Medical Image Analysis and Processing

Medical Image Registration

Introduction

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Distance/online Course: Session 24 Episode#2
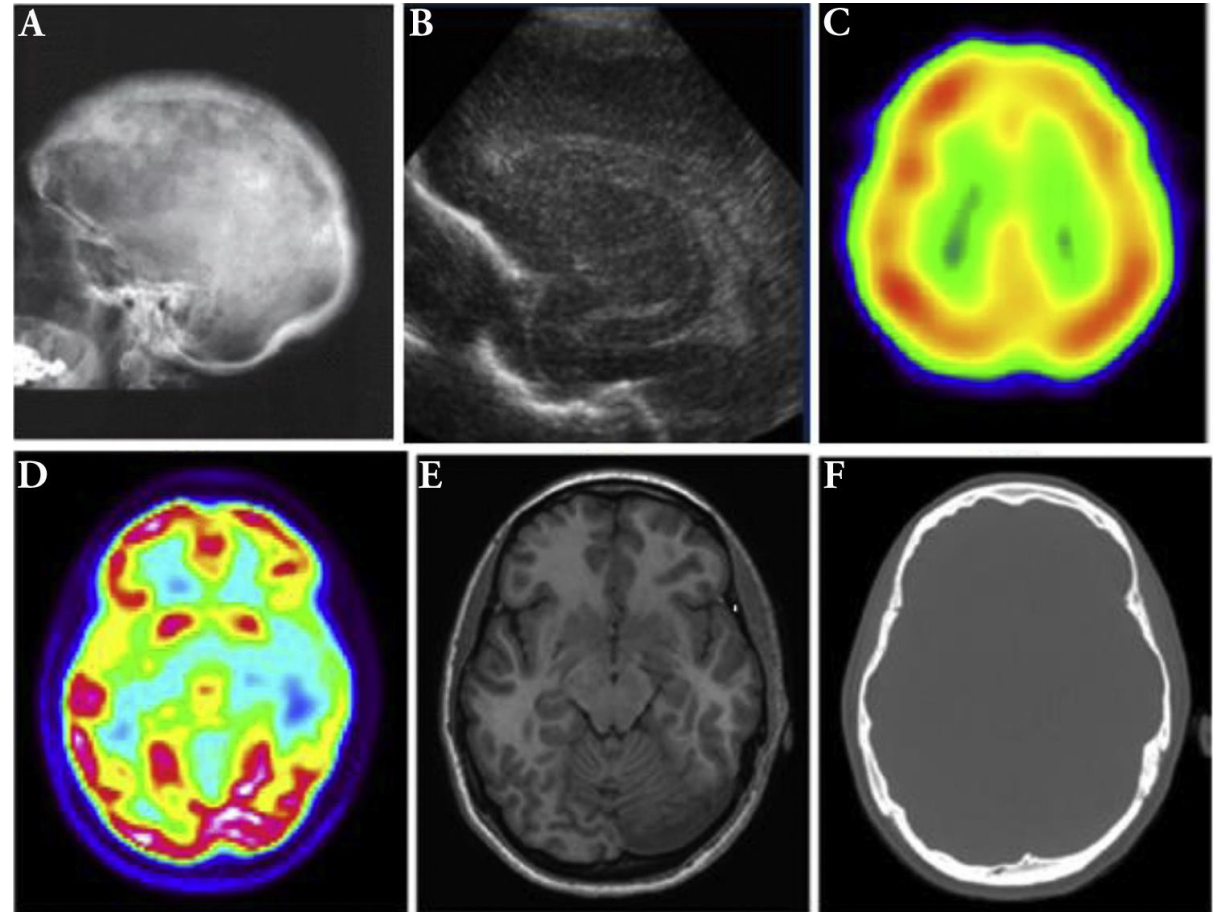Date: 23 May 2021, 2th Khordad 1400

