MRI image reconstruction using fastMRI library

fastMRI

fastMRI is colaborative exploratory project from Facebook AI Research with goal of developing faster ways of MRI image acquisition. It consists of datasets of brain and knee MRI images, and of code repository with tools to work with dataset and model implementation.

Models in fastMRI library

Zero-Filled

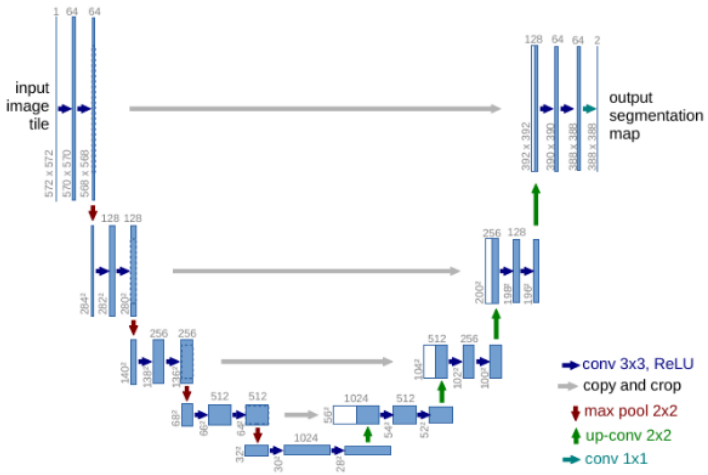
Fills unsampled k-space data with zeroes. Then it applies twodimensional IFT to it and calculates end result.

Compressed Sensing

Compressed Sensing is based on mathematical principal which states images and signals can be represented with less data without loosing significant amount of information, as long as most of the data is zero in some domain. Implementation in fastMRI is based on ESPIRiT work.

U-Net

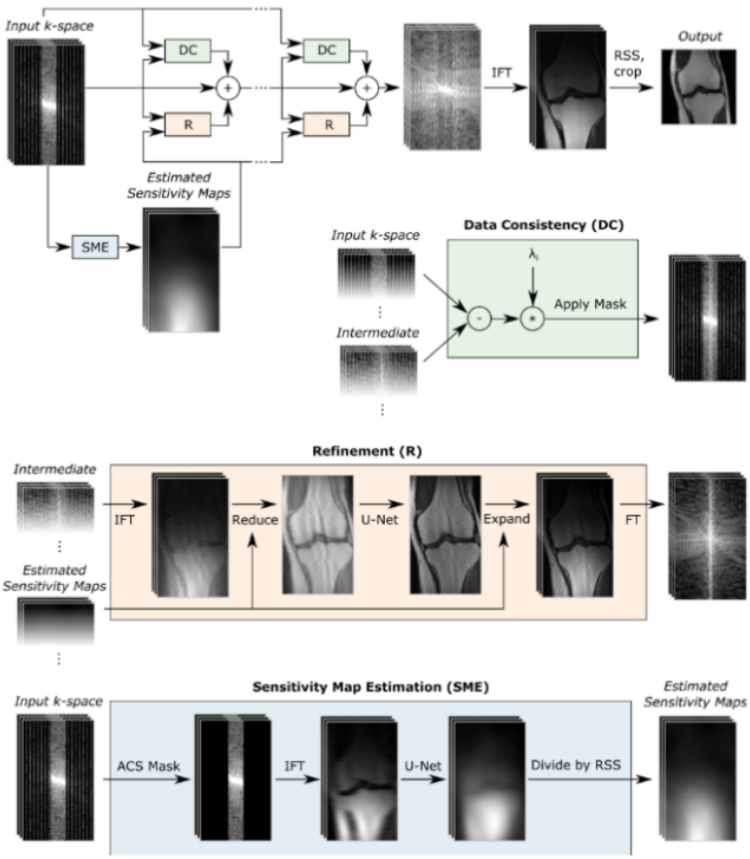
The U-Net model provided by fastMRI is designed for single-coil image reconstruction, but can be adapted to multi-coil images using the zero-fill method for each coil. The model consists of two main paths: a compression path and decompression path. Compression path goal is context and content capture using 3x3 convolutions, instance normalization, ReLU activation and max-pooling down-sampling. Decompresion path is used for spatial localization and block up-scaleing. Both paths are connected with skip connections which enchance detail and precision in the output using high-resolution features.



