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Medical Image Analysis: what for?

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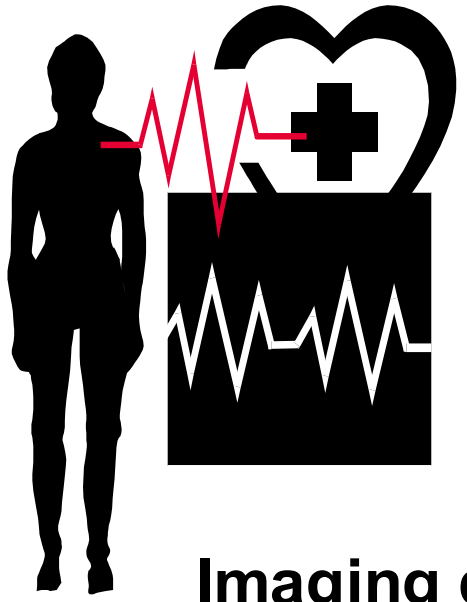
Created: October 2022

Using image data for decision making in medicine

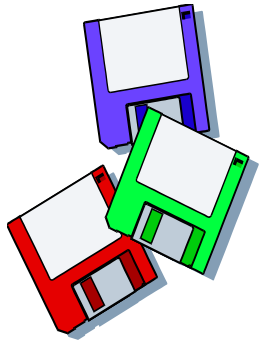
Investigation



Patient

Decision

Imaging data :
ECG, MRI, PET, X-rays
Computed Tomography,
Ultrasoung imaging



Archiving : PACS

Computer-aided diagnosis and therapy

- To improve the reliability of decisions and interventions with :
  - Quantification tools ➔ Measuring in space and time
  - Decision systems ➔ Diagnosing, Prognosing, analyzing populations
  - C-A treatment planning and realization
  - Obtaining new information
    - New modalities ⇒ new parameters
    - Simulation programs : computer models, learning systems

Image analysis and synthesis in Medicine

- **Enhancement, restoration:** ‘pre-processing’
- **Segmentation and shape recognition**
  - shape labelling and quantification
- **Image matching and fusion**
  - inner-modality: patient following
  - inter-modalities: MRI+PET+US+…
- **Evolution tracking**
  - motion estimation
  - characterization of the evolution of parameters
- **Visualization**