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› Imaging Modalities

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Imaging Modalities

› A: X-Ray image

› B: US

› C: SPECT

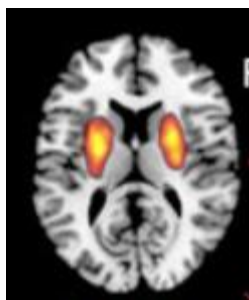› D: PET

› E: MRI

› F: CT

Two Main Categories

› Structural:

  –Anatomy and Morphology

› Functional:

  –Metabolism and Physiology

Stuructural Image

› Show geometry distribution of certain physical properties:

› Exmaples:
- X-Ray and DSA
- CT and CTA
- MRI and MRA
- US
- Video (X-Scopy)

Functional Imaging

› Show functional activity of human organs

› Examples:
- Gamma Camera
- SPECT
- PET
- Brain Mapping (EEG/MEG)
- fMRI
- fCT

Medical Image Integration Importance

› Too many data:
- Limitation of conventional Diagnosis (hardcopy)

› Data Dependency:
- Multiple information from a single slice

› Physical Requirements:
- Stereotactic surgery (Physical frames)

Final Goal: Data Integration

› Registration
  › Bring the modalities involved into spatial alignment

› Fusion:
  › Integrated display of the data involved

› Vocabulary:
  › Registration
  › Warping
  › Co-Registration
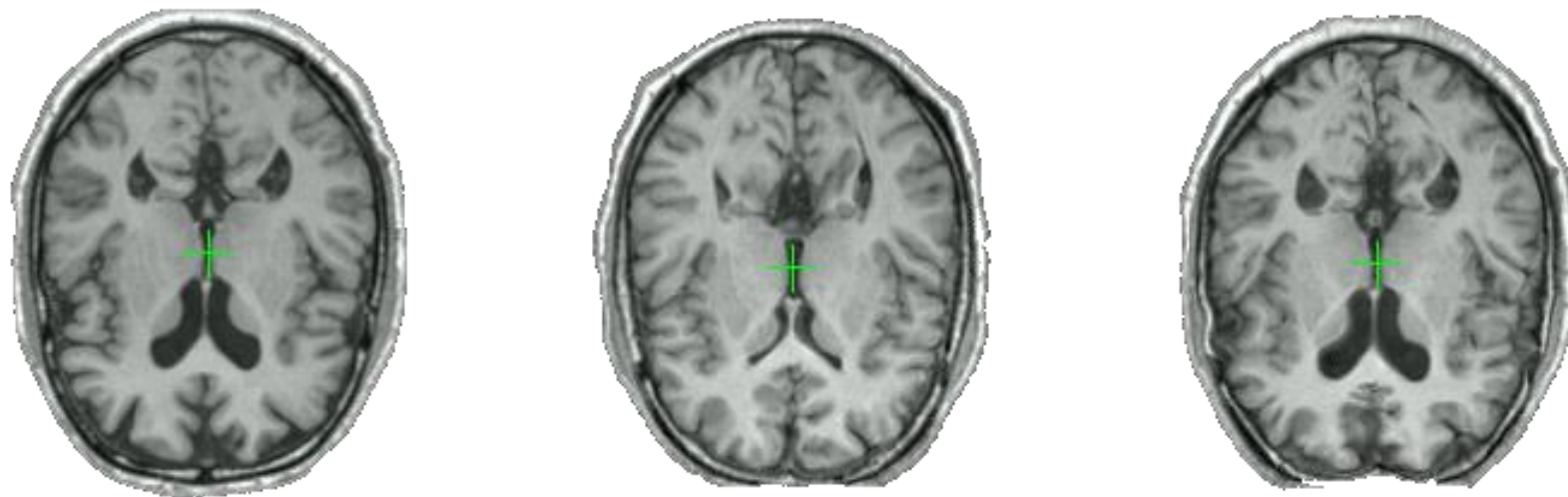 › Matching
  › Alignment
  › Normalization.