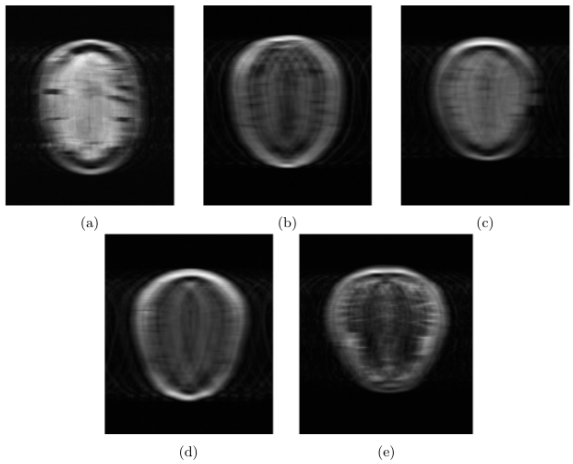
End-to-End VarNet

End-to-End Varnet model is designet do learn complete process of reconstruction. End-to-End means we can give it raw data without any preprocessing and it will give out processed result.

It takes multi coil k-space as input and it applies a series of refinement steps which we call cascades. Each cascade applies an enhancement step similar to gradient descent, but the intermedieate product is k-space, not an image.

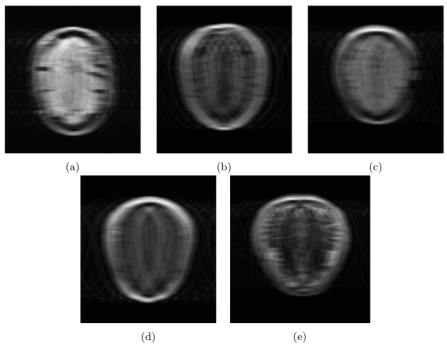


Results:



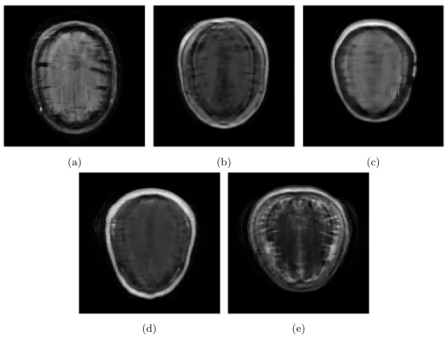
Slika 10: Prikaz testnih slika dobivenih a) AXFLAIR, b) AXT1, c) AXT1PRE, d) AXT1POST i d) AXT2 protokolima.

Test images



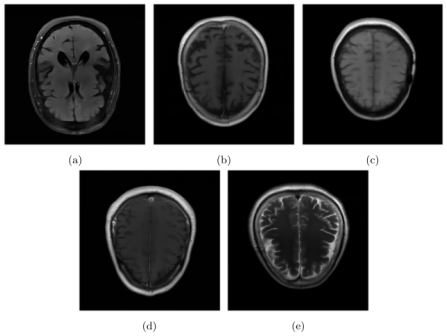
Slika 11: Prikaz testnih slika na kojima je primjenjena *zero-fill* tehnika. a) AXFLAIR, b) AXT1, c) AXT1PRE, d) AXT1POST i d) AXT2.

Zero-fill



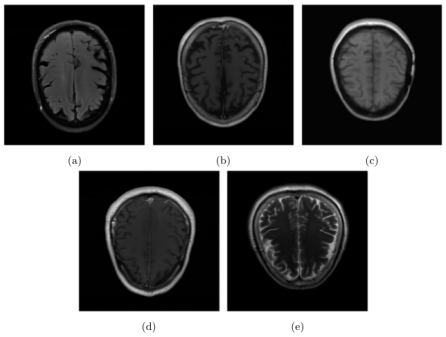
Slika 12: Prikaz testnih slika na kojima je primijenjena *compressed sensing* tehnika. a) AXFLAIR, b) AXT1, c) AXT1PRE, d) AXT1POST i d) AXT2.

Compressed Sensing



Slika 14: Prikaz testnih slika na kojima je primijenjen U-Net model. a) AXFLAIR, b) AXT1, c) AXT1PRE, d) AXT1POST i d) AXT2.

U-Net



Slika 13: Prikaz testnih slika na kojima je primijenjena VarNet model. a) AXFLAIR, b) AXT1, c) AXT1PRE, d) AXT1POST i d) AXT2.

End-to-End VarNet

Future

Goal is to implement modifies U-Net and VarNet models and adapt them for the tash of reconstructing MRI brain images. The to display, explain and compare the results and determine the accuracy of the developed system.