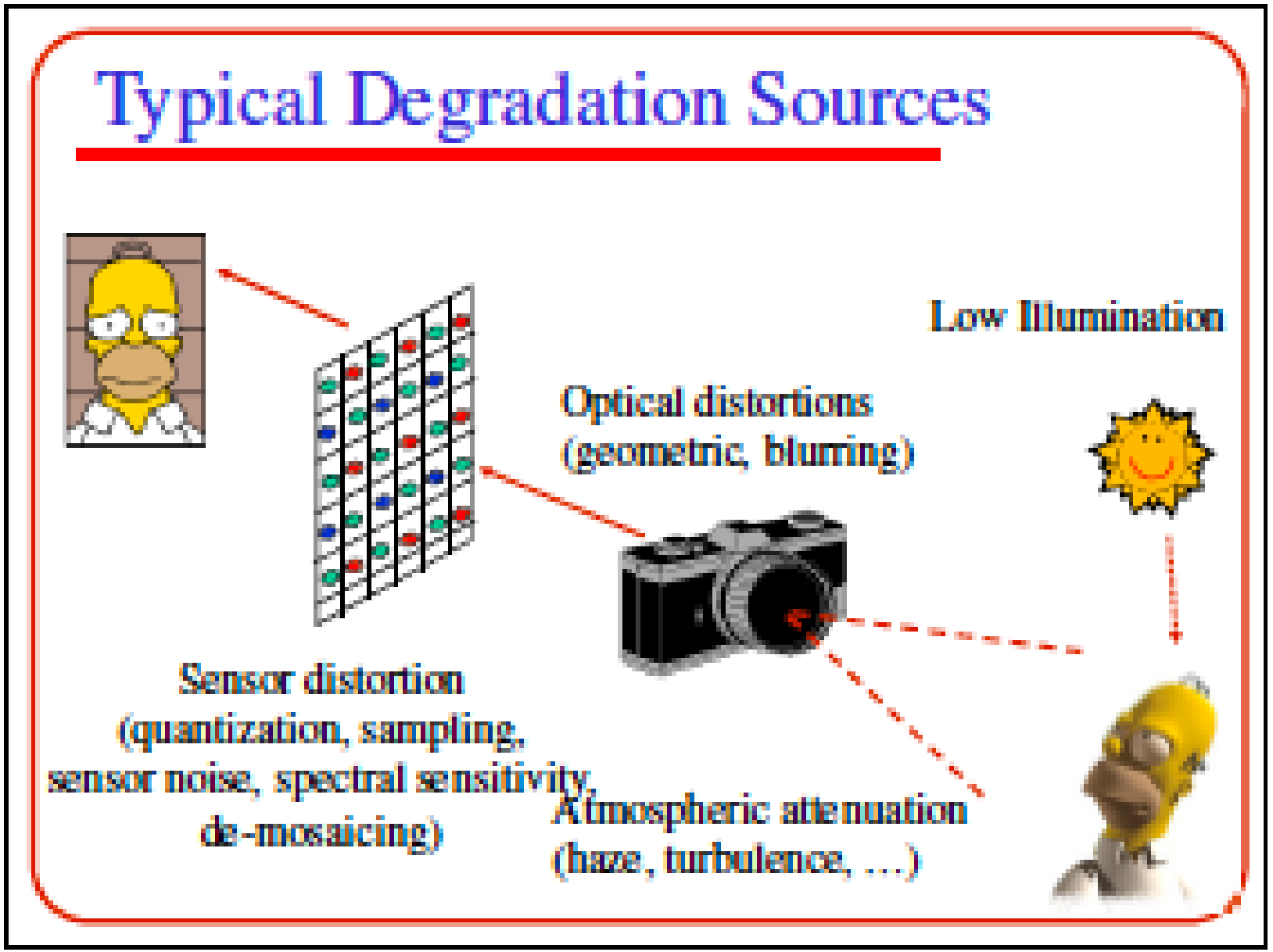

Typical Degradation Sources
Low Illumination
Optical distortions
(geometric, blurring)
Sensor distortion
(quantization, sampling,
sensor noise, spectral sensitivity,
de-mosaicing)
Atmospheric attenuation
(haze, turbulence, …)

Image enhancement & restoration

- Image Enhancement: – A process which aims to improve bad images so they will “look” better.

- Image Restoration: – A process which aims to invert known degradation operations applied to images.