Registration Example (1)

› Human-Baboon Face:
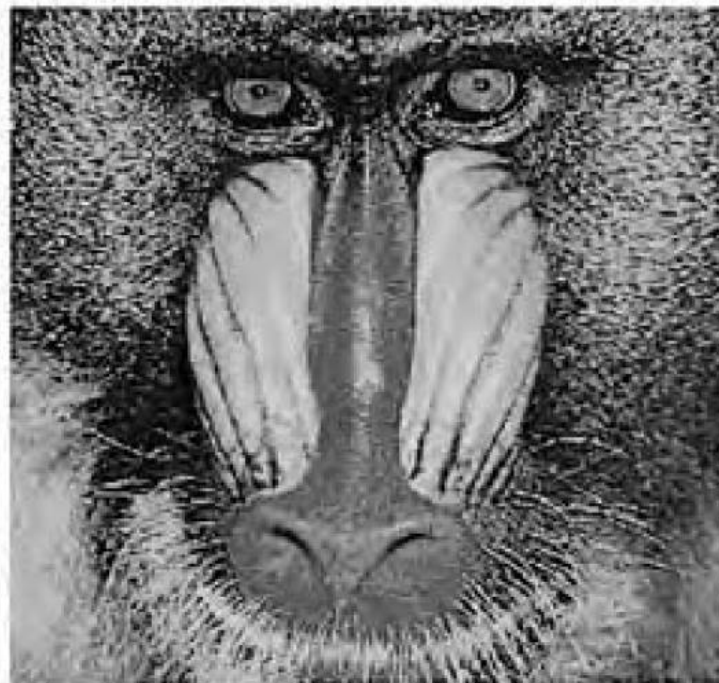
Registration – Example (2)

› MRI-MRI registration
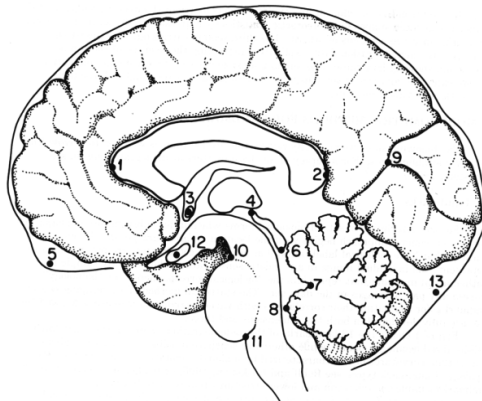
Registration – Example (2)

