Tomographic Medical Image Reconstruction using Deep Learning Semester 2 Plan

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Project Goals

Goals

- Generate high quality synthetic medical data.
- Build a neural network that can efficiently reconstruct medical SPECT data.

Motivation

- We would like to enhance our knowledge of deep-learning and understand how it can be applied to medical imaging.
- We aim to improve how medical image reconstruction is performed.

Features

- The user can generate synthetic SPECT data
- The user can reconstruct SPECT data more quickly than standard methods allow
  - This is a form of zero-shot learning, as our training data is all synthetic
- A user with the proper training can evaluate the reconstructed images and identify potential heart defects.
  - They will be able to rotate the image, zoom out, etc. in order to do this

Novel features and functionalities

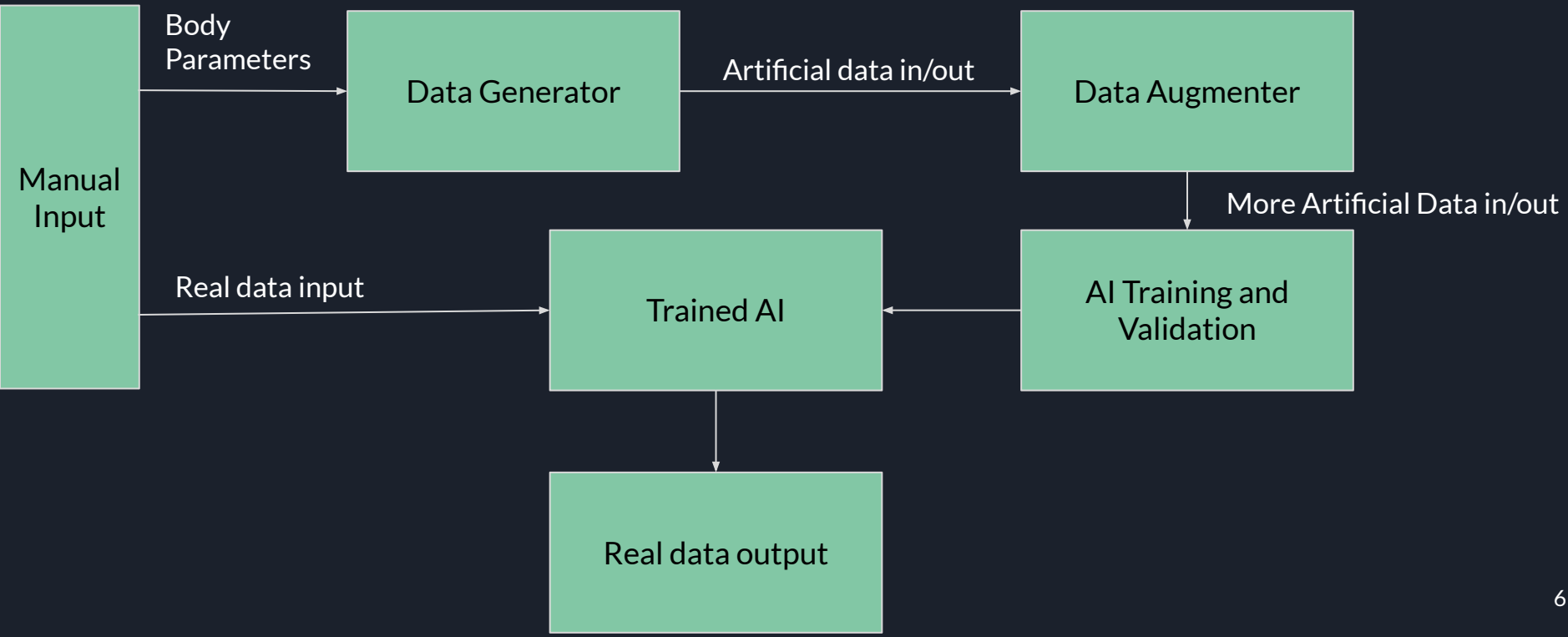
Ways in which our project is unique:

- To the best of our knowledge, no one has ever done a 3D medical image reconstruction by training a neural network without real data.
- The user can view the reconstructed image in milliseconds, whereas it would take upwards of 30 seconds using traditional reconstruction methods.

Technical Challenges

- Our system is bottlenecked by the need to generate more artificial SPECT data in order to train our AI.
- We have no idea how our AI will perform on real data.
- We each need to familiarize ourselves more with different portions of the project.

Design


Manual Input
Body Parameters
Data Generator
Artificial data in/out
Data Augmenter
More Artificial Data in/out
AI Training and Validation
Real data input
Trained AI
Real data output

Evaluation

- We will evaluate our system against objective measures in our requirements document
- We are currently experimenting with image evaluation functions to evaluate our AI outputs

Progress Summary

Module/feature	Completion %	To do
Synthetic data generation	95%	Finish refactoring existing code for more convenient use. Use this data generation pipeline to generate data for AI training (below).
Reconstruction via CNN with Zero-Shot Learning	50%	Choose a better loss function. Generate more training data. Refine AI parameters. Continue fine-tuning the model until we achieve the best possible reconstruction. Look into utilizing AI Panther for faster training. This is our primary focus this semester.
Image viewing	90%	Tool already exists (Fiji/ImageJ); Just need to integrate it with existing methods.

Action Items for Milestone 4

- Generate 3,000 sinograms using the model pipeline
- Train and tune the PyTorch AED model to start reconstructing real sinograms based on the data we have currently
- Validate the model on synthetic data through AI Panther
- Incorporate the validation scoring method for reconstruction quality

Action Items for Milestone 5

- Test the AI on real medical data
- Conduct evaluation and analyze results
- Create project poster

Action Items for Milestone 6

- Finish testing the CNN
- Identify best AI parameters and keep them as our final product
- Test/demo of the entire system
- Conduct evaluation and analyze results
- Create user/developer manual
- Create demo video

Task Matrix (Milestone 4)

Task Matrix for Milestone 4	Asher	Chris	Ty
Generate 3000 sinograms using the model pipeline	10%	10%	80%
Train and tune the PyTorch AED model to start reconstructing real sinograms based on the data we have currently	35%	35%	30%
Validate the model on synthetic data through AI Panther	45%	45%	10%
Incorporate the validation scoring method for reconstruction quality	40%	40%	20%