

Content-Based Image Retrieval for Medicine: Where Do We Stand?

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Medical CBIR

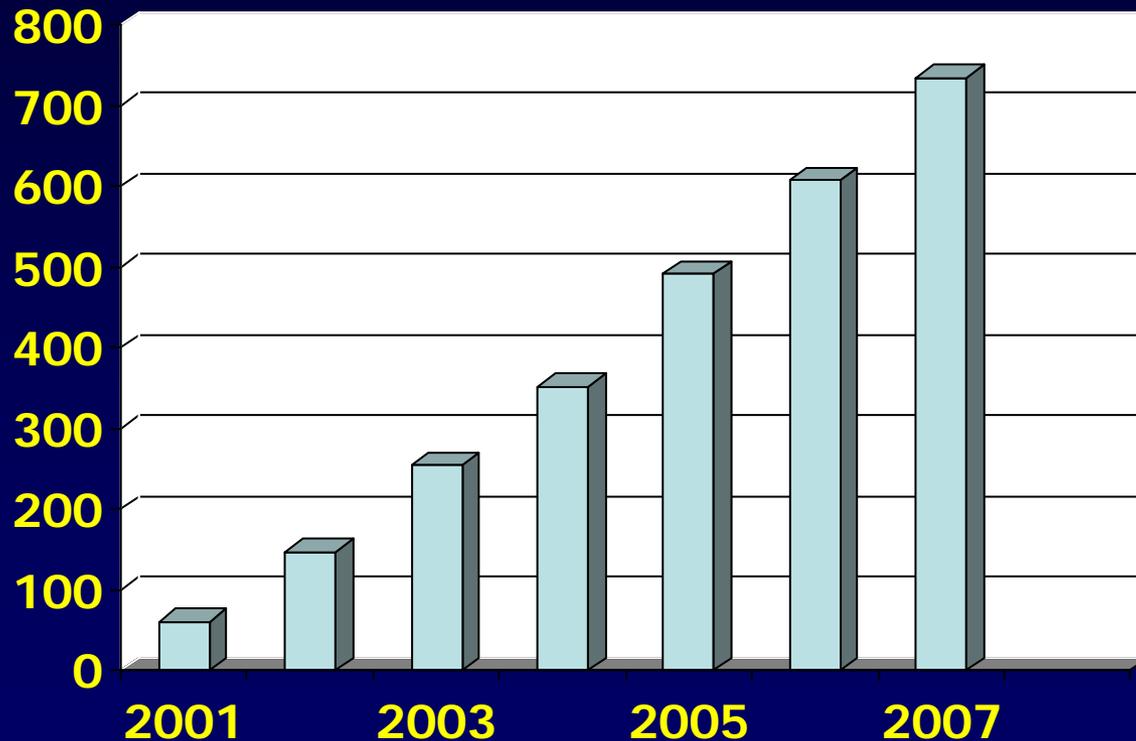
- **Where do we stand?**
- **What are critical limiting factors?**
- **What can we do to advance the field?**

Journal Review

- *Computerized Medical Imaging and Graphics*
- *IEEE Transactions*
 - *Image Processing*
 - *Knowledge and Data Engineering*
 - *Medical Imaging*
 - *PAMI*
- *International Journal of Medical Informatics*
- *JAMIA*
- *Journal of Digital Imaging*
- *Journal of Electronic Imaging*
- *Radiology*

Compare Datta et al., *Image Retrieval: Ideas, Influences, and Trends of the New Age* (2007)

“Medical image retrieval”, since 2000...



10 sampled journals, Google scholar

Observations

- **Apparent tremendous growth in**
 - Number of publications
 - Number of research groups
 - Breadth of problems
- **But how should we assess progress?**

Areas of focus

Healthcare End-User



Collaborative
Efforts



Engineering
Community

Healthcare End-User

Since 2000, a number of medical CBIR applications have been reported...many image types and project goals...