› Statistical Atlas
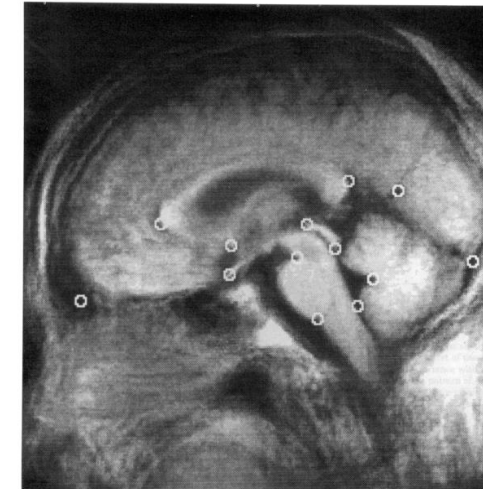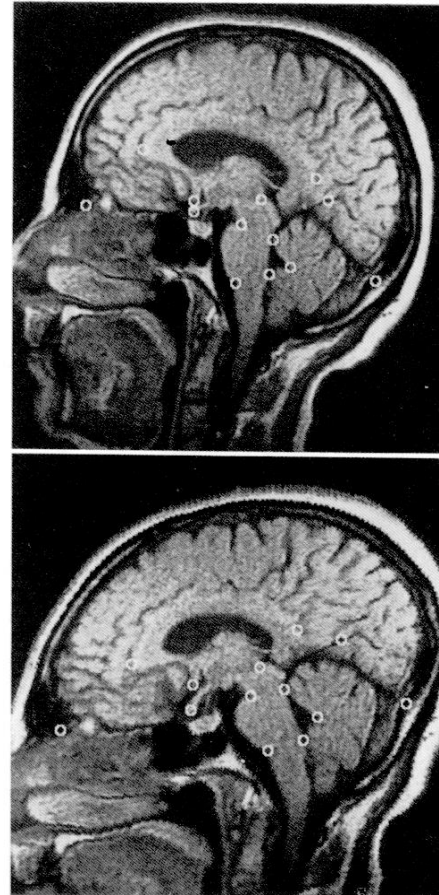
