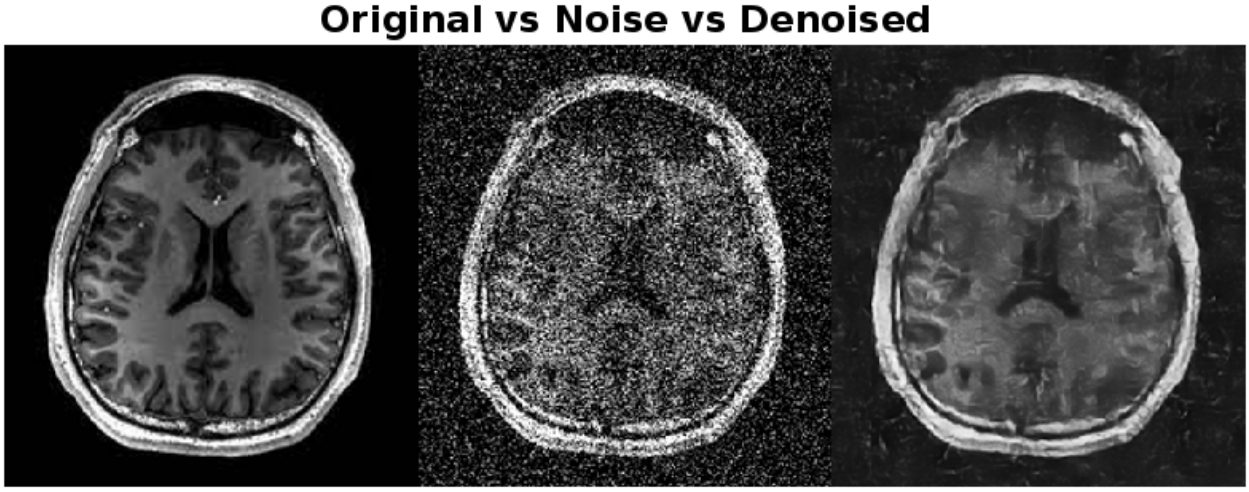
Noise Density: 0.01, PSNR for Denoisy: 26.5829, SSIM for Denoisy: 0.5945



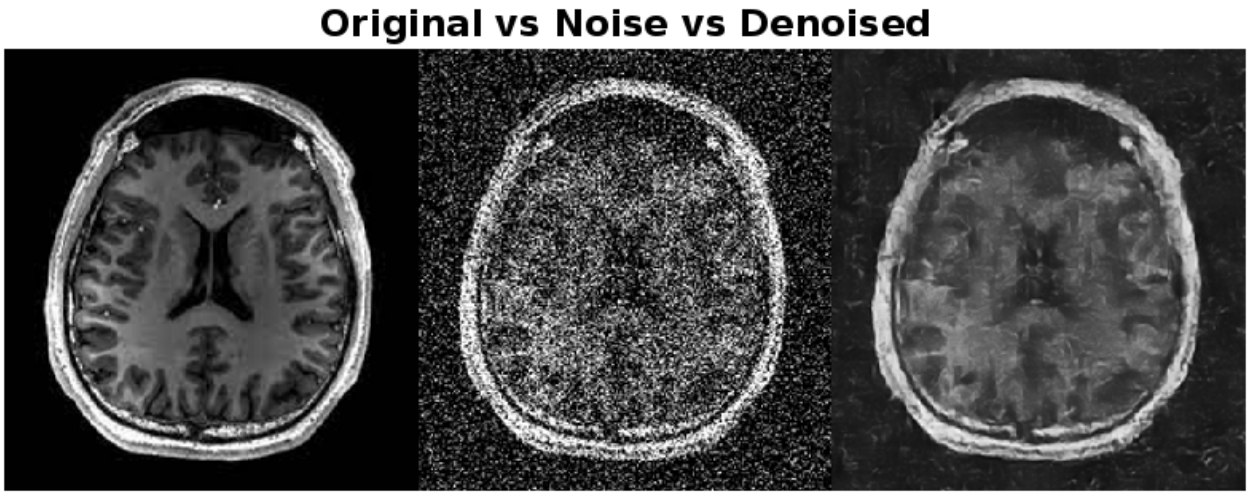
Noise Density: 0.025, PSNR for Denoisy: 23.5315, SSIM for Denoisy: 0.4966



