

IHE-RO 2008 Registration Profile

Not the same as the IHE Fusion
Profile

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Front. Radiat. Ther. Onc., vol. 21, pp. 25–32 (Karger, Basel 1987)

Techniques and Applications of Image Correlation in Radiotherapy Treatment Planning

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Journal of Computer Assisted Tomography
11(6):948–954, November/December
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Radiation Oncology was one of the first areas to incorporate image registration / fusion into practice

Three Dimensional Image Correlation of CT, MR, and PET Studies in Radiotherapy Treatment Planning of Brain Tumors

Lothar R. Schad, Robert Boesecke, Wolfgang Schlegel, Günther H. Hartmann, Volker Sturm, Ludwig G. Strauss, and Walter J. Lorenz

Int. J. Radiation Oncology Biol. Phys., Vol. 20, pp. 881–889
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● *Oncology Intelligence*

IMAGE CORRELATION OF MRI AND CT IN TREATMENT PLANNING FOR RADIOSURGERY OF INTRACRANIAL VASCULAR MALFORMATIONS

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TOWARDS MULTIDIMENSIONAL RADIOTHERAPY (MD-CRT): BIOLOGICAL IMAGING AND BIOLOGICAL CONFORMALITY

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Considerable interest in incorporation of information from emerging functional and molecular imaging modalities into definition of RT target volumes

I. J. Radiation Oncology • Biology • Physics Volume 47, Number 3, 2000

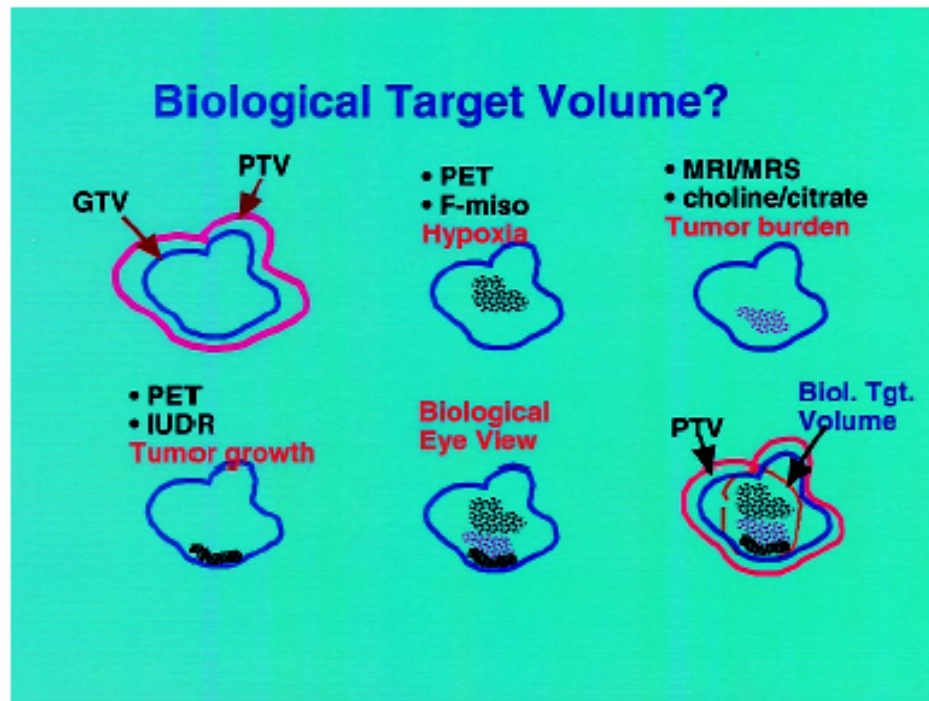


Fig. 2. An idealized schematic illustrating the concept of biological target volume (BTV). Whereas at present the target volume is characterized by the concepts of GTV, CTV, and PTV, biological images as depicted in Fig. 2 may provide information for defining the BTV to improve dose targeting to certain regions of the target volume. For example, regions of low pO_2 level may be derived from PET- ^{18}F -misonidazole study, high tumor burden from MRI/MRS data of choline/citrate ratio, and high proliferation from PET- ^{124}I UdR measurement.