Fusion – Example (1)
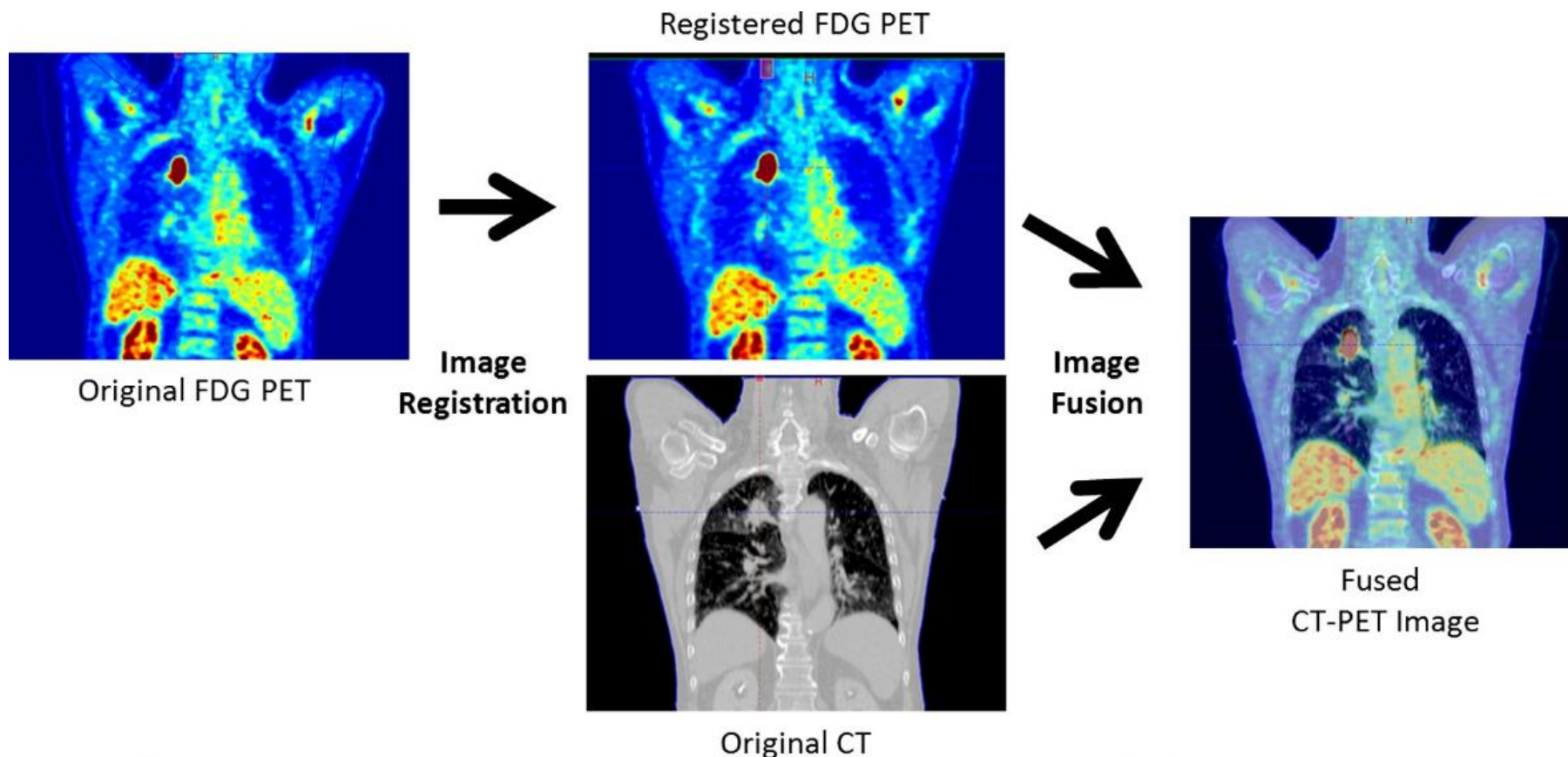
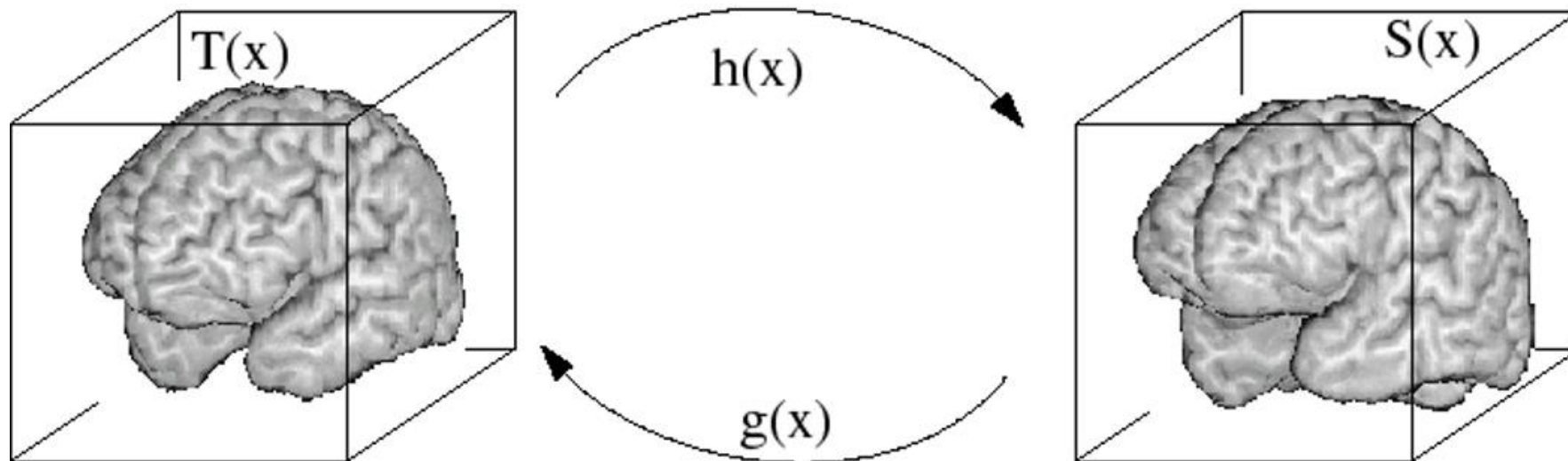