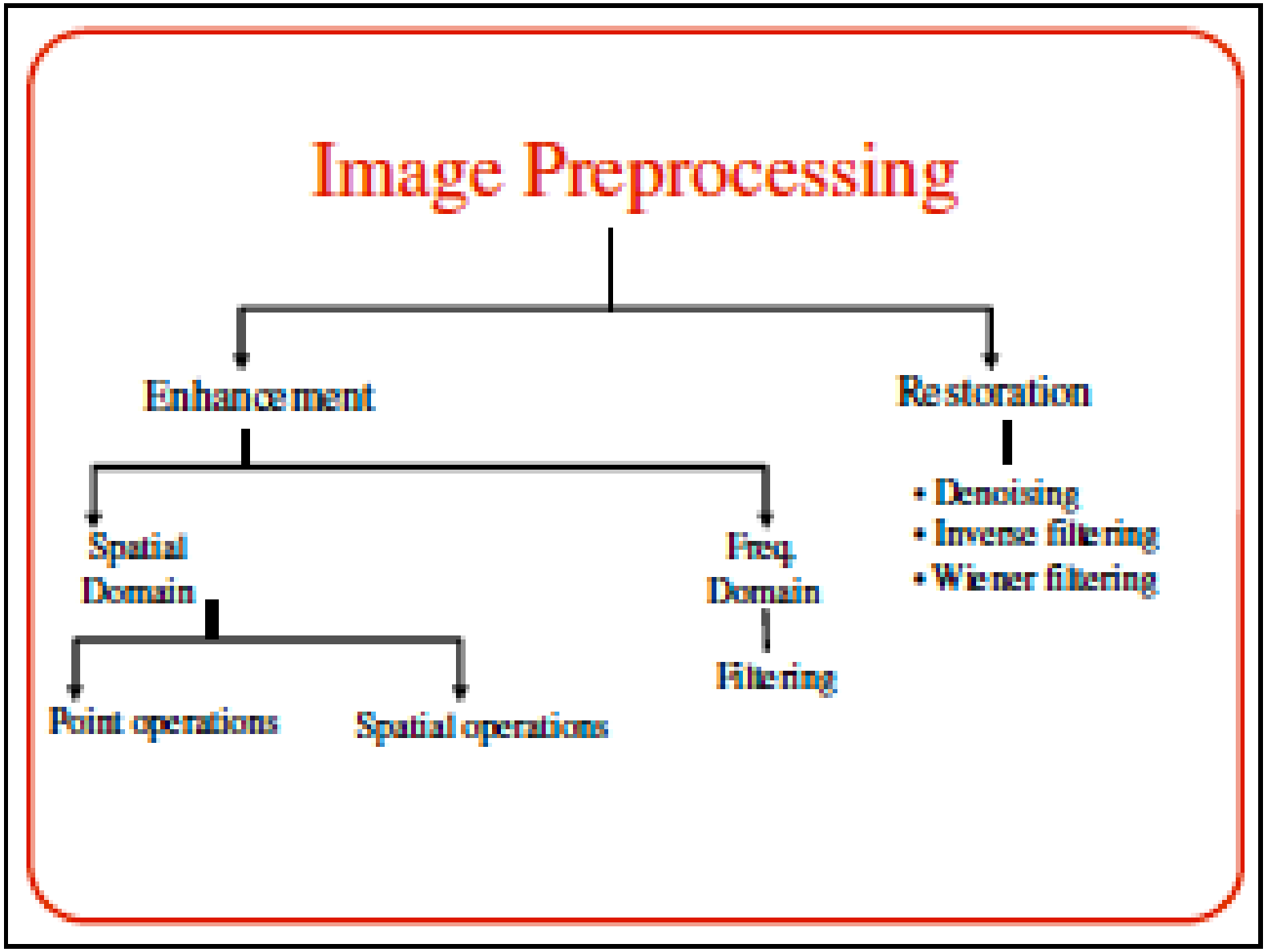


Image Preprocessing
Enhancement
Restoration
Spatial Domain
Freq. Domain
Point operations
Spatial operations
Filtering
• Denoising
• Inverse filtering
• Wiener filtering

Image enhancement

docsity.com

Spatial Domain

Point operations:
- Contrast stretching
- Histogram operation

Spatial operations:
- Spatial filtering
  - Linear (e.g. onvolutions)
  - Non linear (e.g. median)
- Morphological operatorss

