Databases for mammography

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OUTLINE

Databases for mammography:

- Introduction (“personal”)
- Historical overview
- Applications
- Requirements
- Examples of public research databases
- Conclusions (“personal”)
- Perspectives
- Conclusions

Introduction ("personal")

Thanks for this invitation-opportunity to collect and evaluate the different aspects related to the topic "Databases for mammography".

- Very current, evergreen topic …
  - … for at least the last 25 years
  - … with ups and downs
  - … with different meanings, contents, applications
  - … strictly related to fundamental progress in
    - imaging instrumentation
    - storage and computational power
    - software development

Introduction ("personal")

Other principal works but also Involved in:

- Collection of an italian multicentric dataset of digitized mammograms (end of last century-millennium).
- Collection of a pan-european dataset of digitized and digital mammograms (beginning of this century-millennium).

Draft of a book chapter about mammographic databases (few years ago). Meanwhile: physiological changes and news.

This year: need for a dataset for breast density studies (RADIOMA project).

No available public annotated database of digital images OK for density studies with deep learning techniques.

Historical overview

- First working groups
- Digitized mammograms
- Digital mammograms

Historical overview

1993 US:

Panel discussion, moderator F. Shtern, at IS&T/SPIE Symposium on Electronic Imaging: Science and Technology, 1993, San Jose, CA, US.

29 July 1993

Database for mammographic image research

Rangaraj M. Rangayyan; Raman B. Paranjape; Liang Shen; J. E. Leo Desautels

SPIE Conference on Biomedical Image Processing and Biomedical Visualization, 1993 Proceedings volume 1005.

Historical overview

1994 UK:

The Mammographic Image Analysis Society Digital Mammogram Database

ABSTRACT

The Mammographic Image Analysis Society has produced a *Digital Mammography Database*. It contains 161 pairs of films and includes examples of abnormalities commonly encountered in screening as well as a comprehensive set of normal cases. The mammograms have been carefully selected from the United Kingdom National Breast Screening Programme to be of the highest quality of exposure and patient positioning. Each medio-lateral oblique view was digitised to a spatial resolution of 50μm pixel edge with a scanning microdensitometer with a linear response in the optical density range 0.0 to 3.2 with 8 bits representing each pixel. The entire database, when compressed, occupies less than 2 GBytes fitting onto a single 8mm magnetic tape. Copies are available for research purposes.

Historical overview

1995 US:

A Proposal for a National Mammography Database: Content, Purpose, and Value

Janet Rose Osuch[1], Marietta Anthony[2,3], Lawrence W. Bassett[4], Marydale DeBor[5], Carl D'Orsi[6], R. Edward Hendrick[7], Michael Linver[8], Robert Smith[9]

AJR 1995;164:1329–1334 0361–803X/95/1646–1329

A national mammography database is a centralized, computerized method of data collection consisting of two possible parts: a national mammography audit and a system for monitoring and tracking patients. A national mammography audit refers to collecting and analyzing medical audit data of individual mammography practices at a national level and is a critical step in improving the interpretive component of mammography. The monitoring and tracking component refers to a centralized system that provides women and physicians with a recruitment and follow-up mechanism to optimize participation in mammography services. Both parts of a national mammography database represent important components in the improvement of mammography quality. However, unique scientific, legal, and fiscal concerns are important to consider before establishing a national mammography database.

Historical overview

TABLE 1: Essential Data Elements and Outcome Measures of a National Mammography Database

Identification of practice (confidential ID)
Anonymous ID number of mammography interpreters
Dates of audit period and number of examinations audited for each practice
Number of examinations by type (screening or diagnostic[a]) audited for each practice
Patient ID number (confidential ID) compatible with database(s) for linkage, for example, to tumor registry
Patient date of birth
Interpretation of mammogram (BI-RADS™ nomenclature)
Follow-up recommendation (BI-RADS™ nomenclature)
Dates and results of follow-up studies, if any
If abnormality found, palpable versus nonpalpable
Results of cytology, core biopsy, or open biopsy
Cancer data[b] (for each tumor diagnosed)
Size of tumor in millimeters
Histologic appearance of each tumor
Lymph node status
Pathologic stage
Date of patient's death[c]
Outcome measures[d]
False-negative rate
True-positive rate
False-positive rate (see text)
Positive predictive value (see text)
Screening cancer detection rate (prevalent or incident)
Percentage of cases with invasive cancer less than or equal to 1 cm and ductal carcinoma in situ
Patient survival

[a]Screening mammography is performed on women without symptoms. Diagnostic mammography is performed on individuals with clinical signs or symptoms or an abnormal screening mammogram or who fit special circumstances, such as women who have implants or have had breast-conserving surgery.