Note one can also use functional information to define critical regions to avoid.

Imaging for therapy guidance (not only RT)

- **Multiple modalities, purposes**
- **Chain of image guidance steps**
 - planning (+++)
 - setup for procedure (++)
 - real time procedure guidance (+)
 - real time feedback on effect (-)
 - adaptation of multiple treatments (+)
 - “postop” assessment of effect (+)
 - followup (++)
- **Most applications use only a few of these at present but number will certainly increase.**

**Center for Computer-Integrated
Surgical Systems and Technology**

A National Science Foundation
Engineering Research Center

Johns Hopkins University
Carnegie Mellon University
Massachusetts Institute of Technology
Brigham and Women's Hospital



Annual Report – Year 9
May 1, 2007
DRAFT Volume I

Radiotherapy has these needs in common with other image guided treatment modalities, e.g. computer-integrated or robotic surgery.

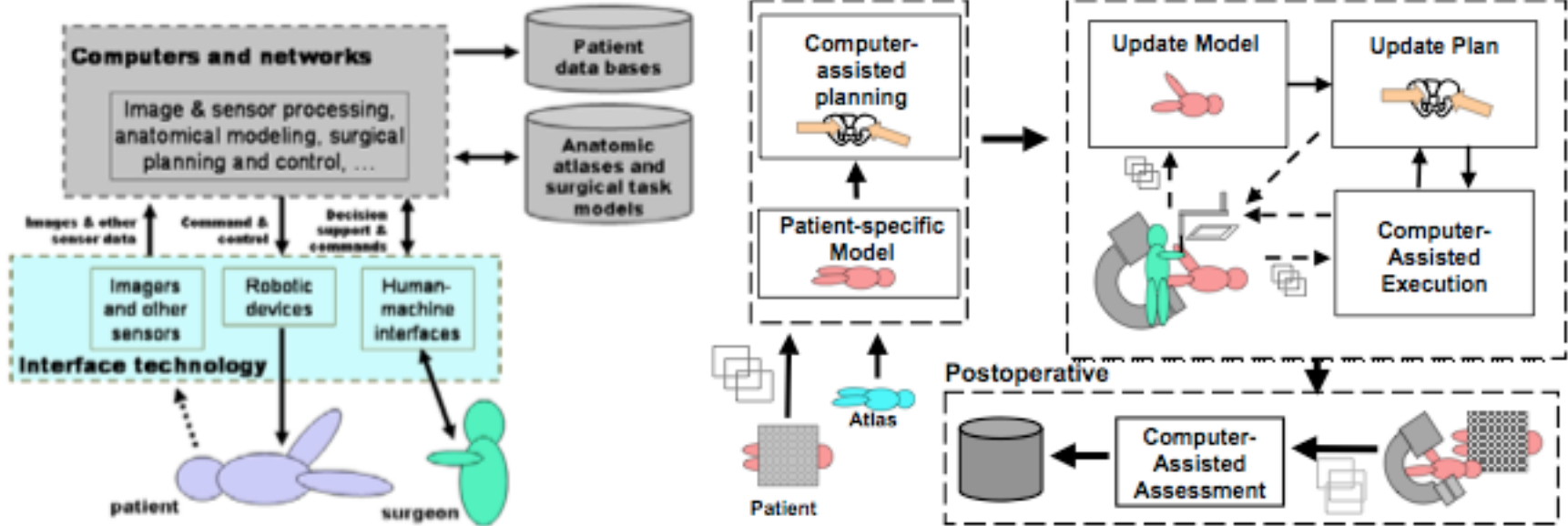


Figure 1: (Left) Block diagram of a typical Computer-integrated surgery system; (right) information flow in CIS.

IGRT X-ray treatment machines

Isocentric linac equipped with on-board kV imager for cone-beam CT localization (Varian, Elekta, Siemens)



Cyberknife – robot mounted 6MV linac with biplane radiographic patient localization

Tomotherapy: ring gantry mounted 6MV linac, capable of helical CT with MV beam



Why isn't this the same as the IHE Fusion Profile?