Frequency Domain

High-pass / low-pass filtering

Restoration: Image denoising

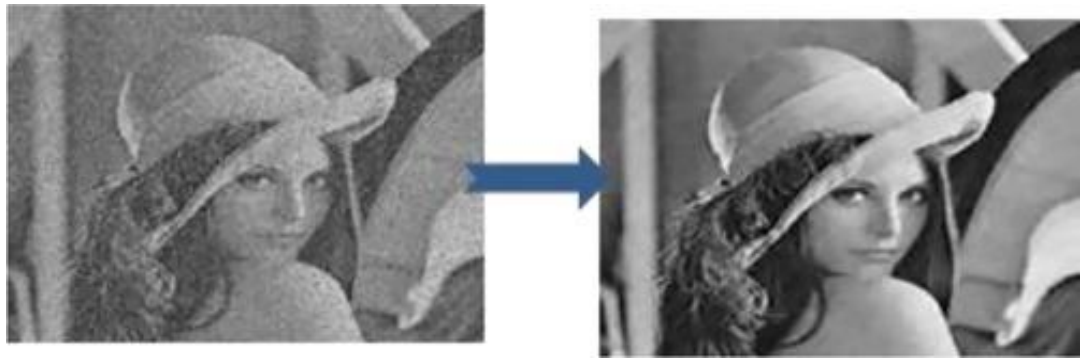
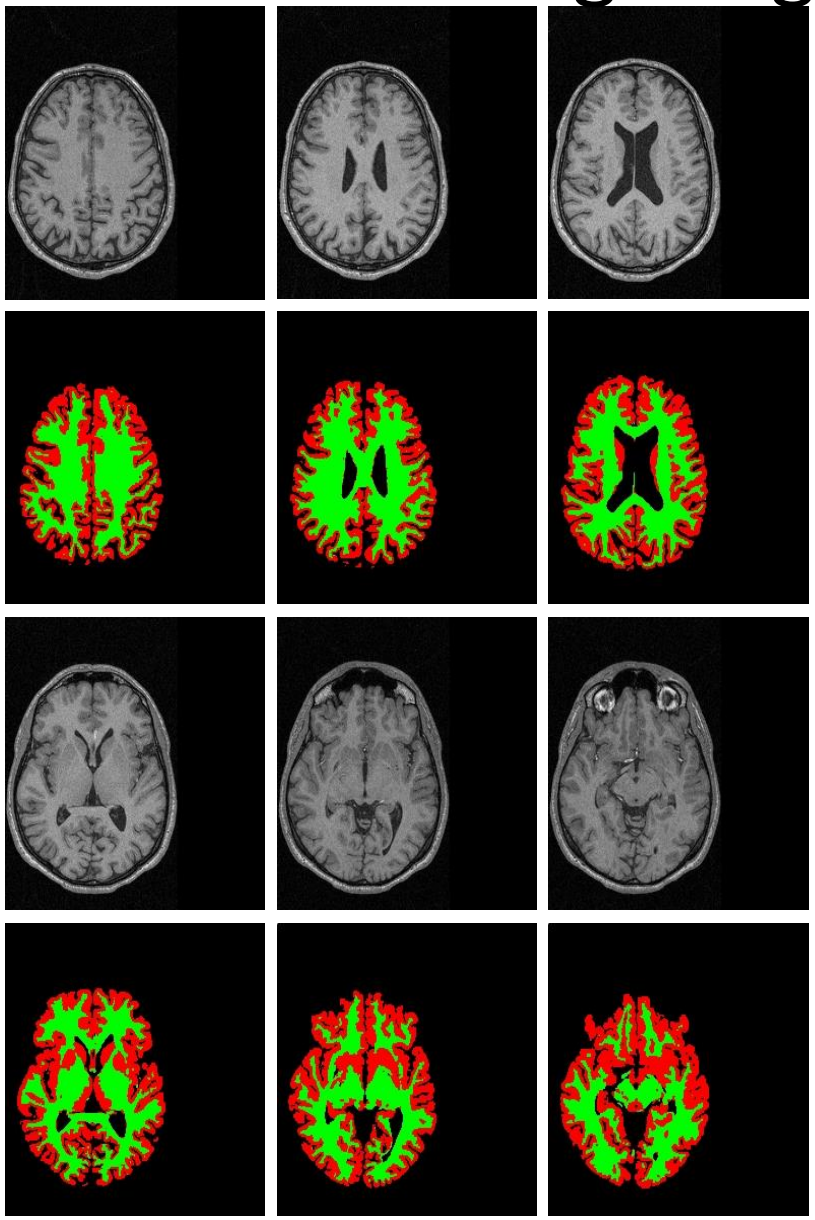


Image segmentation

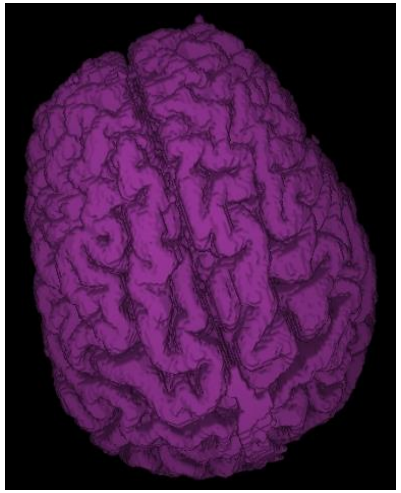


3D statistical segmentation of brain MR Images for extraction of cerebral tissues and multiple sclerosis lesions.

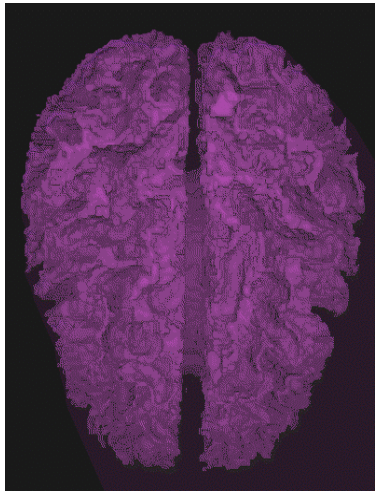
PhD Thesis C. Pachai, CREATIS, February 2000.

