DENOISING AUTOENCODER FOR THE REMOVAL OF NOISE IN MEDICAL IMAGES

Guided by
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Contents

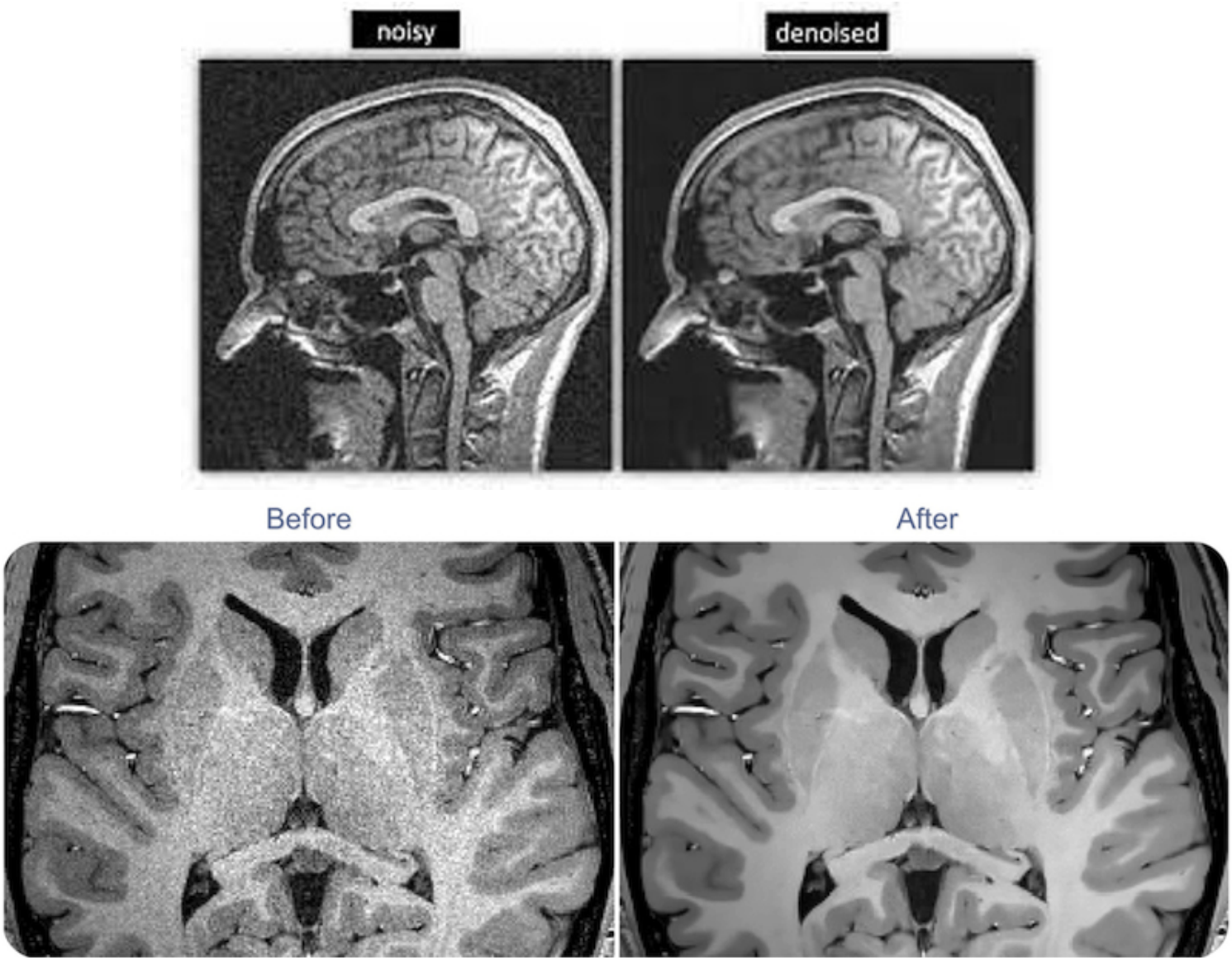
Introduction

- Medical imaging including X-rays, Magnetic Resonance Imaging (MRI), Computer Tomography (CT), ultrasound etc. are susceptible to noise.So denoising is often required for proper image analysis.
- Common deep learning techniques used are Denoising AutoEncoder(DAE) ,Noise2Noise ,Noise2Void ,and GANs .
- **Most of these methods are based on the use of Convolutional Neural Networks, which take advantage of the spatially structured information in medical images that has enabled neural networks to outperform other methods for image processing.**
- Here we are trying to develop an autoencoder model that can efficiently remove noise from these images.

Introducion(Contd.

- Image denoising is an important pre-processing step in medical image analysis. Different algorithms have been proposed in past three decades with varying denoising performances.
- More recently, having outperformed all conventional methods, deep learning based models have shown a great promise.However they require large training sample size and has high computational costs.
- **Here we will use a denoising autoencoders constructed using convolutional layers for efficient denoising of medical images.**
- Heterogeneous images can be combined to boost sample size for increased denoising performance.
- Simplest of networks can reconstruct images with corruption levels so high that noise and signal are not differentiable to human eye.