- In Radiation Oncology there is currently little support for Presentation states among vendors.
- The Fusion Profile doesn't deal with RT objects such as RT Structure Set and RT Dose.
- *The IHE-RO Registration Profile did begin by editing the Fusion Profile.*

20 Image Registration Integration Profile

This Integration Profile specifies how images, RT Structure Sets, RT Doses, and associated spatial registration information can be exchanged, stored, processed and displayed. For a display workstation, it is essential that a workstation correctly identifies the corresponding image sets,

IHE-RO Technical Framework Supplement – Registration Profile for 2008

matches data from single-slice and multi-slice datasets, matches coordinate systems, and performs spatial translations. The use of relevant DICOM objects (Spatial Registration) is clarified and constrained in order to avoid misinterpretation.

Image Registration Integration Profile focuses on content for image registration and does not define a registration workflow. Such workflow could be managed by using mechanisms described in the Post-Processing Workflow Integration Profile.

The Image Registration Integration Profile currently only handles rigid registration. The intention is to add deformable registration as an extension to the Profile in the future.

Basic Tenets

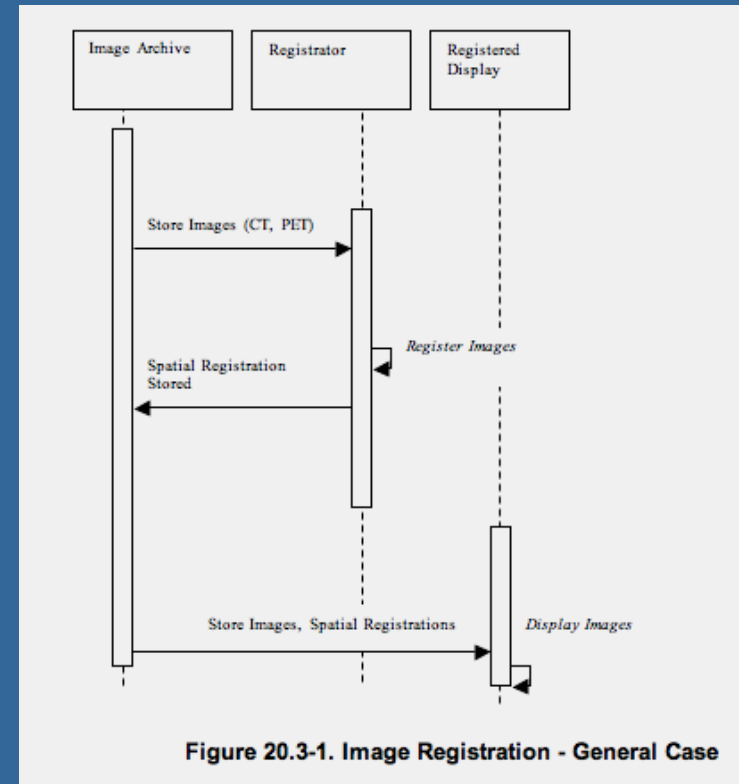
- Registration may be expressed implicitly by objects sharing the same Frame of Reference (FoR) UID or explicitly using Spatial Registration Objects.
- RT Structure Set and RT Dose objects will share a FoR UID with the image set on which they were created.
- Resampling of images, dose, or structure sets is a display function. Those resampled results are not saved.

Profile Actors

- **Registrar**
 - Perform the Registration
- **Registered Display**
 - Display the results of the Registration
- **Registered Contourer**
 - Perform contouring operation on multiple Registered Image Sets
- **Registered Dose Display**
 - Display Dose information overlaid on Registered Image Sets.
- **Archive**
 - Store and distribute Image, Registration, Contouring, and Dose information.

Registrar Transactions

- Creator Images Stored
- Spatial Registrations Stored
- Capabilities
 - Perform the registration by resampling image sets into a common FoR, or associating FoRs using Spatial Registration objects.
 - How the registration is performed is out of band for the Profile. The result is all that is transmitted.