[b]Include all invasive cancers and ductal carcinoma in situ; do not include lobular carcinoma in situ.

[c]Data available from tumor registry link.

[d]Desirable goals for an individual mammography audit have been published previously [1].

TABLE 2: Data for Monitoring and Tracking Functions

Patient's name, including all prior names[a]
Patient's current address[a]
Patient's date of birth[a]
Identification number of patient[a]
Patient's telephone number[a]
Patient's spoken language[a]
Dates and locations of prior mammograms
Date and type of follow-up studies, if any
Date to send patient/clinician reminder for next study
Clinician name and address (for purposes of sending clinicians reminders)

Historical overview

Stud Health Technol Inform. 1997;43 Pt B:601-5.

Medical image databases for CAD applications in digital mammography: design issues.

Kallergi M[1], Clark RA, Clarke LP.

Author information

Abstract

The evaluation of algorithms' developed for computer assisted diagnosis in digital mammography requires image databases that allow relative comparisons and assessment of algorithms clinical value. A review of the literature indicates that there is no consensus on the guidelines of how databases should be established. Image selection is usually done based on subjective criteria or availability. The generation of common database(s) available to the research community makes relative evaluations of algorithms with similar properties easier. However, questions regarding the "right database size," the "right image resolution," and the "right contents" remain. In this paper, database issues are reviewed and discussed and possible remedies to the various problems are proposed.

Historical overview

2005 EU: The first Full Field Digital Mammography images in a research database (28 exams from Valdese Hospital, Turin. IT)

MAMMOGRID

Project ID: IST-2001-37614
Funded under: FP5-IST

European federated mammogram database implemented on a GRID structure

From 2002-09-01 **to** 2005-08-31 | MAMMOGRID Website

Clinical Radiology (2007) 62, 1044–1051

INFORMATION TECHNOLOGY REVIEW

MammoGrid — a prototype distributed mammographic database for Europe

R. Warren[a,*], A.E. Solomonides[b], C. del Frate[c], I. Warsi[a], J. Ding[a], M. Odeh[b], R. McClatchey[b], C. Tromans[d], M. Brady[d], R. Highnam[e], M. Cordell[e], F. Estrella[b], M. Bazzocchi[c], S.R. Amendolia[f]

Applications

- Teaching and training
- Archive of particular cases
- Statistical and epidemiological studies
- Development and validation of software analysis tools

Teaching and training

International Nuclear Information System
IAEA

META

Teaching atlas of mammography

Tabar, L. (Zentralkrankenhaus Falun (Sweden). Mammographie-Abt.); Dean, P.B. (Turku Univ. Central Hospital (Finland). Dept. of Diagnostic Radiology)

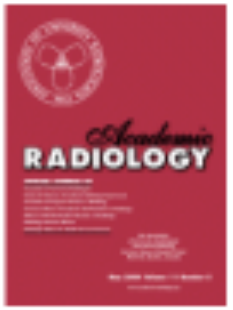
Original Title
Lehratlas der Mammographie
Primary Subject
RADIOLOGY AND NUCLEAR MEDICINE (S62)
Source
1985; 230 p; Thieme; Stuttgart (Germany); ISBN 3-13-666801-4; Worldcat; Translated by Ulrich R. Koeppen

Teaching and training

ELSEVIER

Academic Radiology

Volume 11, Issue 5, May 2004, Pages 566-572



Technical report

Online annotation tool for digital mammography[1] [2] ☆

Yuanshui Zheng PhD [a] ✉, Min Wu MS [a], Elodia Cole MS [a], Etta D Pisano MD [a]

Teaching and training

MAMMOED

Digital Interactive Breast Imaging Education

MammoEd strives to provide up-to-date information and educational material for Radiology Residents and Attendings, Clinicians, Technologists and Patients.

Practicing Radiologists & Residents: The Teaching Files are a 61-case educational module covering the essentials of breast imaging. Additional cases are added periodically-- stay tuned!