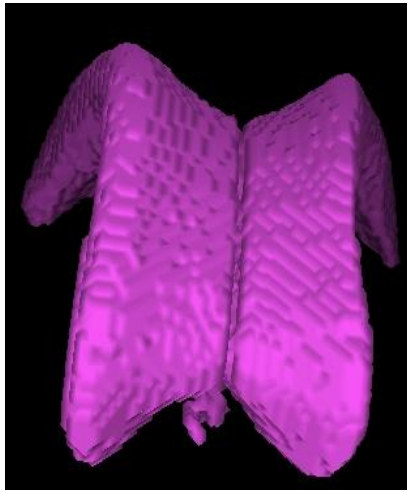
T1 weighted, 1mm thickness

Image segmentation: from 2D maps to 3D shapes

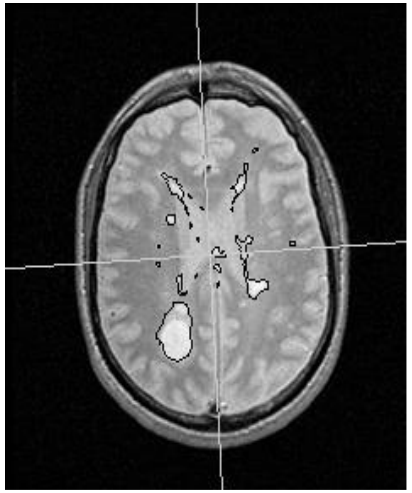


Cortex





Ventricles



Multiple sclerosis lesions

Difficulties

- Is what you are looking at what you are looking for?

