# ABSTRACT SUBMISSION FORM

Please email to: info@mriinrt2018.com with 'abstract' as the subject

6th MR in RT Symposium 2018



| | |
|---|---|
| Name (First, last) | Yihang Zhou |
| Mailing address (including province/state, country, postal/zip code) | 8/F, Li Shu Fan Block, 2 Village Road, Happy Valley, Hong Kong |
| Institution/organization | Medical Physics and Research Department, Hong Kong Sanatorium & Hospital |
| Position | Assistant Research Officer |
| Telephone (including country prefix) | +852 2835 3475 |
| Email | |



| The submission is to be considered in the following category | Trainee status |
|---|---|
| ☒ Oral presentation preferred | ☐ I am a trainee (student or postdoctoral fellow) |
| ☐ Poster presentation only | ☐ I wish to be a candidate for best student paper/poster |

**PRESENTATION TITLE**

**Accelerating 3D head-and-neck MR imaging using convolutional neural network for MR-guided radiotherapy**

**AUTHOR(S)**


Yihang Zhou[1]*, Jing Yuan[1], Kin Yin Cheung[1], Siu Ki Yu[1]


**ABSTRACT**


**Purpose:**

MR image-guided radiotherapy (IGRT) holds potentials on outcome improvement and toxicity reduction in the head-and-neck (HN) radiotherapy. Accelerating high spatial resolution 3D MR imaging is essential for MR-guided HN IGRT to maximize radiation dose delivery to target tumor meanwhile minimize the radiation dose in small organ-at-risks (OARs) due to the possible patient motion even under tight immobilization. Recently, deep learning techniques have demonstrated ability to accurately reconstruct images from highly incomplete k-space thus significantly shorten the scan time. In this work, we aim to investigate the feasibility of accelerating high spatial resolution 3D MR imaging using convolutional neural network (CNN) for MR-guided HN radiotherapy application.

**Materials & Methods**:

*Image Acquisition under Radiotherapy Setup:* Eleven healthy volunteers were recruited and informed consent was obtained from each subject. MR images were acquired on a 1.5-Tesla MR scanner (Siemens, Germany) dedicated for radiotherapy applications. All volunteers were immobilized at RT treatment position using a personalized 5-point thermoplastic mask to simulate the HN-RT treatment fractions, and carefully aligned using a well-calibrated 3-dimensional external laser system. T1-weighted SPACE images were acquired with: FOV=470mm×470mm×269mm and matrix size=448×448×256(PE×FE×SE); TR/TE=420/7.2ms, echo train length (ETL)=40, bandwidth =657Hz/pixel, yielding an isotropic voxel size of 1.05mm.

*Image Reconstruction:* The first volunteer's data, in a total of 40 3D volumetric images were used as training data $\mathbf{x}_i$, while other volunteers' data were retrospectively undersampled with AF = 4 to simulate the accelerated scans. The training images were undersampled using the same sampling pattern to generate their corresponding aliased images. Then both the training images and the aliased images were decomposed into overlapping patches with a block size of 33x33 (in total of 460,000 patches) and were put into the convolutional neural network for training. The end-to-end

| | |
|---|---|
| Name (First, last) | Yihang Zhou |
| Mailing address (including province/state, country, postal/zip code) | 8/F, Li Shu Fan Block, 2 Village Road, Happy Valley, Hong Kong |
| Institution/organization | Medical Physics and Research Department, Hong Kong Sanatorium & Hospital |
| Position | Assistant Research Officer |


mapping function $C$ that restores the original MR images from its undersampled data was obtained by: $\Theta = \underset{\Theta}{\operatorname{argmin}} \frac{1}{n}\sum_{i=1}^{n}\left\|C(\mathbf{F}_u^H\mathbf{F}_u\mathbf{x}_i,\Theta)-\mathbf{x}_i\right\|_2^2$, where $\Theta$ is the hidden parameters, $n$ is number of training samples, $\mathbf{F}_u$ is the undersampled Fourier transformation matrix and superscript $H$ represents the complex conjugate transpose.