Tools: specific educational resources can be found by clicking on the navigation bar to the left

Teaching and training

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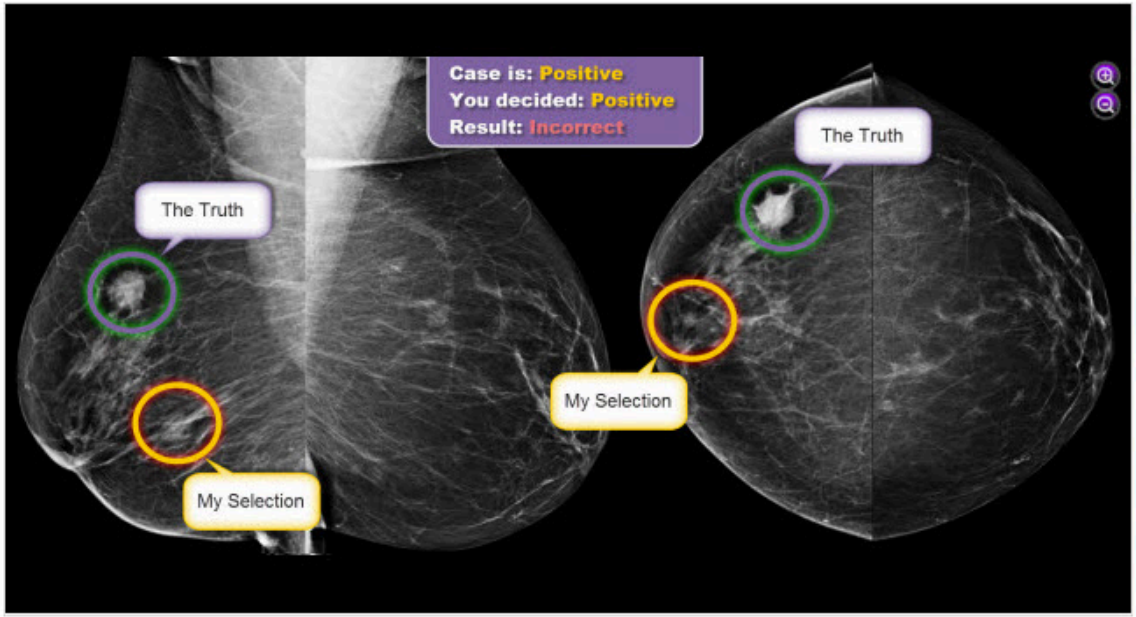


Improve your benchmarks and performance in screening mammography

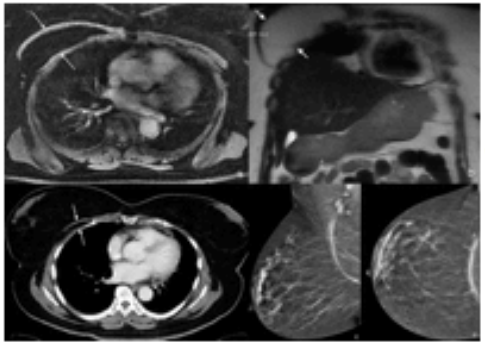
Qualified by the American Board of Radiology in meeting the criteria for practice quality improvement (PQI), toward the purpose of fulfilling requirements in the ABR Maintenance of Certification Program.

Archive of particular cases

Breast Imaging

Large Subpectoral Lipoma on Screening Mammography by Andres Su et al.

Published: 2017 Sep
Issue: 11(9) :: Pages: 22-27



Abstract: *A 61 year-old woman presenting for bilateral screening mammogram was found to have an oval fat-density mass in the posterior right breast, partially visualized, with anterior displacement and thinning of the pectoralis major muscle. This mass was found on CT and MRI correlation to represent a large fat-containing mass, likely a lipoma, deep to the pectoralis major. On subsequent screening mammograms, the visualized portion of the mass remained stable. Subpectoral lipomas and intramuscular lipomas within the pectoralis major are rare, and their appearance on mammography may not be familiar to most radiologists. A review of the literature and a discussion of their appearance on multiple imaging modalities is provided.*

Available image modalities: (click on modality to browse for other articles)
Conventional Radiography, Computed Tomography, Magnetic Resonance Imaging, Table

Free Fulltext

PDF

The Teaching Point

Learning Tables

Archive of particular cases

The Teaching Point

Subpectoral lipomas and intramuscular lipomas of the pectoralis major, whether idiopathic or post-traumatic, may present as a clinically palpable mass with or without associated symptoms, or be found incidentally on screening mammography as a fat-density, far posterior mass displacing the overlying muscle anteriorly. Cross-sectional imaging is useful to evaluate for aggressive features, monitor for stability over time, and/or plan for surgical (typically transaxillary) resection.

