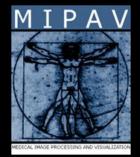
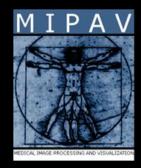


Creating a Streamlined Pipeline Utility for the Analysis of Universal Diffusion Tensor Imaging Data



Beth Tyrie October 20, 2011

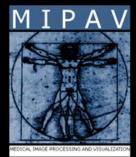




What is MIPAV?



- Medical Image Processing, Analysis, and Visualization
- Created by the Biomedical Imaging Research Services Section (BIRSS) of the Center for Information Technology (CIT)
- Enables quantitative analysis and visualization of medical images from numerous modalities (i.e. PET, MRI, CT, microscopy)

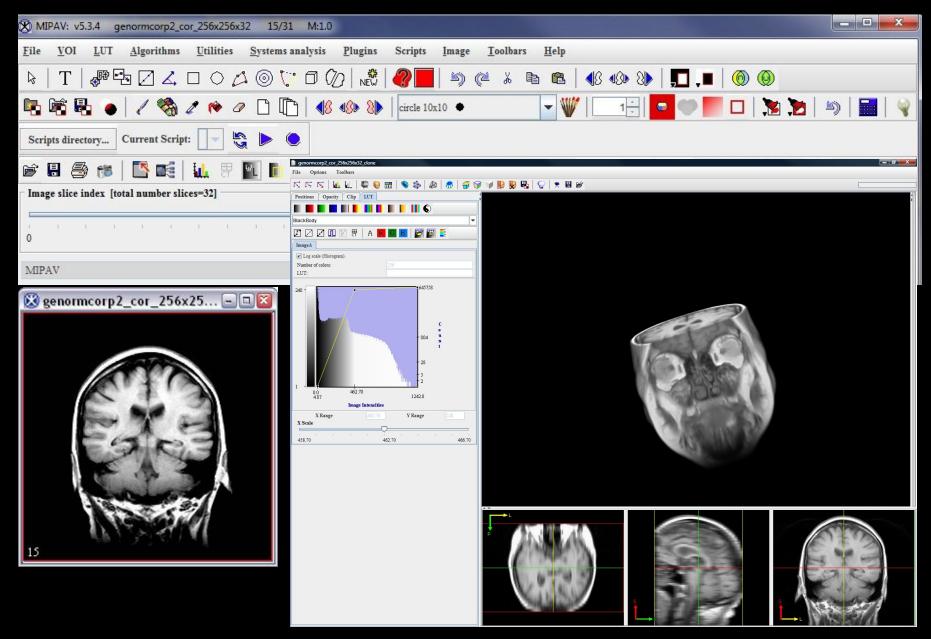


MIPAV Goals



- Develop computational methods and algorithms to analyze and quantify biomedical data
- Establish collaborations with NIH researchers and colleagues at other research centers
- Provide needed tools (in both hardware and software) to support the discovery and advancement of biomedical knowledge.

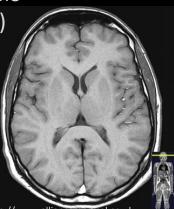
MIPAV Interface



Conventional Magnetic Resonance Imaging vs. Diffusion Tensor Imaging

MRI

- Directly constructs an image of soft tissue in the body by using magnetic fields
- In the brain, MRI shows distinction between white and gray matter
 - Does not show fine detail of the white matter (neuronal tracts)



http://www.alliancemedical.co.uk

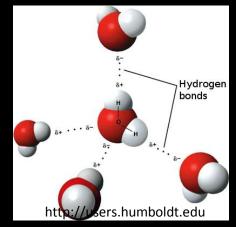


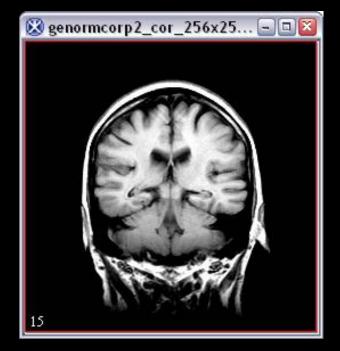
- Determines directionality and magnitude of water diffusion in the brain
 - This information is used calculate to fiber tract anatomy located in the white matter