➔The problem of image interpretation

➔The need for confronting multiple information

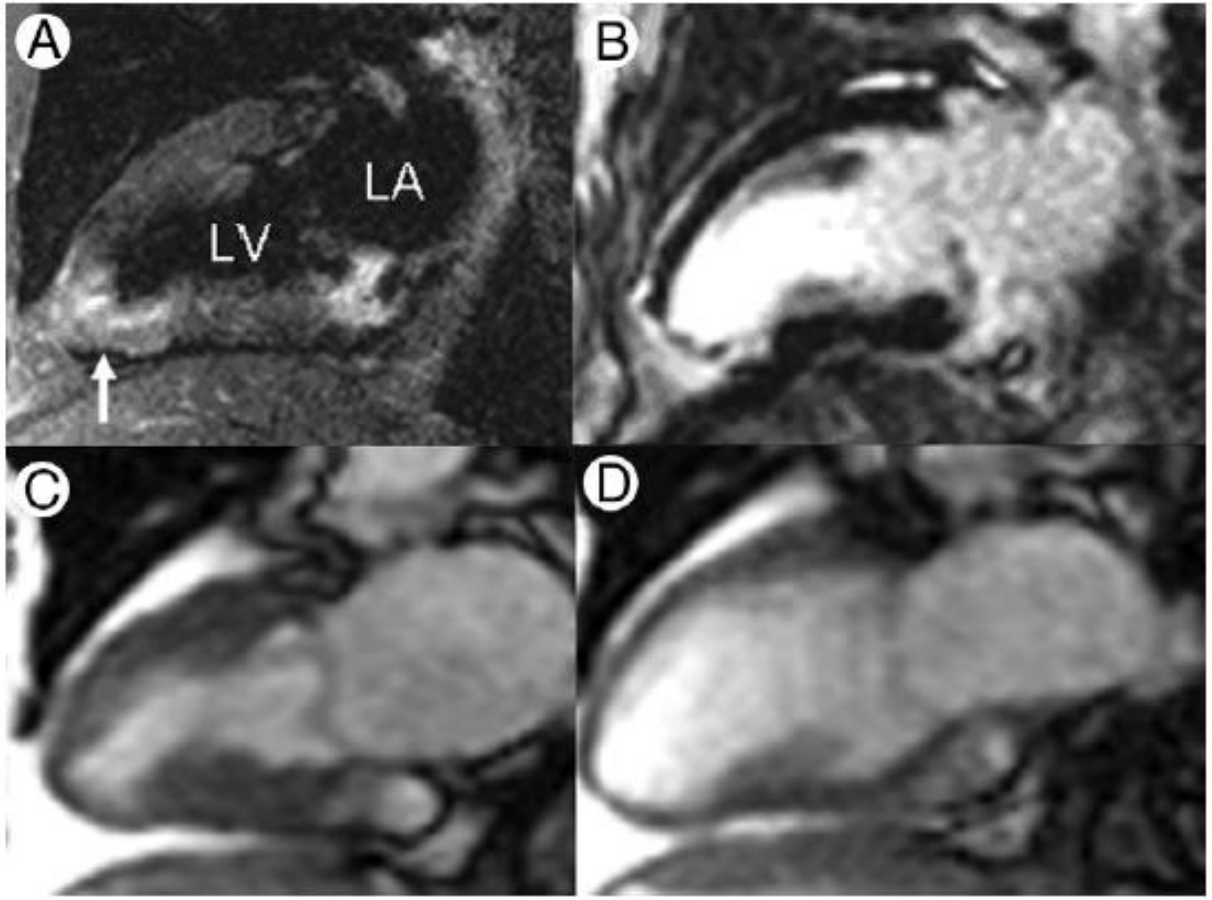


Figure 1 **Myocardial Edema at Initial Presentation With NSTE-ACS**

Magnetic resonance images obtained in a 63-year-old female nonsmoker with chest pain, nonspecific electrocardiographic abnormalities, and troponin-I that increased from 0.04 to 2.36 mg/dl over the initial hours of hospital stay. T2-weighted imaging (**A**; vertical long-axis plane) shows infero-apical edema (**arrow**), and late post-gadolinium enhancement (**B**) indicates irreversible injury. There is corresponding wall motion abnormality indicated by abnormal myocardial thickening at end-systole (**C**) compared with end-diastole (**D**) of a vertical long-axis cine. NSTE-ACS = non–ST-segment elevation acute coronary syndrome.

MATCH!