- ASSERT
- BASS
- CervigramFinder
- HealthGrid
- I-Browse
- IRMA
- MEDIM
- PathMaster
- SPIRS
- VOI-FIRS
- cbPACS
- medGIFT
- HRCT lung images
- Breast biopsy
- Uterine Cervix
- MRI, biopsy
- GI tract biopsy
- General radiology
- General DICOM
- Cell images
- Spine X-rays
- 4D PET
- General DICOM
- General medical

Healthcare End-User

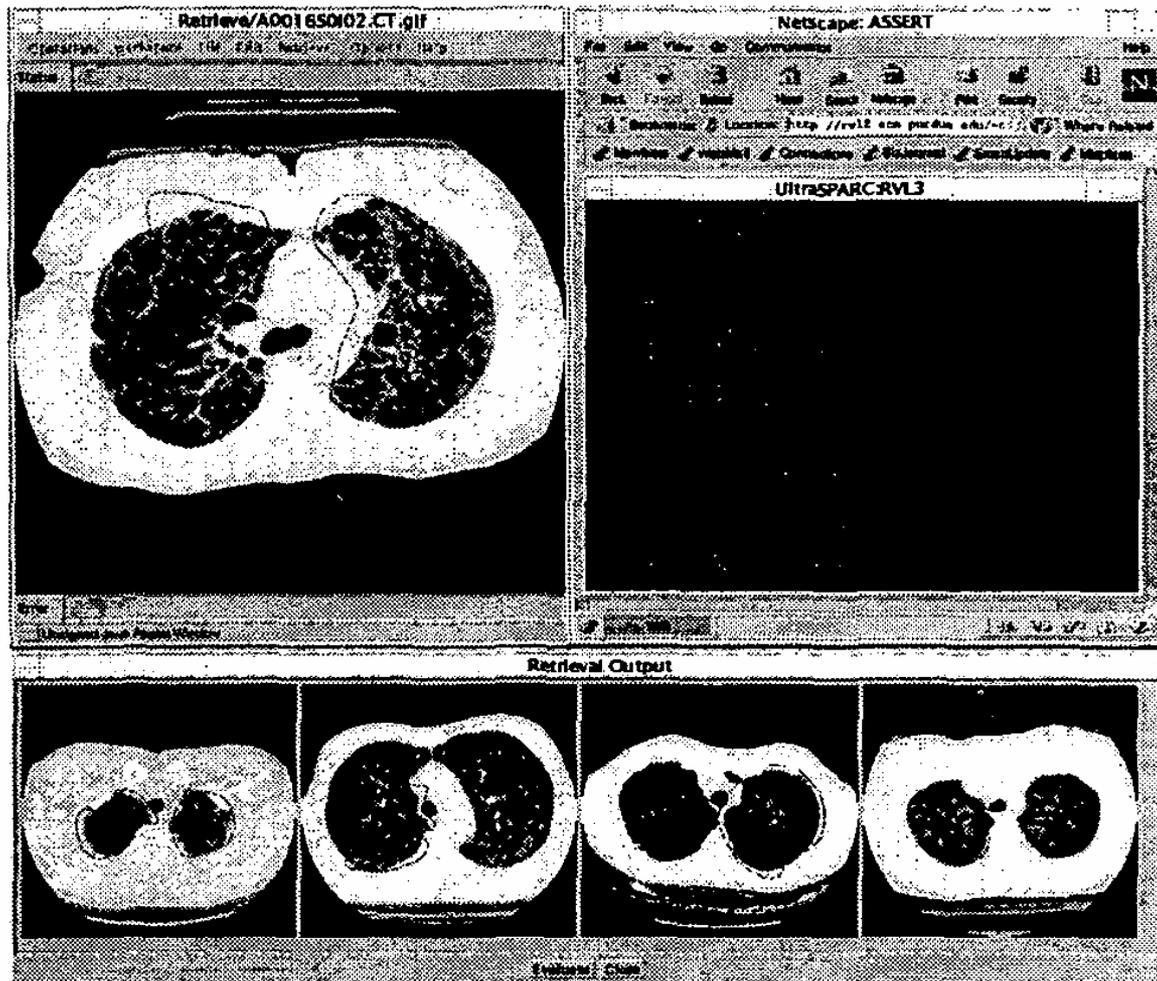


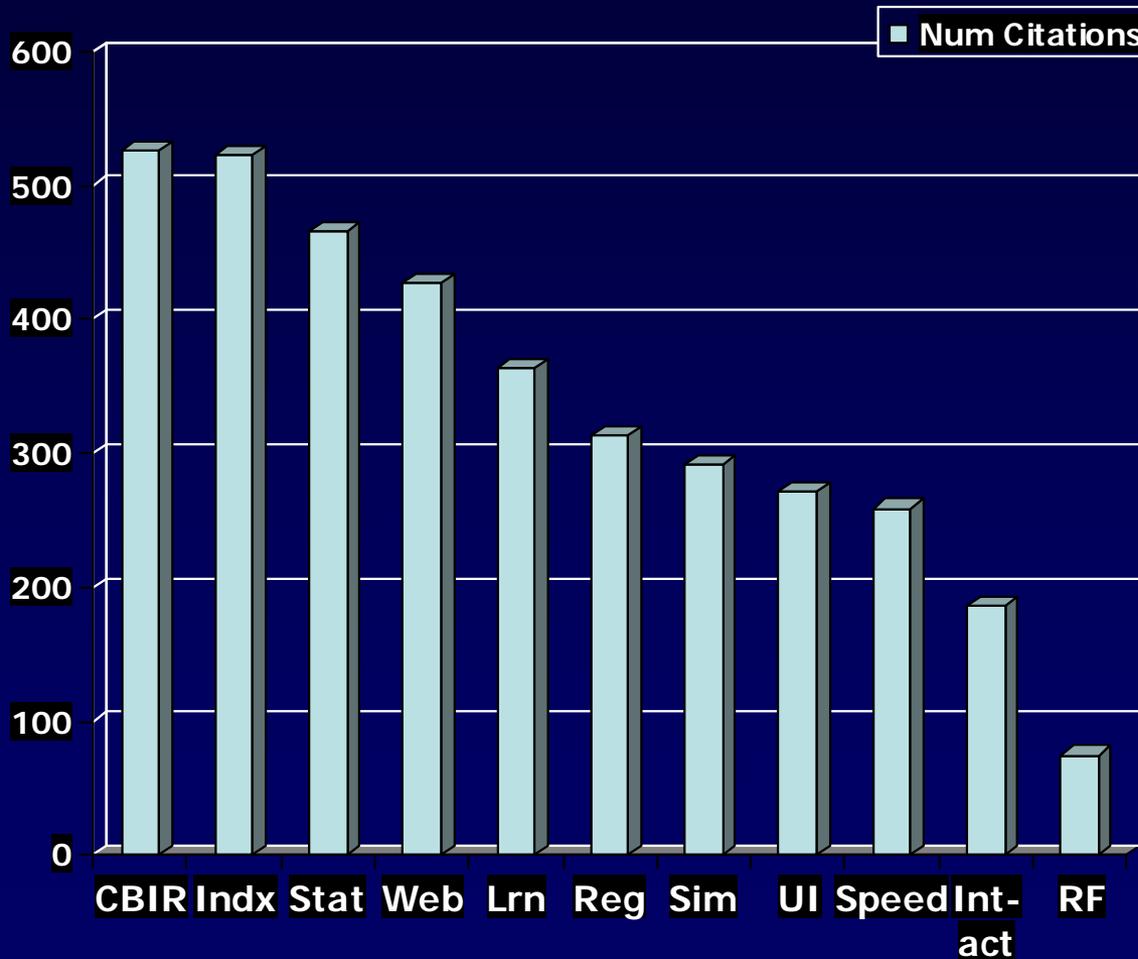
Figure 2. *Graphical interface of ASSERT system.*

Healthcare End-User

- **Reported medical CBIR projects/systems**
 - **Some support focused biomedical research projects**
 - **Most**
 - **Appear to have a large experimental flavor**
 - **Are outside of mainline healthcare**
 - **Are outside of mainline biomedical research**

Engineering Community

Since 2000, "medical image retrieval" trends in general CBIR...



Results from 10 sampled journals, Google scholar

Survey suggests...

- Widespread attention to
 - Indexing
 - Statistical methods
 - Learning methods
- Lesser attention to
 - User interface
 - Interactivity
 - Relevance feedback

Collaborative Efforts

Since 2000...

Public data sets	casImage ImageClef IRMA NCI Archive (NCIA) NLM Spine x-rays NLM Visible Human
Evaluation methodologies	Expert review
Collaborations	Many small-scale collaborations for specific projects
Collaborative environments	Web interface IRMA SPIRS

Collaborative Efforts – Public Data Sets

The screenshot displays the National Cancer Institute (NCIA) National Cancer Imaging Archive website. The browser address bar shows the URL <https://imaging.nci.nih.gov/ncia/faces/bas>. The page features a navigation menu with options like HOME, SEARCH IMAGES, REMOTE SEARCH, MANAGE DATA BASKET, HELP, and LOGOUT. A sidebar on the left contains links for DICOM Image Viewers, MY DATA BASKET, MY QUERIES, QUICK LINKS, and logos for caBIG, Cancer Imaging Program, Center for Bioinformatics, RSNA, and NCI.