Registered Display Transactions

- Modality Images Stored
- Structure Sets Retrieved
- Utilize Spatial Registrations
- Capabilities
 - Accept and display registered image sets and their associated structures using information created by the Registrator actor.
 - Allow the user to selectively display associated image sets in a fused presentation.
 - Structures may be displayed overlaid on a different image set from that which they were derived.

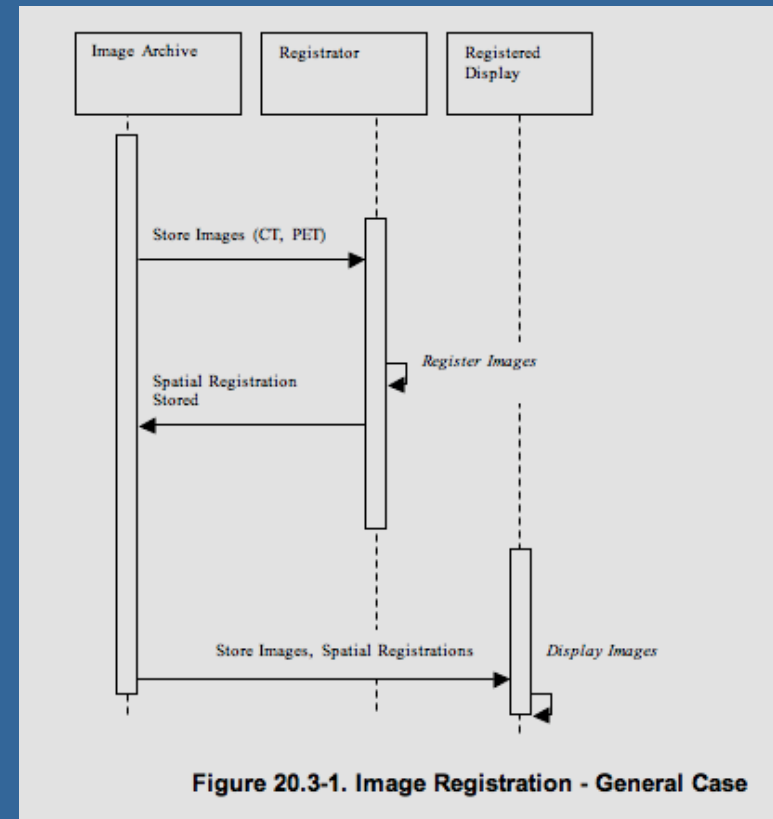
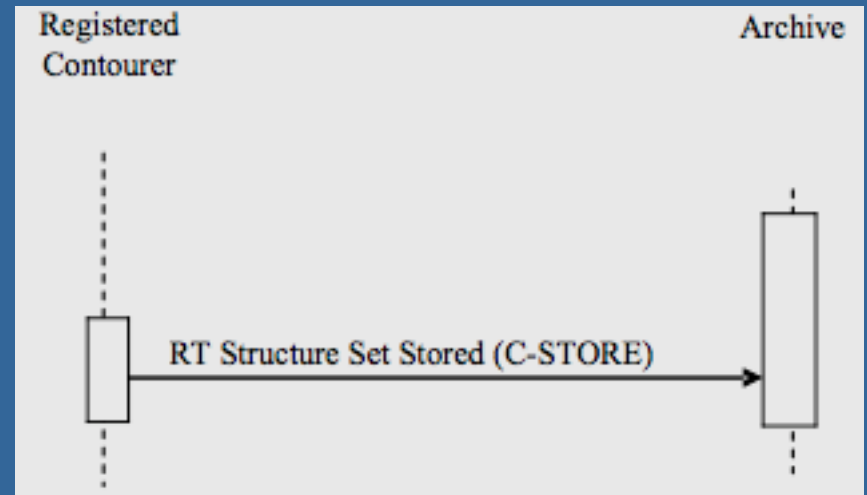


Figure 20.3-1. Image Registration - General Case

Registered Contourer Transactions

- Modality Images Stored
- Structure Sets Stored
- Structure Sets Retrieved
- Structure Transfer
- Spatial Registrations Stored
- Utilize Spatial Registrations



•Capabilities

- Accept and display registered image sets and their associated structures using information created by the Registrator actor.
- Allow the user to selectively display associated image sets in a fused presentation.
- Allow the user to modify and store the RT Structure Set objects in a fused presentation.
- Allow the user to transfer structures from one image set to another.