Once $\Theta$ was learned, we can reconstruct the MR images by: $\mathbf{x} = \arg\min_{\mathbf{x}}\left\|C(\mathbf{F}_u^H\mathbf{y},\Theta)-\mathbf{x}\right\|_2^2 + \lambda\left\|\mathbf{F}_u\mathbf{x}-\mathbf{y}\right\|_2^2$, where $\mathbf{y}$ is the undersampled k-space data from the accelerated scan, and $\lambda$ and $\beta$ are regularization parameters.

**Results:**
Fig. 1 shows different views of one representative slice from the 3D volumetric image of the eleventh volunteer with fully sampled scans, the zero-filled aliasing images from retrospective undersampling, and reconstructed images. It can be seen that the reconstructions are very similar to the fully sampled scans without loss of resolution. In particular, the fine structure information of important small organs-at-risks (OARs) in HN radiotherapy such as pituitary gland and inner ear are well-preserved.

**Conclusions:**
In this study, we investigated the feasibility of applying CNN network to accelerate the acquisition for MR-guided head-and-neck radiotherapy. The preliminary results show that the reconstruction using CNN is able to preserve spatial details of fine OAR structures for highly accelerated scans.

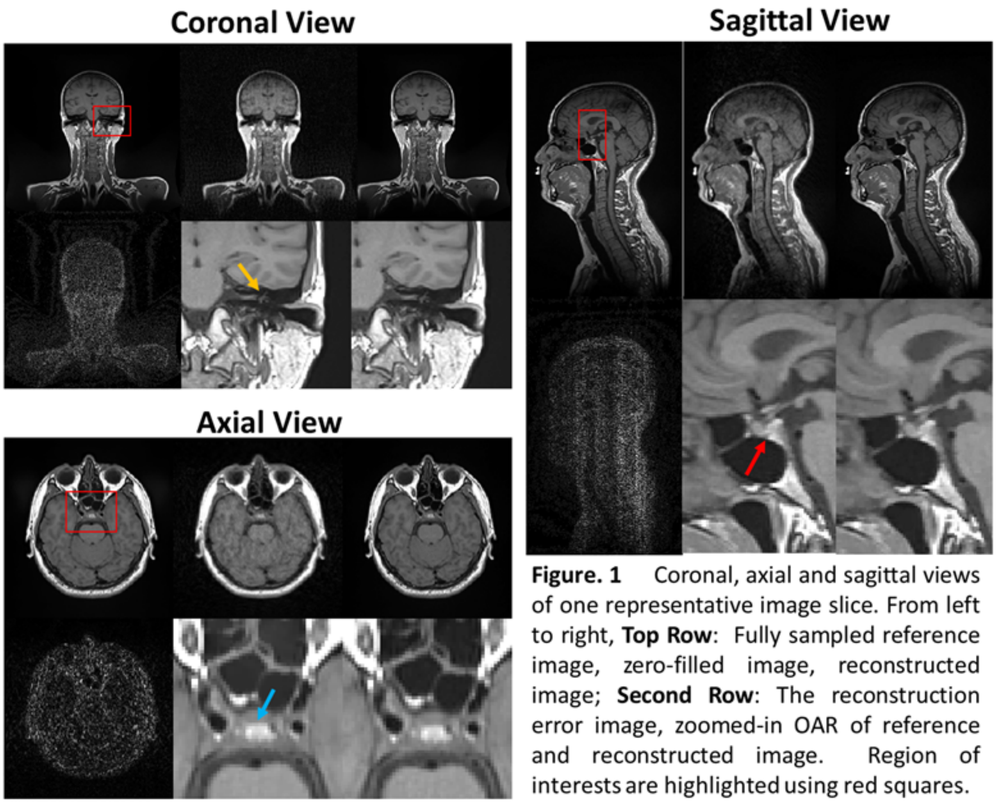


**Figure. 1** Coronal, axial and sagittal views of one representative image slice. From left to right, **Top Row**: Fully sampled reference image, zero-filled image, reconstructed image; **Second Row**: The reconstruction error image, zoomed-in OAR of reference and reconstructed image. Region of interests are highlighted using red squares.