Abstract(Contd...



Objectives

1. To denoise medical images (here we mainly try to focus on MRI images) even when noise levels are very high
2. To show that the denoising encoders requires less dataset compared to traditional methods
3. To measure the Structural Similarity Index Measure(SSIM) for its consistency and accuracy

Literature Survey

1. Armando,Fau,Stanislas,Julien Wojak, Hugues,Benkreira,Adel, **"Improving image quality in low-field MRI with Deep learning"**, 2021 IEEE International Conference on Image Processing

2. Lovedeep Gondara, **"Medical image denoising using convolutional denoising autoencoders"**, 2016 IEEE 16th International Conference on Data Mining Workshops (ICDMW).

Methodology

1. Data Preparation
2. Network Architecture and Training
3. Evaluation

Methodology(Contd.

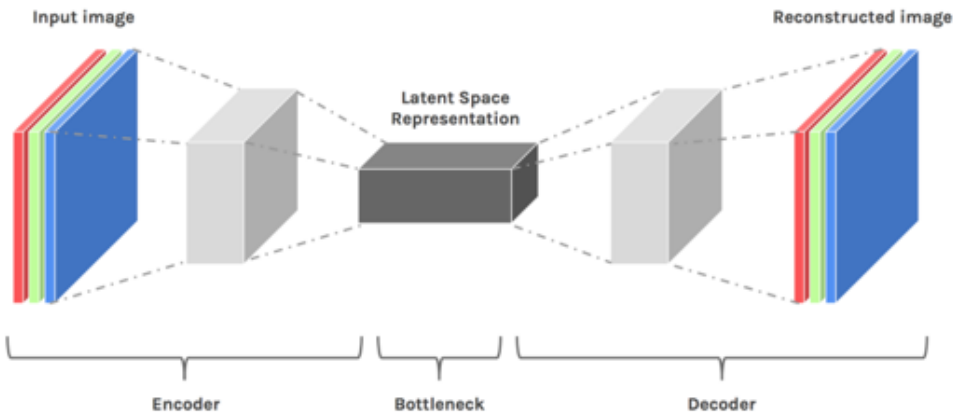
Data Preparation

- Medical images like X-rays,MRI etc. is to be collected
- Preprocessing of the data
- Noisy training data is to be generated by artificially adding noise
- Different noise levels are to be introduced
- The data is split randomly for training and validation, while the remaining for testing.

Methodology(Contd..

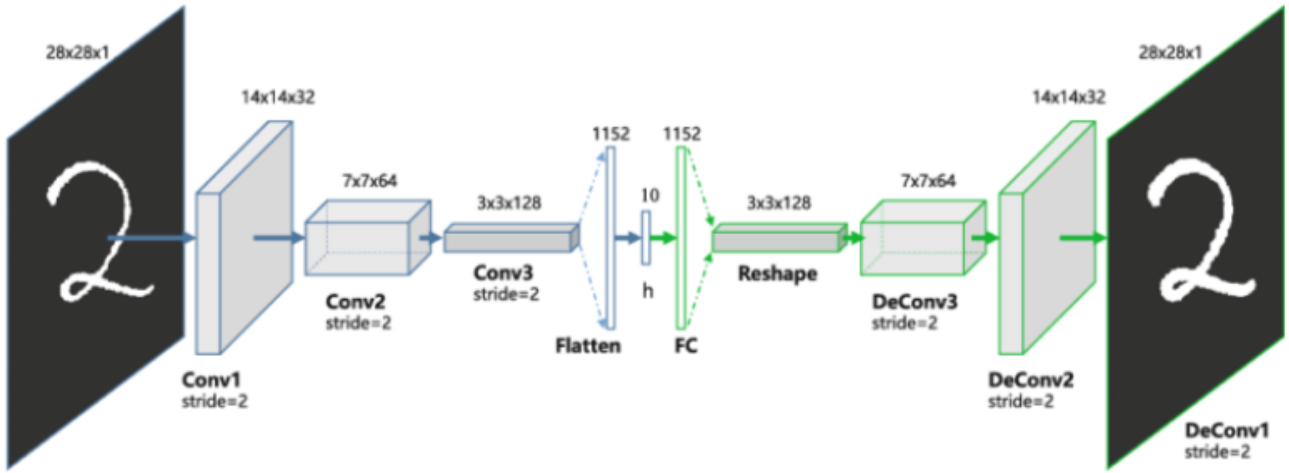
Network Architecture and Training

- Autoencoders are Neural Networks which are commonly used for feature selection and extraction.
- Denoising autoencoder is a stochastic extension to classic autoencoder.
- We force the model to learn reconstruction of input given its noisy version.
- They corrupt the data on purpose by randomly turning some of the input values to zero.



Methodology(Contd..