The main content area is titled "Simple Search" and includes a help icon. Below the title, it states: "All searches are conducted at the series level" and "Different types of criteria are ANDed together when searching. Different values for the same criteria are ORed together. For example, if two modalities and two collections are selected, results will be returned that match at least one of the selected modalities and at least one of the selected collections." It also notes "Default equals 'All'" and provides a link to "ADVANCED SEARCH".

The "SEARCH CRITERIA" section is organized into several rows:

- Image Modality(ies):** Available options include CR, CT, DX, HC, MR, and PT. Buttons for "SELECT >", "SELECT ALL >>", "<< REMOVE ALL", and "< REMOVE" are present.
- Contrast:** A dropdown menu set to "Either Enhanced or Unenhanced".
- Anatomical Site:** Available options include ABDOMEN, BRAIN WITH _, CHEST, CHEST - PA AN, CHEST 1B, CHEST ABDOM, and CT CEREBRUM. Buttons for "SELECT >", "SELECT ALL >>", "<< REMOVE ALL", and "< REMOVE" are present.
- Image Slice Thickness:** A checkbox for "I would like to filter by 'Image Slice Thickness'", with dropdown menus for "0 mm" and "5 mm" separated by an "AND" operator.
- Collection(s):** Available options include LIDC, Phantom, RIDER, RoswellStrong, and Virtual Colonos. Buttons for "SELECT >", "SELECT ALL >>", "<< REMOVE ALL", and "< REMOVE" are present.
- Series Includes Annotations:** A dropdown menu set to "Series With or Without Annotations".

The status bar at the bottom shows "Done" and the address "imaging.nci.nih.gov".

<http://imaging.nci.nih.gov>

Collaborative Efforts – Public Data Sets

NCIA - National Cancer Imaging Archive - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://imaging.nci.nih.gov/ncia/faces/stuc

Customize Links Free Hotmail Windows Marketplace Windows Media Windows

NCIA - National Canc...

View Query History

QUICK LINKS

- NCIA NEWS
- NCIA USER'S GUIDE
- NCI HOME
- NCICB HOME

caBIG™

CANCER IMAGING PROGRAM

Center for Bioinformatics

RSNA

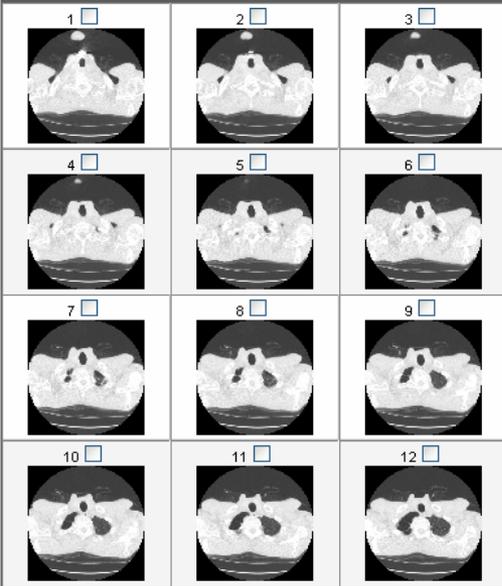
NIBIB

Subject ID	Study ID	Date	Modality	Manufacturer	Contains Annotations	Data Location
13614193285030047	1.3.6.1.4.1.9328.50.3.9660	Jan 1, 2000	CT	GE MEDICAL SYSTEMS	Yes	NCI-1

Images checked can be added to your basket.

CHECK ALL UNCHECK ALL  ADD TO BASKET

Images for Series 30242



Done imaging.nci.nih.gov

Collaborative Efforts

For a real medical application of CBIR and the integration of these tools into medical practice:

- We need a very close cooperation over an extended period of time**
- Not simply an exchange of data or a list of the necessary functionality**

Müller et al., A review of content-based image retrieval systems in medical applications—clinical benefits and future directions (2004)

Need for engineering community to

- “Bend the technology toward the end user rather than the end user toward the technology”?
- Integrate CBIR with other healthcare resources?
- Provide more simple, experimental CBIR tools that help educate the medical community to potential, limitations of CBIR?

So...

- Why isn't CBIR used more in healthcare and healthcare research?
- One way to think about what's missing
 - Conceptual hierarchy of gaps
 - Ontology of gaps in CBIR (Deserno et al.)