› MRI-PET Fusion:
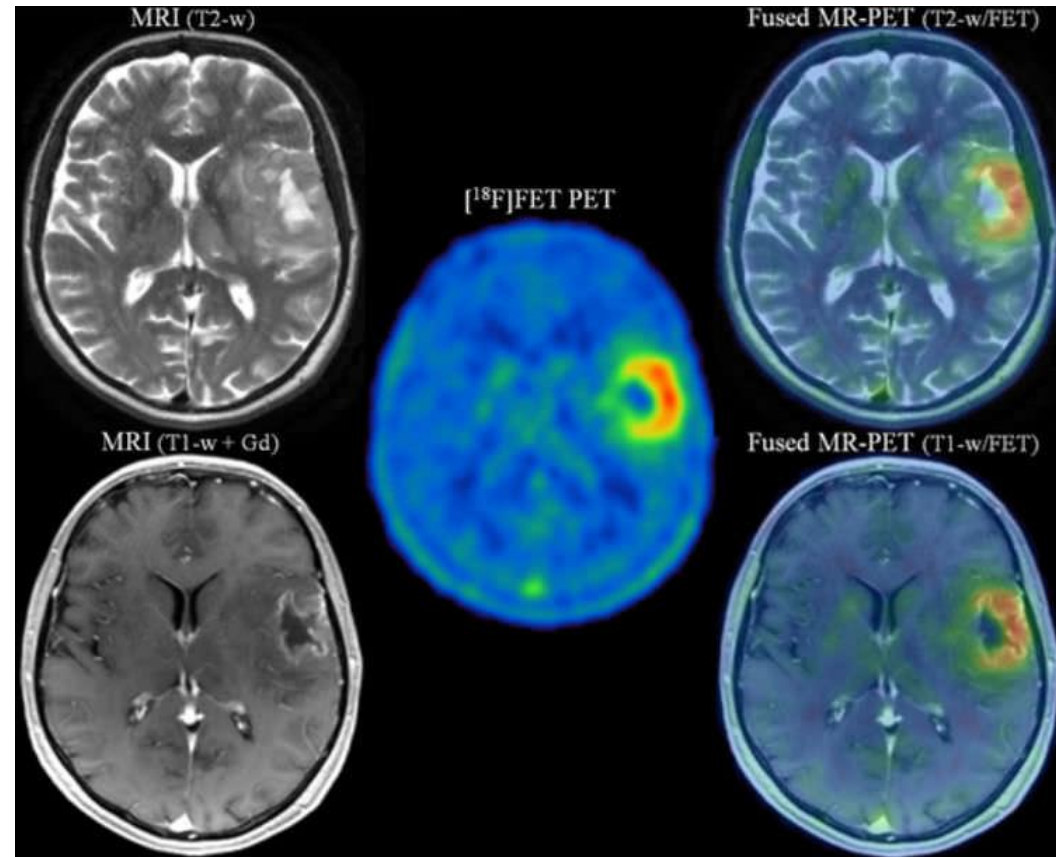
Fusion – Example (2)