Registered Dose Display Transactions

- Modality Images Stored
- Structure Sets Retrieved
- Dose Retrieved
- Utilize Spatial Registrations

- Capabilities
 - Accept and display registered image sets and their associated dose using information created by the Registrator actor.
 - Allow the user to selectively display associated image sets in a fused presentation.
 - Dose information may be displayed overlaid on a different image set from that which they were derived.
 - There is no requirement to combine doses.

Archive Transactions

- Modality Images Stored
- Creator Images Stored
- Structure Sets Stored
- Spatial Registrations Stored

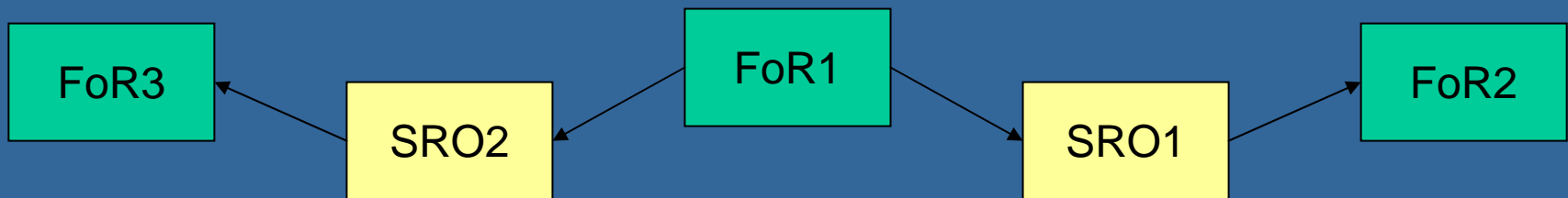
- Capabilities
 - Store DICOM objects.
 - Send the objects to a specific actor.

Creator Images Stored

- Taken from the IHE Profile
- Allow an actor to resample and store an image set into a common Frame of Reference rather than using a Spatial Registration object.

Spatial Registrations Stored

- Store Spatial Registration Objects (SRO).
- Must be able to store a series of registrations into a common FoR.
- All SROs will transform from a new FoR to a registered FoR.
- We're missing a mechanism which associates all of the SROs.



Utilize Spatial Registrations

- Use the Spatial Registration objects stored via the Spatial Registration Stored transaction.
- Assure that the registered image sets are available.
- Apply the transformations expressed in the SROs between the loaded FoRs.

Modality Images Stored

- Support for CT, PET, and MR image sets.
- There are no modality specific actions specified with the transaction.
- There is guidance specified to deal with modality specific information such as Hounsfield Units for CT vs. SUVs (Standard Uptake Values) for PET.

Structure Sets Stored

- Each RT Structure Set instance shall reference a single image set.
- Because actors are dealing with multiple image sets, more than 1 RT Structure Set may be stored in a single operation.
- The resulting Structure Sets must be usable by actors from the 2007 Profile.

Structure Transfer

- Provide the user with a mechanism to transfer a structure from one image set to another.
- When the structure is assigned to the second image set the contours must be resampled onto the slices of the new image set.

Structure Sets Retrieved

- Utilize the Structure Sets resulting from the Structure Sets Stored transactions.
- There may be more than 1 Structure Set, if the actor is managing multiple image sets.
- The actor must determine which structure set applies to a specific image set and determine its FoR transformation.

Dose Retrieved

- Utilize an RT Dose object created by another actor.
- The actor must determine which RT Dose object is associated with a specific image set and determine its FoR transformation.



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