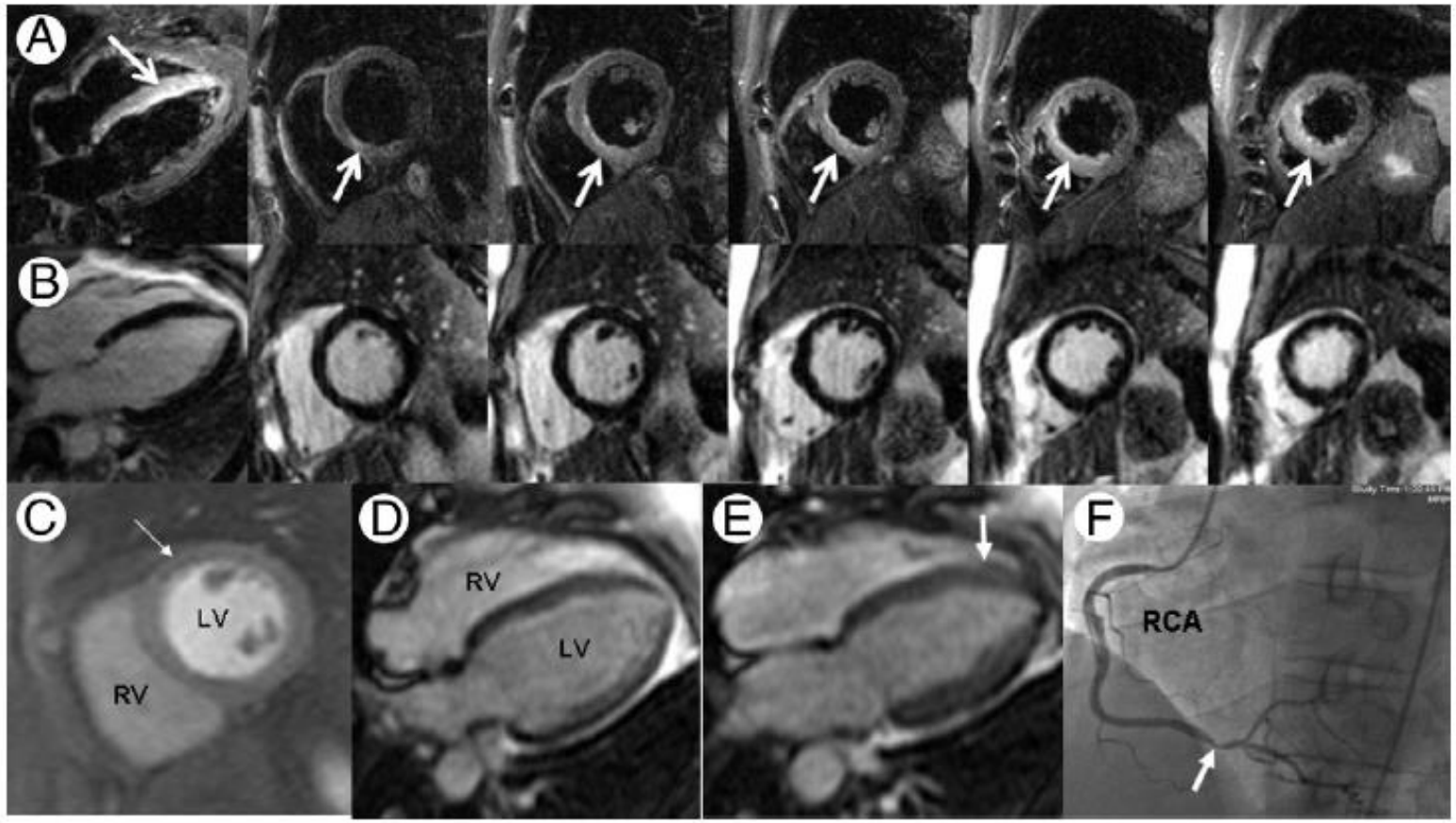


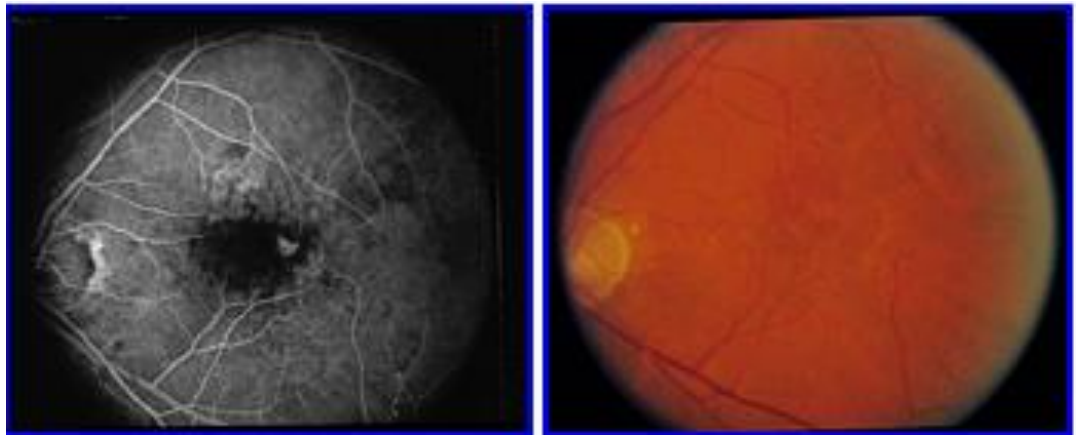
Figure 2 **Myocardial Edema Without Necrosis in Unstable Angina**

Magnetic resonance images were obtained in a 41-year-old male smoker with non–ST-segment elevation acute coronary syndrome and serially negative biomarkers including troponin-I and creatine kinase-myocardial band. T2-weighted imaging (**A**; horizontal long-axis and serial short axis planes) showed edema **(arrows)** involving the inferoseptum from base to apex. Edema was present without infarction, on the basis of lack of late gadolinium enhancement at the same slice locations **(B)**. Contrast-to-noise in the edematous versus remote myocardial regions averaged 18.8 ± 5.1, consistent with prior reports using this technique. Resting perfusion showed a mild subendocardial abnormality **(C, arrow)**. End-diastolic **(D)** and end-systolic **(E)** frames from a horizontal long-axis cine showed abnormal thickening of the septum **(E, arrow)** compared with the lateral wall. Overall left ventricular (LV) ejection fraction was 40%. Invasive angiography **(F)** confirmed high-grade right coronary artery (RCA) stenosis **(F, arrow)** supplying an occluded left anterior descending coronary artery, prompting surgical revascularization.

PARTIAL MATCH!