› PET-CT Fusion:

Definition

› A *Transform* (Mathematical mapping) which relates position of *correspondence* structures in two images.

› Correspondence:
  – Exact: point by point.
  – Non-Exact: structure by structure

› Two Images:
  – Source-Destination
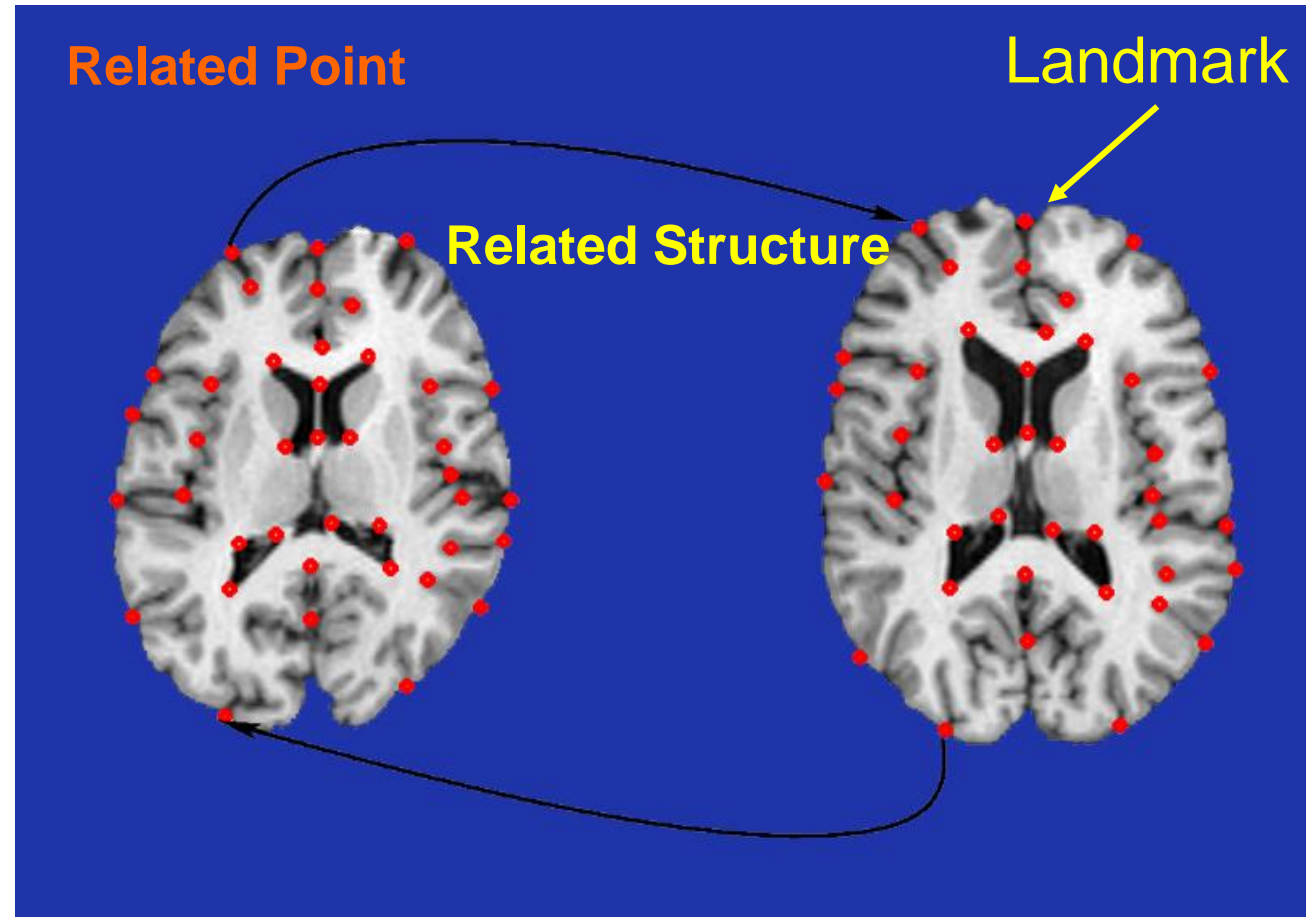 – Head-Hat
  – Source-Target
  – Fixed-Float