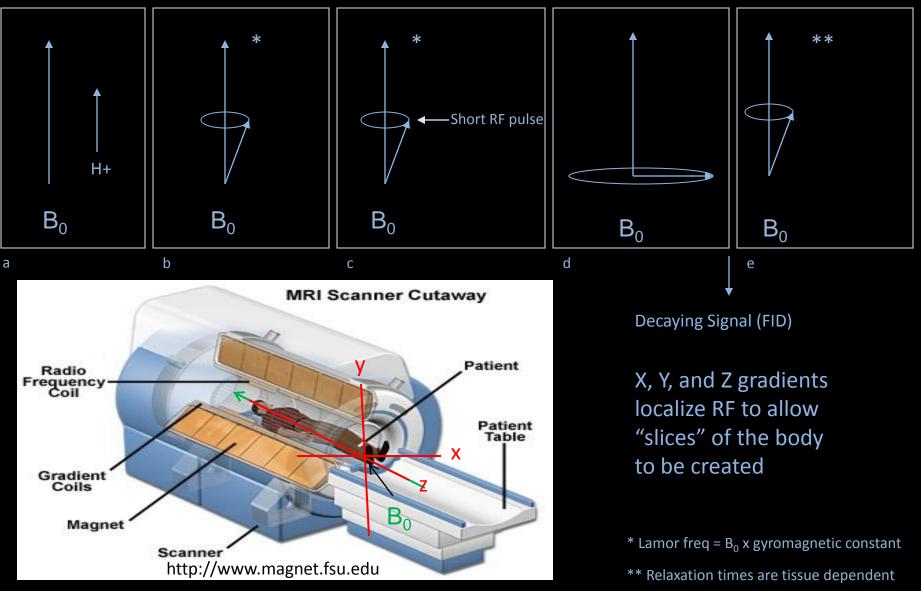
Importance of Protons in MRI

- MRI images are primarily derived from the hydrogen protons (H+) found in water
- Water is found in 70% to 90% of most body tissue and alters dramatically with disease and injury
- Protons become magnetized when immersed in an externally applied static field (B₀)



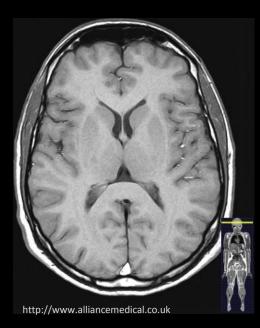


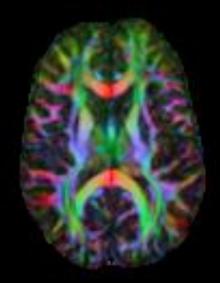
Fundamentals of MRI



Diffusion Tensor Imaging

MRI Imaging modality that indirectly images fibrous white matter brain tissue (nerve axons) by detecting water diffusion that tends to occur anisotroprically along the nerve fibers.





Advantages of DTI

• Non-invasive



- Can measure water diffusion along any oblique angle
- Reveals detailed anatomy of white matter through fiber orientations

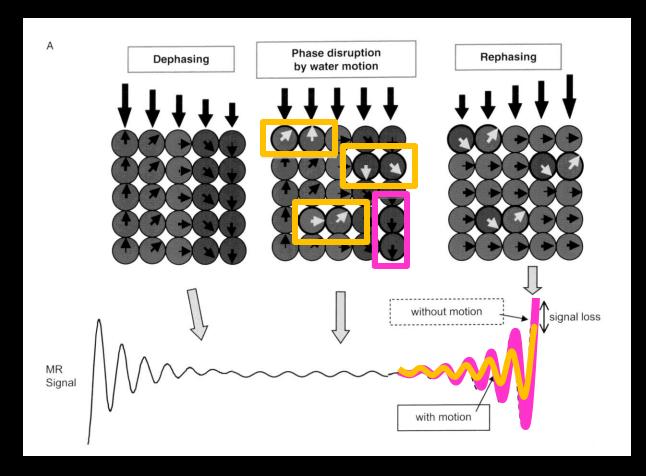
 MRI cannot view detailed anatomy due to white matter homogeneity in chemical composition

• Improves understanding of connectivity





Sensitizing the MRI Scan to Water Diffusion

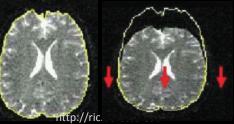


In the absence of diffusion, a rephasing gradient brings the spins back in phase. (no signal loss)

Computation of Diffusion Tensor and Applications



- Requirements for Tensor Calculation:
 - I. A minimum of 7 scans from various directions
 - The first scan should be without the application of gradients with the $\rm B_0$ set to zero
 - II. Registration of the other scans in the Diffusion Weighted Imaging (DWI) data set to the first scan
 - III. Distortion correction



- MIPAV Tensor Calculation Applications:
 - I. Fiber Tracking
 - II. Visualization



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Current MIPAV DTI Pipeline

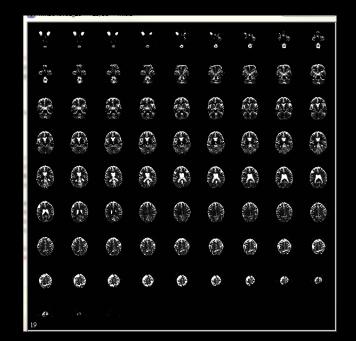
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New MIPAV DTI Pipeline Project