Image matching and fusion

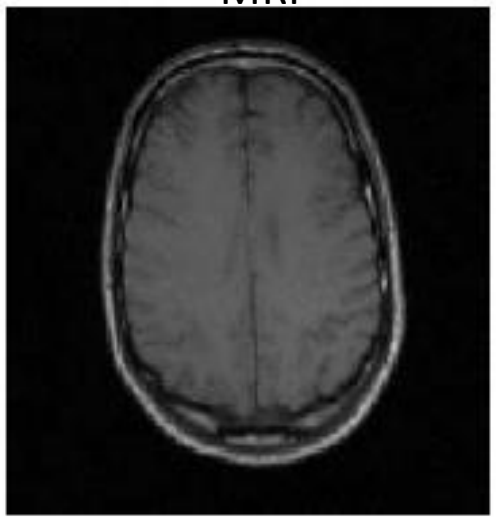
Photography



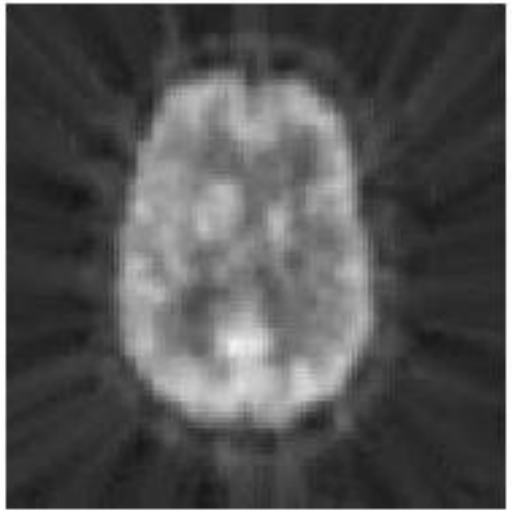
Fluorescein angiography

Retinal image reconstruction

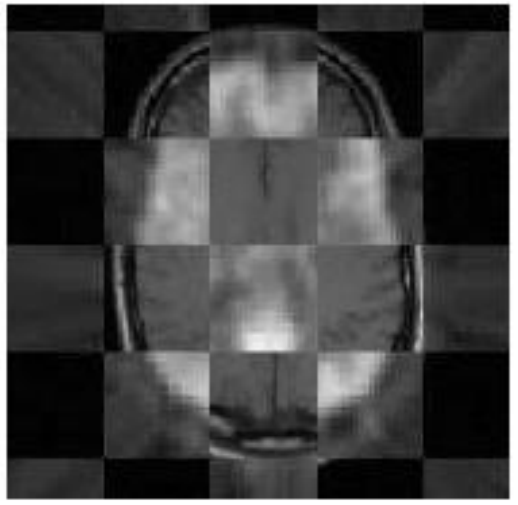
MRI



SPECT

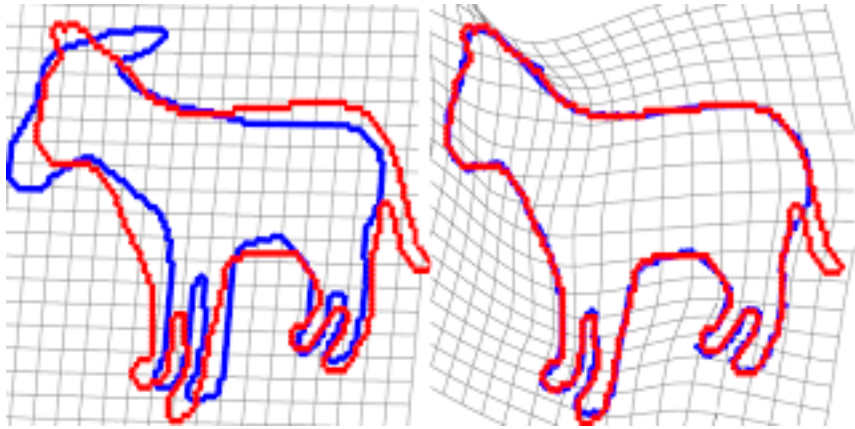


MRI + SPECT



Brain image reconstruction

- **Image matching / registration:**
  - Geometrical transformation + [intensity transformation]



- **Image fusion**
  - Combining multiple information with mathematical and statistical operators

Evolution tracking