Illustration

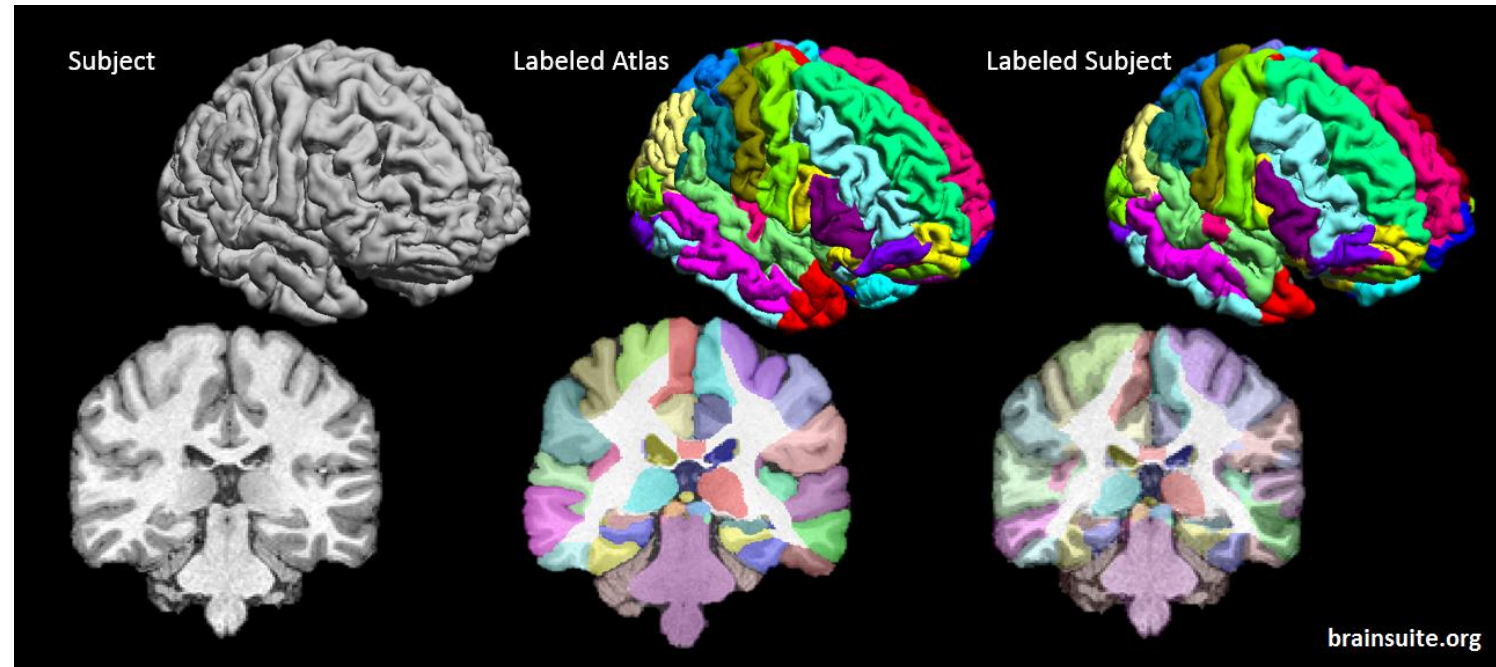› Mathematical Mapping

Correspondence (1)

› Point-to-Point

Application

› Multi-Modality Fusion

› Image Segmentation - Deformable atlas

› Population modeling and statistical atlases

› Characterization of normal vs. abnormal (shape variation)

› Longitudinal studies

› Surgical planning and evaluation

› Image guided surgery

› Pre-surgical Simulation
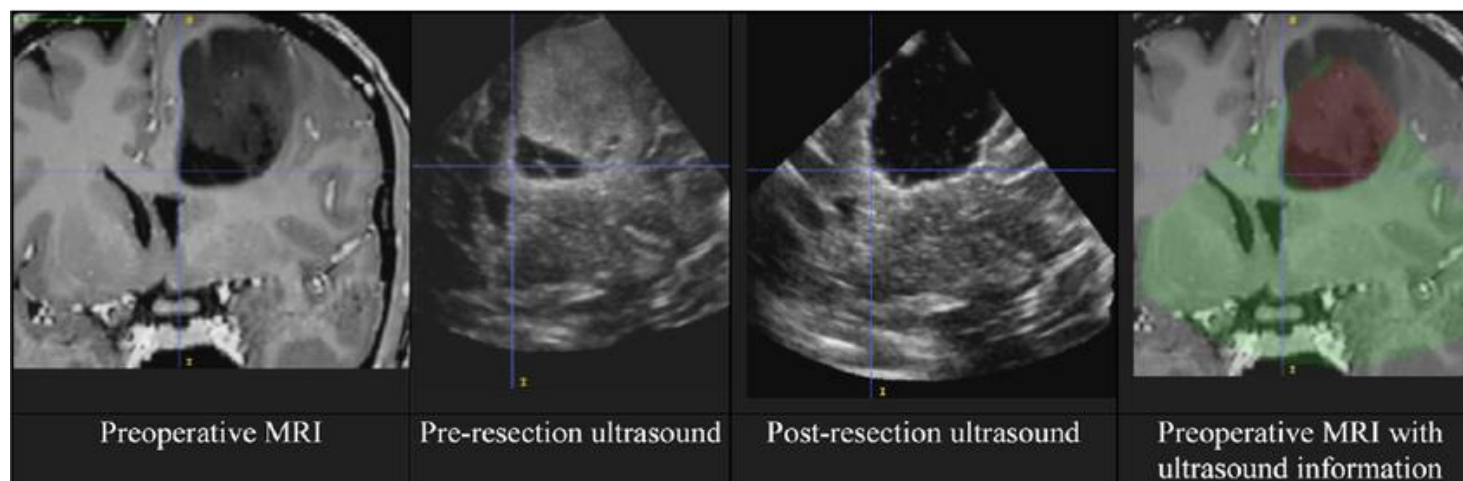
› Other field (GIS and etc.)

Segmentation Example

› Atlas-based Segmentation

Segmentation Example

› Multimodality Fusion

| Preoperative MRI | Pre-resection ultrasound | Post-resection ultrasound | Preoperative MRI with ultrasound information |

The End

› AnY QuEsTiOn?