Magnetic Resonance Image Reconstruction

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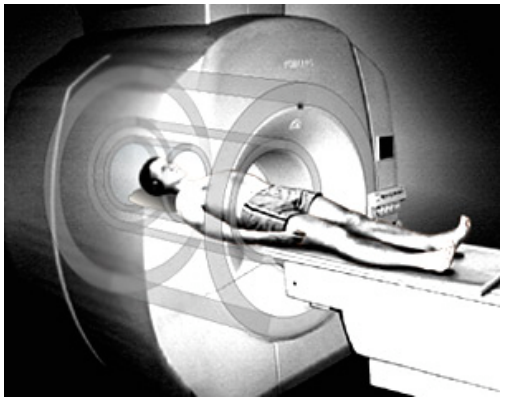
Background

- Magnetic Resonance Images are detailed images of the body in and given plane.
- The images are created by the alignment of hydrogen atoms in our body with the magnetic field created by the MRI machine.
- The MRI image is especially useful in the detection of tumors, the measuring of blood flow, the detection of nerve problems and testing of cardiovascular functionality



MRI machines

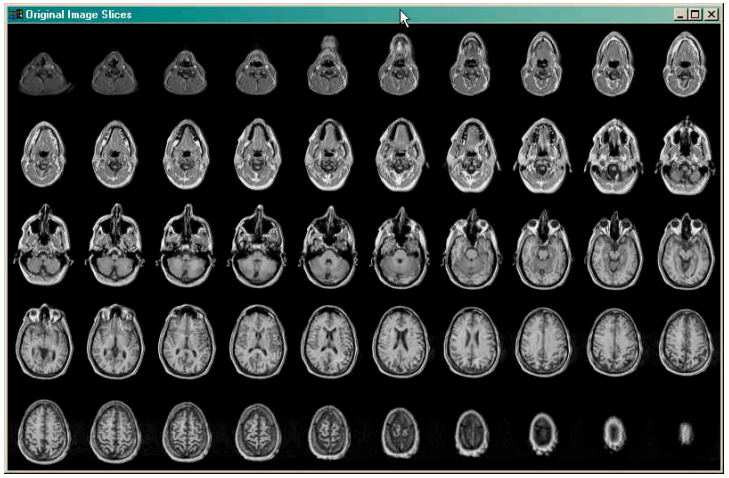
Motivation

- Quicker reconstruction leads to a quicker diagnosis and immediate treatment, ultimately yielding better health care.
- When using MR images for blood flow analysis the only way to see irregularities in blood flow is through generating slices in real time.
- A typical 3D MR image acquisition takes approximately 22 minutes.
- If one employs an accelerated method for acquisition, pMRI, at an acceleration of 4x, the time can be reduced to 5.3 minutes.

Problem

- In the MRI problem we are attempting to find a quick and less expensive way of building a 3D image from a series of 2D slices. Accelerated parallel MR imaging, which builds the MR images from data taken with many receiver coils, is a good way to increase the efficiency of gathering information from an MRI scan, but is not used regularly because it is computationally costly.
- Our goal is to come up with an algorithm that reconstructs the images quickly with the ultimate goal of being to reconstruct them in real time.

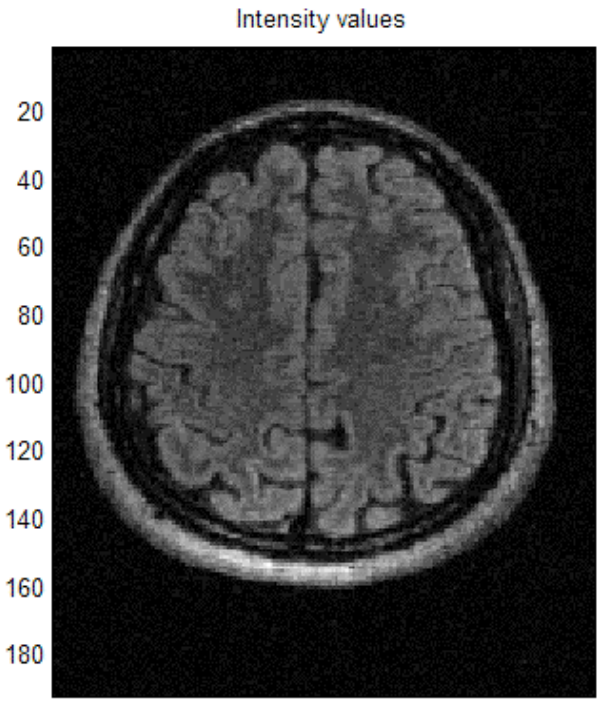
These two dimensional images are stacked one on top of another to create the three dimensional image of the brain.