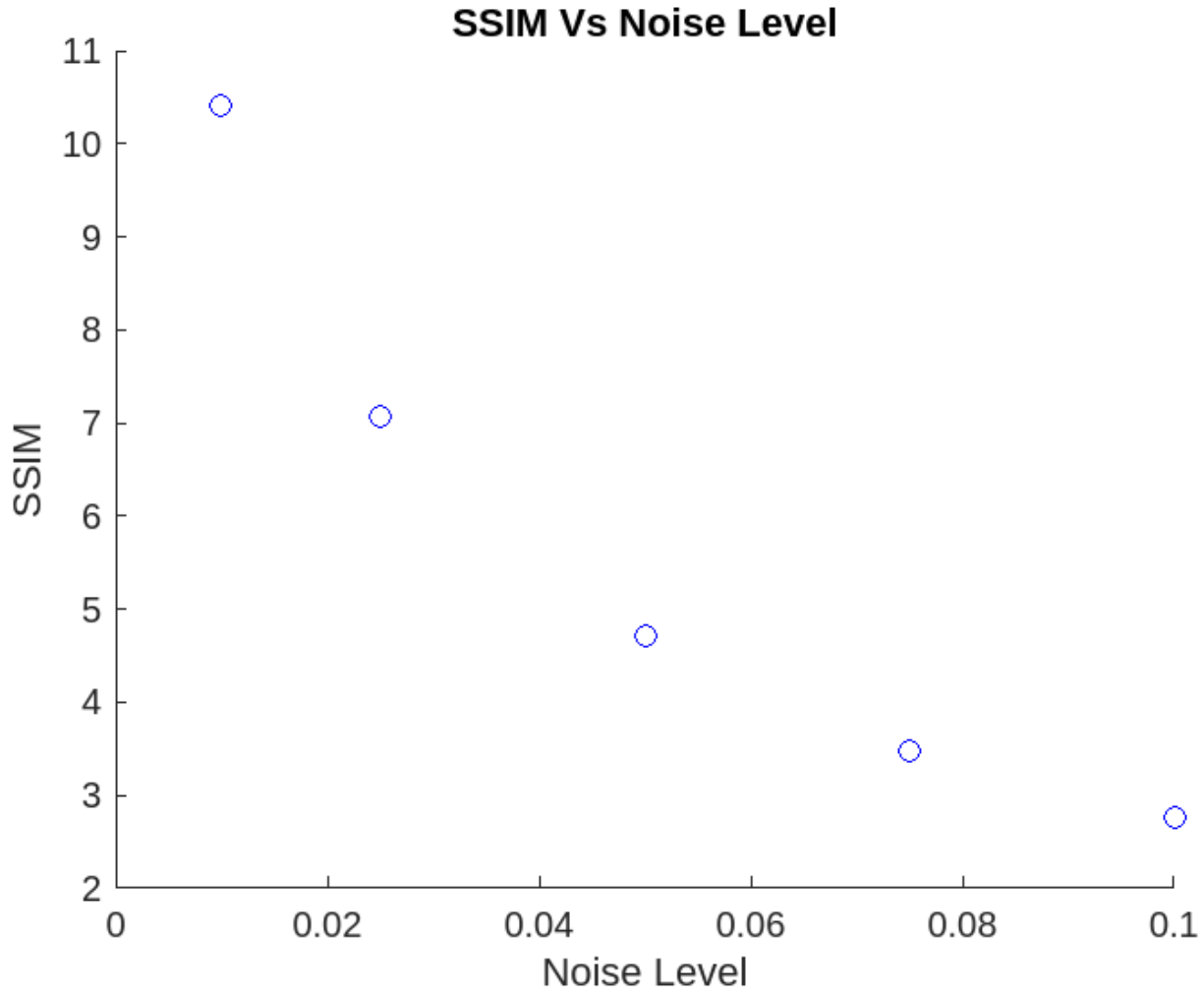
Noise Density: 0.05, PSNR for Denoisy: 21.1745, SSIM for Denoisy: 0.3754



Noise Density: 0.75, PSNR for Denoisy: 19.6439, SSIM for Denoisy: 0.3754



Noise Density: 0.1, PSNR for Denoisy: 18.6439, SSIM for Denoisy: 0.3492



A larger PSNR indicates that noise has a smaller relative signal, and is associated with higher image quality. SSIM: Structural Similarity, structural similarity, is also a full-reference image quality evaluation index, which measures image similarity from three aspects: brightness, contrast, and structure. The value range of SSIM is [0,1]. The larger the value, the smaller the image distortion. An SSIM index close to 1 indicates good agreement with the reference image, and higher image quality. SSIM is superior to PSNR in image denoising and image similarity evaluation.

Conclusions

This work demonstrates MATLAB pretrained denoising CNNs and their effectiveness at various noise density levels. If we put a very small noise level of the image, we will get a more similar denoise image with the original image, and better SSIM value, which means the accuracy is higher. On the other hand, with a higher noise level of the image, the output denoise image will be more different with the original image, because there are more distractors to get close to the original.

Appendix A

The MATLAB code is hosted on GitHub.

https://github.com/LukeWuU/COSC-4372-Project.git

- finalProject.m: The base of the project. Simply run for the results and data. Used for individual observation and testing.
- finalProjectCmpOutputs.m: Alternative that displays all models and noise levels along with SSIM vs. Noise Level graph

References

Deep Learning Toolbox. Get started with deep learning toolbox. (n.d.). Retrieved December 7, 2022, from https://www.mathworks.com/help/deeplearning/getting-started-with-deep-learning-toolbox.html

Image Processing Toolbox. Get started with image processing toolbox. (n.d.). Retrieved December 7, 2022, from https://www.mathworks.com/help/images/getting-started-with-image-processing-toolbox.html