Super Resolution of Magnetic Resonance Images

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SUMMARY

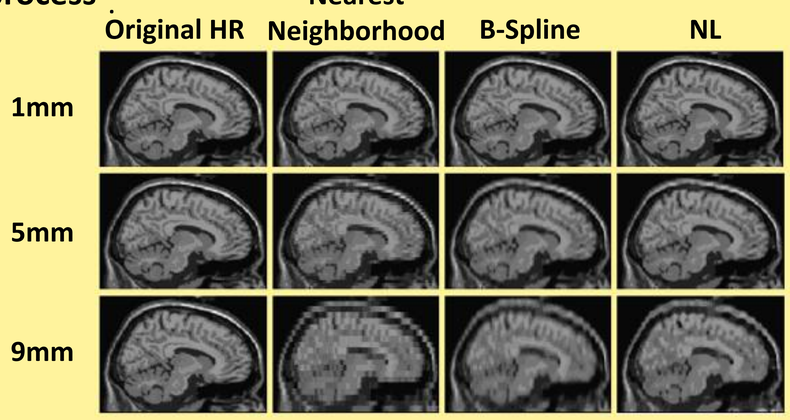
Resolution in Magnetic Resonance (MR) imaging is limited by hardware, signal to noise (SNR), time constraints and patients comfort. To improve image resolution a variety of interpolation techniques are commonly applied resulting in blurrier versions of the original data. In recent years super resolution (SR) techniques have emerged as an alternative to effectively increase the resolution of the reconstructed data.

BACKGROUND

- Multiple image SR: Superposition of multiple low resolution (LR) images with small shift.
- Single image patch-based non-local reconstruction (NL): Takes advantage of image self similarity using regularization expression. Voxels in the LR data can be related to the corresponding underlying high resolution (HR) voxels by:

$$y_p = \frac{1}{N}\sum_{i=1}^{N} x_i + n$$

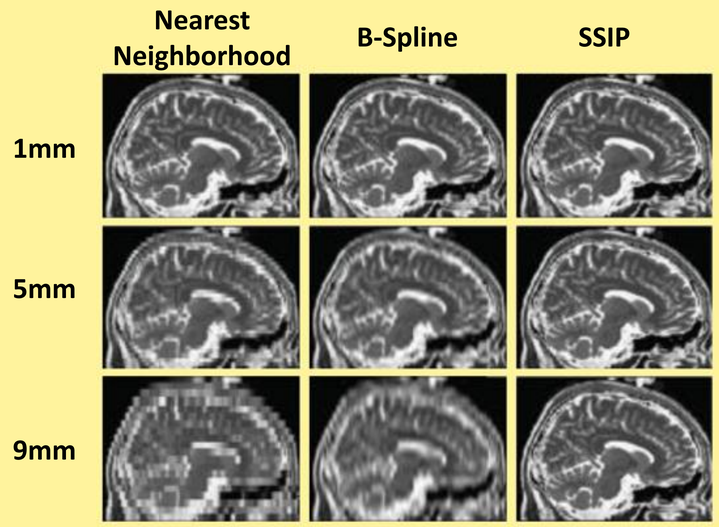
Where y_p is the observed LR voxel at location p, x_i is each of the N HR voxels contain within this LR voxel, and n is the additive noise from the measurement process[1].



Sagittal view of reconstructed downsampled version of HR T1-w with no noise added. The LR data were upsampled using different methods. Visual appearance seems much better with the NL approach for all slice thickness .

BACKGROUND

- Self similarity and image priors (SSIP): Having HR data of the same subject available, is possible to recover some of the lost high frequency information in the LR image. Anatomical information from the HR data can be used to recover image detail in the SR reconstruction[2].



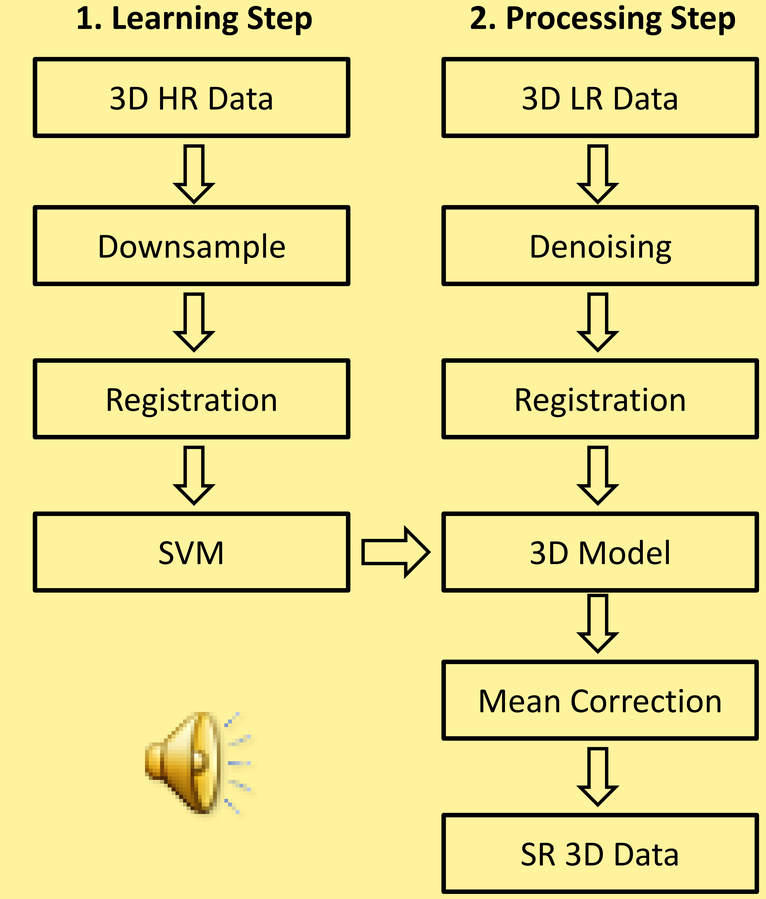
Sagittal view of reconstructed downsampled version of HR T2-w images for a normal anatomy with no noise added. The SSIP algorithm had as reference a HR T1-w from the same subject. The reconstructed data was compared to reconstructions with different interpolations techniques. The SSIP method improves the results for all slice thickness.

SUPER RESOLUTION

SR of MR would improve:

- Detection and visualization of small anatomical structures within the brain
- Detection of emerging lesions (ie. cancer ,stroke)
- Detection of lesion boundaries for therapeutic intervention
- Provide improved anatomical basis for resting state and fMRI network analysis via improved connectivity maps

APPROACH



Based on anatomical similarities of brain structures a 3D model learned by support vector machine (SVM) can be applied to a MR volume to obtain high quality SR images.

CONCLUSIONS

Future work will include the evaluation of SR based on contrast to noise (CNR).

ACKNOWLEDGEMENTS

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REFERENCES

[1]Manjón MRI Superresolution Using Self-Similarity and Image Priors. International Journal of Biomedical Imaging Volume 2010.

[2]Manjón, Non-Local MRI upsampling. Medical Image Analysis 14 (2010) 784–792