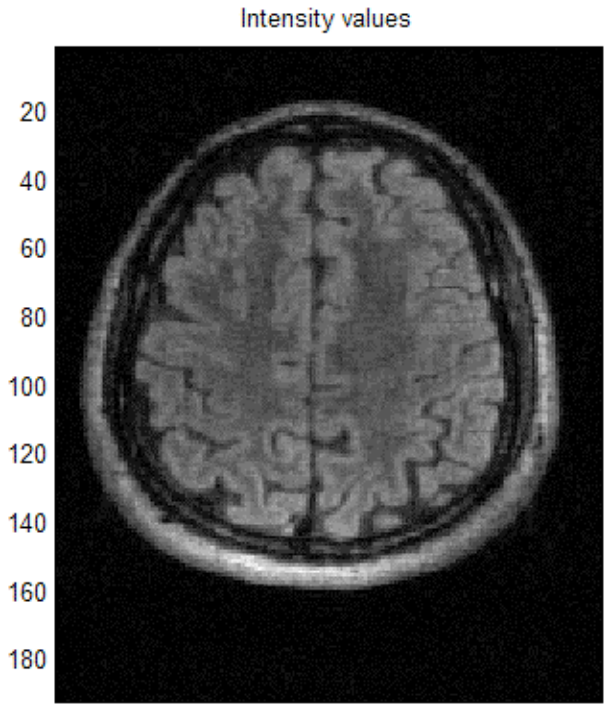
Algorithm

- The first used the framework of the Singular Value Decompositions (SVD) to reconstruct an MR Image. The SVD is defined as the decomposition, $A=U\sigma V^T$ where U and V are orthogonal matrices and σ is a diagonal matrix.
- In the algorithm that we propose to help solve the problem of costly MRI reconstructions, we first reconstruct one slice by an approximate TSVD obtained by an iterative method. The cost of this computation is 2(nlog(n)) for and n x n image in this problem.
- The cost to do an approximate TSVD reconstruction is too expensive for multiple slices, so the idea is to re-use approximate SVD's from previous slices to reconstruct subsequent slices.

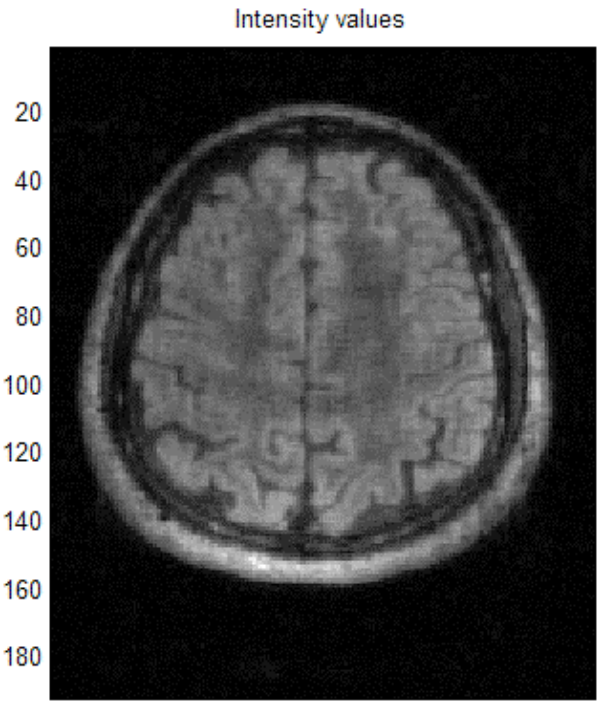
Results



Reconstruction of slice 83 using its own SVD.



Reconstruction of slice 83 using the SVD of the previous slice.



Reconstruction of slice 83 using the SVD of the slice 2 slices before it.

Further Research

- Since the reconstruction of the third image doesn’t have enough contrast and clarity to be used in medical diagnoses we are looking to find a new way of creating the images and reusing data in order to improve on quality while still increasing the speed at which images are reconstructed.

Thank you!

Any questions?