INTRODUCTION

- Majority of the image reconstruction models were trained based on a dataset that does not contain raw data. The phase of the image is typically missing or being synthesized[1].
- A standard repository of raw data training dataset which includes phase information is needed for deep learning MRI reconstruction models[2].
- Deep learning model which directly reconstructs raw scanner data can be non-practical due to the heavy memory requirement of the fully connected layers[2].
- Image Reconstruction Database (ImRiD) is designed exclusively for the purpose of training deep learning MR image reconstruction models.
- ImRiD provide the MR reconstruction development community a standard database.

METHODS

- 3D T1 weighted MP-RAGE scan of the American College of Radiology (ACR) and Alzheimer’s Disease Neuroimaging Initiative (ADNI) phantom were acquired on a 3T Siemens Prisma scanner.
- The acquisition parameters: FOV=256x256x192 mm³, TR=900 ms, flip angle=8°, TR=2300 ms, isotropic voxel size of 1.05 mm with a matrix size of 254 x 254 x 192.
- This was performed to utilize the T1 targets available in phantoms for quantitative imaging.
- The orthogonal slices and arbitrary slices (Figure 2) were chosen by indicating the vector normal to the desired plane.
- Then the corresponding k-space mapping can be obtained by performing the inverse Fourier transform. The MATLAB code to leverage these planes are provided in the GitHub repository[3]. The code for arbitrary plane selection is downloadable from ref.[4].
- To demonstrate the importance of phase in MR reconstructions, the k-space from the magnitude of the images was synthesized and multiplied with random phase maps as shown in figure 1a.

RESULTS

Figure 1 shows an axial slice of the ACR phantom with original (1b,f) and randomly applied phase (1c,g). Figures (1d,h) and (1e,i) correspond to the ADNI phantom. The data is available at ref.[5] for free download.

Figure 2 shows orthogonal slice of ACR phantom. Position of the slice is visualized by the blue line in the actual phantom picture.

Figure 3 shows arbitrary plane obtained from ADNI phantom data. It illustrates that the arbitrary plane can be specified and obtain from the database.

DISCUSSION

The proposed data set could be utilized as a standard training data for deep learning MR image reconstruction algorithms for the following reasons:
- MR data from these phantoms are typically employed to test/calibrate the system as well as protocols;
- The complex image data captures the phase, noise and related characteristics of the system;
- Image processing algorithms to slice an acquired 3D complex volume with high resolution would provide infinite number of slices and therefore unrestricted size of example to train on;
- Extension to include acquisition methods tied to hardware such as parallel imaging, selective excitation could be easily and directly incorporated;
- This library could be then also used to under-sample k-space with different non-Cartesian trajectories to perform transform learning of under-sampled data;
- The ground truth/construction of the phantom is well specified and purposely designed.

CONCLUSION

- The number of training examples that can be obtained from this dataset is infinite.
- Researchers can perform the experiment detailed in this work readily, easily and in line with tests determined by respective guidelines such as those provided by ACR and/or ADNI.
- Phantom tests cover different aspects of MR image quality such as low contrast detectability, resolution, slice thickness, slice accuracy, etc.
- This would allow benchmarking the reconstructions performed using deep learning in line with these prescribed tests by the phantom makers/approvers.
- Reconstruction algorithms trained would cater to multiple anatomies and related artifacts. Therefore, the model would be trained to learn the transform rather than be restricted by the anatomy.
- For a typical training process, the full k-space information of an image can be sub-sampled by any k-space sampling methods the researchers propose (such as radial, spiral). The actual slice image can be the ground truth that the resampled k-space would be trained against.

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REFERENCES

[5] https://drive.google.com/drive/folders/1i7C2bk7psdcZ91a28Vid38yopXVC8zj?usp=sharing