Synthetic Segmented Virtual Head Model Generation Using Generative Adversarial Network (GAN)

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Abstract:
The structural information of the human brain assists in different research such as Transcranial Magnetic Stimulation (TMS), Transcranial Direct Current Stimulation (tDCS), brain tumor detection, uncertainty quantification analysis, etc. However, MRI images of less than 3T resolution are of little use since the tissue boundaries become uncertain in the brain. On the other hand, acquiring a substantial number of higher resolution images (3T, 5T, 7T) is significantly expensive. Hence, an expanded database is often necessary for population-based studies, which is often quite impossible to gather from a single machine, environment, or race of people. Therefore, we aim to develop a workflow to generate synthetic segmented MRI images, which will help in the population-based analysis and machine learning algorithms. Since generating "3D synthetic human head models" is computationally expensive, we aim to work with a single slice of MRI scans. The virtual head models (for ground-truth MRI scans), generated from SimNIBS/Fresurfer, are voxelated to a uniform grid space. Next, we utilize the Generative Adversarial Network (StyleGAN) to produce synthetic segmented MRI slices using over 800 MRI data from Human Connectome Project. The Frechet Inception Distance (FID) score between 5000 generated images and real dataset resembles realistic synthetic data.