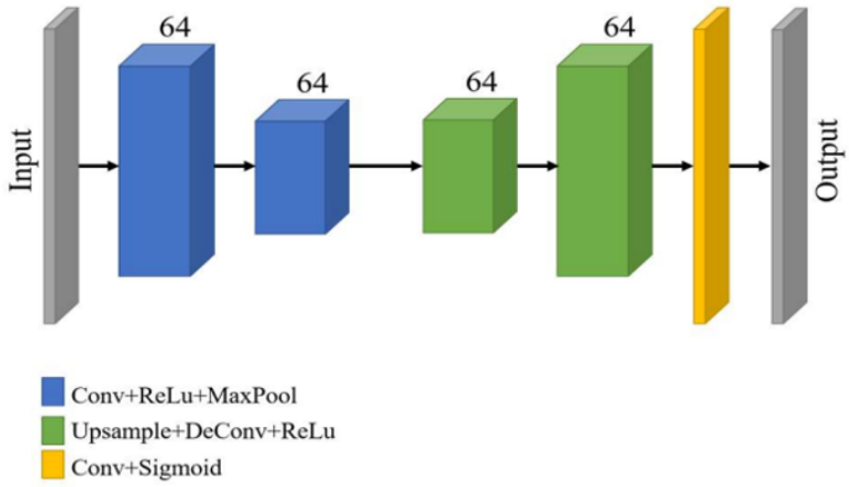
- The best-known neural network for modeling image data is the Convolutional Neural Network (CNN, or ConvNet).
- It can better retain the connected information between the pixels of an image.
- The particular design of the layers in a CNN makes it a better choice to process image data.
- When CNN is used for image noise reduction,it is applied in an Autoencoder framework, i.e, the CNN is used in the encoding and decoding parts of an autoencoder.



Methodology(Contd...

input_1 (InputLayer)	input:	(None, 1, 64, 64)
	output:	(None, 1, 64, 64)
convolution2d_1 (Convolution2D)	input:	(None, 1, 64, 64)
	output:	(None, 64, 64, 64)
maxpooling2d_1 (MaxPooling2D)	input:	(None, 64, 64, 64)
	output:	(None, 64, 32, 32)
convolution2d_2 (Convolution2D)	input:	(None, 64, 32, 32)
	output:	(None, 64, 32, 32)
maxpooling2d_2 (MaxPooling2D)	input:	(None, 64, 32, 32)
	output:	(None, 64, 16, 16)
convolution2d_3 (Convolution2D)	input:	(None, 64, 16, 16)
	output:	(None, 64, 16, 16)
upsampling2d_1 (UpSampling2D)	input:	(None, 64, 16, 16)
	output:	(None, 64, 32, 32)
convolution2d_4 (Convolution2D)	input:	(None, 64, 32, 32)
	output:	(None, 64, 32, 32)
upsampling2d_2 (UpSampling2D)	input:	(None, 64, 32, 32)
	output:	(None, 64, 64, 64)
convolution2d_5 (Convolution2D)	input:	(None, 64, 64, 64)
	output:	(None, 1, 64, 64)

Architecture of CNN DAE



Denoising AutoEncoder architecture

Methodology

Evaluation

- To evaluate the performance of the DAE ,MSE, Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity (SSIM) Index were used.
- These metrics are usually calculated on the test image-set that are not seen by the network during training.
- PSNR is related to MSE in that it measures the ratio of maximum pixel intensity in the image to the distortion that affects it .
- SSIM provides a more accurate and consistent metric for human perception.
- The SSIM values ranges between 0 to 1, 1 means perfect match the reconstruct image with original one.Generally SSIM values 0.97, 0.98, 0.99 for good quality reconstruction techniques.

Workplan

Timeline for Tasks in Phase I		
Task	**Task Description**	**Deadline**
1	Basic understanding of python libraries, various research papers, concepts in deep learning	15/10/22
2	Understanding about different types of Denoising autoencoders	25/10/22
3	Data collection and preprocessing	30/10/22
4	Model selection for autoencoder	10/11/22
5	Model training using Gaussian noise	25/11/22
6	Testing and evaluation	30/11/22
7	Presentation for project phase 1	05/12/22
8	Report for project phase 1	10/12/22

References

- Lovedeep Gondara, "Medical image denoising using convolutional denoising autoencoders", 2016 IEEE 16th International Conference on Data Mining Workshops (ICDMW).
- Armando,Fau,Stanislas,Julien Wojak, Hugues,Benkreira,Adel," Improving image quality in low-field MRI with Deep learning ", 2021 IEEE International Conference on Image Processing
- El-Shafai,El-Nabi, El-Sayed,El-Rabaie,Ali1,Soliman, Algarni,El-Samie,"Efficient Deep-Learning-Based Autoencoder Denoising Approach for Medical Image Diagnosis"
- Image denoising using autoencoders-a beginners guide to deep learning project

Work Done So Far

1. Denoised images from MNIST dataset using a simple autoencoder build using ANN
2. Collected the MRI image dataset from kaggle

Thank You