**Faster and Better MRI using Generative AI**

* Motivations
  + MRI is slow
    - Possible solutions
      * Compressed sensing: collect fraction of data
        + Uses alternating minimization approach by alternating between conjugate step and denoiser
      * Recover images using deep learning
        + Fast
        + Needs a lot of training data
  + Motion artifacts/noise during process
* Diffusion Model
  + Train a denoising model by iteratively denoising an image
  + Use a diffusion model and a guidance system
  + Reconstructions was pretty fast
  + Currently under FDA approval
  + What if methods do not have fully sampled data
* Challenges
  + Requires a lot of data and hard to acquire
    - What about applying to different parts of the body
  + Are the models really robust
    - Convergence guarantees
    - Guarantee robustness
* Build Larger and Robust Models
  + Use equilibrium model
    - Unique fixed point iff some condition is satisfied
    - Way to measure robustness to perturbation
  + Constrain operator to be monotone
    - Assumption: data lies on a low-dimensional manifold
      * Operator is monotone in a certain ball => relaxes monotonicity performance
      * Successful
      * Still not perfect
* Unrolling
  + Adding noise => unrolling makes it more robust
    - Unrolling improves quality but not universal
* Proposal
  + Join pretrained model with another model
  + Pre-learn energy model for image recovery
  + Train combination of energy model
  + One algorithm that has multiple energy steps even though it has one energy function and trained it on multiple noise levels
* Extensions/Applications
  + Segmentation
  + Motion compensation
  + Silence
  + Cardiac mri
  + Pseudo-3D speech MRI

Mathews Jacob is from the UVA’s ECE department and in the *Generative AI for Faster and Better MRI* talk, he discusses using generative AI in order to make better MRI’s. Some of the problems he describes in the talk is that current MRI technology tends to be very slow and noise/artifacts can be introduced during the process. A couple of solutions were proposed. One approach was to compress the amount of sensor data collected by alternating minimization approach by alternating between the conjugate step and the denoiser. The second approach was to recover images using a deep learning algorithm which would be fast but requires lots of training. Diffusion models which train a denoising model by iteratively denoising an image was also proposed but the approach is still under FDA approval and may not fully sample data. Some of the challenges for making better MRIs include requiring a lot of data that is hard to acquire and current models are not robust enough for more unusual cases. Therefore, Jacob’s research team proposes to join a pretrained model with another model. The model will pre-learn the energy model for the image recovery and trains a combination of energy models. They also propose a single algorithm that has multiple energy steps, one energy function, and trained on multiple noise levels. Possible extensions and limitations with the proposed approach includes segmentation for various body parts, motion compensation, silence, cardiac MRI, and pseudo-3D speech MRI. One thing I thought was insightful was the use of machine learning model for something like an MRI machine, especially using a diffusion model to recover an image. It is quite interesting and a new way to perceive diffusion models. Perhaps instead of only generating images, it could also be used to make images more clearer.