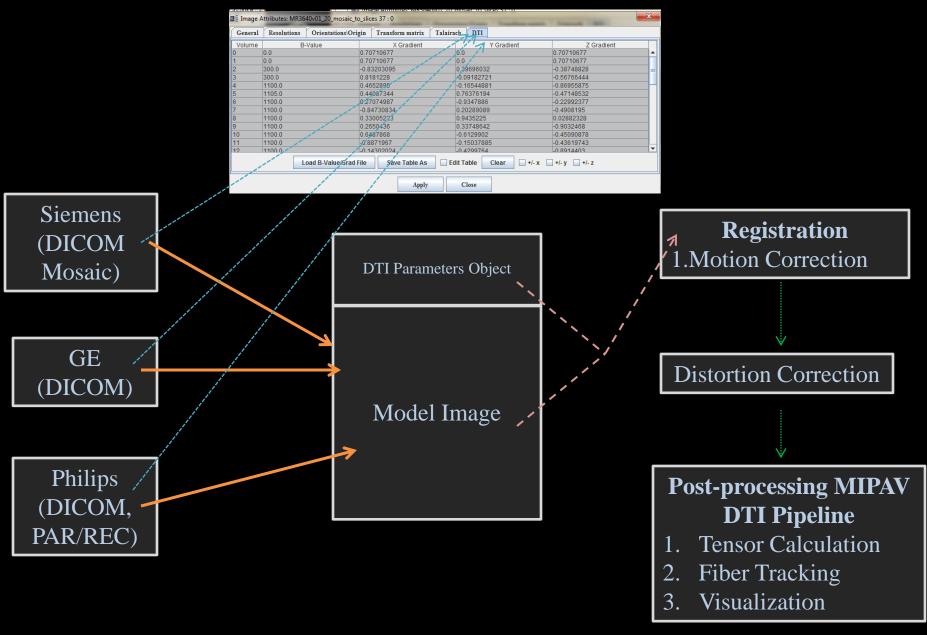
to create a user-friendly DTI pipeline that has universal processing for all Diffusion Weighted Imaging (DWI) datasets acquired from any MRI scanner (i.e. Philips, Siemens, and GE)







New MIPAV DTI Pipeline Project



Completed MIPAV DTI Pipeline Steps

3D Mosaic to 4D Volume Utility

<u>DTI Tab</u>

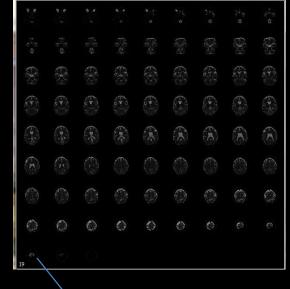
Automatic Population of Gradient/Bvalue
Table for various image types

- Ability to save DTI parameters with image to be used for tensor calculation, fiber tracking, and visualization

-Save bvalue and gradient table to different text formats

File Type	Auto Pop of Bvals	Auto Pop of Grads
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Philips P/R V4.1+	\checkmark	✓
Siemens Mosaic DCM	\checkmark	\checkmark
GE DCM	?	?
Philips V4.1+ DCM		
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The Import Data Step



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Next Step

Create an integrated DTI dialog incorporating all the

steps of the pipeline including pre-processing and post-processing steps

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The Fornix Sign: A Potential Sign for Alzheimer's Disease Based on Diffusion Tensor Imaging.

Oishi K, Mielke MM, Albert M, Lyetsos CG, Mori, S (2011) J Neuroimaging. 1552-6569

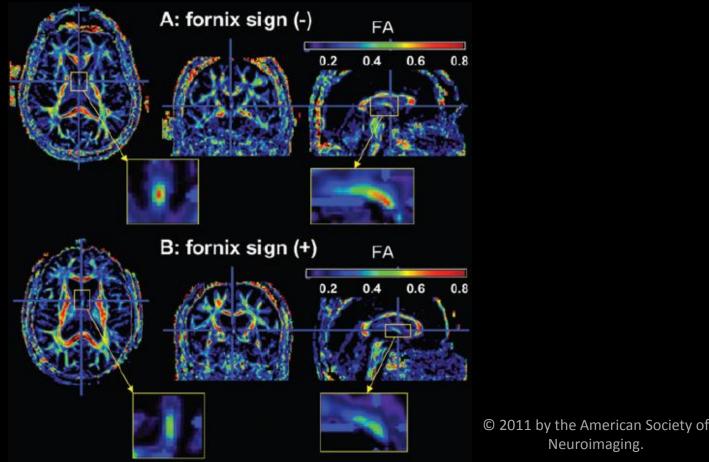


Fig 1. Example of the fornix sign. The axial (left), coronal (middle), and sagittal (right) slices of the color-scaled FA map are shown with the magnified view of the fornix (yellow rectangle). (A) FA map of a cognitively normal 80-year-old woman without a fornix sign. The core part of the fornix appears yellow to red (FA .5-.8). (B) FA map of an 80-year-old woman with Alzheimer's disease with the fornix sign. The fornix appears green (FA < .5). FA = fractional anisotropy.

References

http://mipav.cit.nih.gov/

Oishi K, Mielke MM, Albert M, Lyetsos CG, Mori S (2011) The Fornix Sign: A Potential Sign for Alzheimer's Disease Based on Diffusion Tensor Imaging. J Neuroimaging. 1552-6569

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Mori, Susumu (2007) Introduction to Diffusion Tensor Imaging. Amsterdam, The Netherlands: Elsevier

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