Learning Tables

Summary table for Subpectoral Lipoma.

Tap on the table to enlarge and then on the magnify symbol to see it in original size.

Etiology	Lipomas are slow-growing masses composed of mature adipocytes. Their etiology is unclear, but a combination of endocrine, metabolic, and genetic abnormalities is suspected. In addition, they are known to develop following chronic or acute trauma. Proliferation of adipose tissue following rupture of fibrous septae and herniation of fat has been proposed as an etiology in post-traumatic cases.
Incidence	Subpectoral lipomas are very rare. There are four reported cases in the English-language literature.
Gender ratio	1 male, 3 female among the reported cases
Age predilection	Ages 30-60 (all lipomas)
Risk factors	Chronic/acute trauma; syndromes such as PTEN hamartoma tumor syndrome
Treatment	Surgical excision if indicated/desired
Prognosis	Lipomas are usually slow-growing but occasionally may enlarge rapidly. If benign, primary risk is recurrence following resection, especially in the setting of incomplete resection.
Findings on imaging	On mammography and CT, the subpectoral lipoma appears as a fat-density mass displacing the pectoralis major muscle anteriorly. On MRI, the lipoma homogeneously follows fat signal on all sequences, and may contain thin septations. On cross-sectional imaging, the mass should contain no thick septations, nodular enhancing components, or other aggressive features.

Statistical and epidemiological studies

2016 US:

The National Mammography Database: Preliminary Data

Cindy S. Lee[1]
Mythreyi Bhargavan-Chatfield[2]
Elizabeth S. Burnside[3]
Paul Nagy[4]
Edward A. Sickles[1]

OBJECTIVE. The purposes of our study were to analyze screening mammography data submitted to the National Mammography Database (NMD) since its inception to confirm data collection feasibility, to draw parallels to data from the Breast Cancer Surveillance Consortium (BCSC), and to examine trends over time. We also retrospectively evaluated practice-level variation in terms of practice type, practice setting, census region, and annual volume.

MATERIALS AND METHODS. Data from 90 mammography facilities in the NMD registry were analyzed. The registry receives mammography data collected as part of standard clinical practice, including self-reported demographic information, clinical findings, screening mammography interpretation, and biopsy results. Outcome metrics calculated were cancer detection rate, recall rate, and positive predictive values for biopsy recommended (PPV_2) and biopsy performed (PPV_3).

RESULTS. The NMD successfully collected and analyzed data for 3,181,437 screening mammograms performed between January 2008 and December 2012. Mean values for outcomes were cancer detection rate of 3.43 per 1000 (95% CI, 3.2–3.7), recall rate of 10% (95% CI, 9.3–10.7%), PPV_2 of 18.5% (95% CI, 16.7–20.2%), and PPV_3 of 29.2% (95% CI, 26.2–32.3%). No statistically significant difference was seen in performance measurements on the basis of practice type, practice setting, census region, or annual volume. NMD performance measurements parallel those reported by the BCSC.

CONCLUSION. The NMD has become the fastest growing mammography registry in the United States, providing nationwide performance metrics and permitting comparison with published benchmarks. Our study shows the feasibility of using the NMD to audit mammography facilities and to provide current, ongoing benchmark data.

Keywords: medical auditing, national mammography database, performance benchmarks, screening mammography

DOI:10.2214/AJR.15.14312

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Statistical and epidemiological studies

TABLE 1: National Mammography Database (NMD) Facility Demographic Characteristics

Facility Characteristic	Number of NMD Facilities	Number of Screening Examinations (%)
Total no.	90[a]	3,181,437
Practice type		
Community	39	1,276,470 (40.1)
Academic	11	415,737 (13.1)
Multispecialty	7	83,864 (2.6)
Freestanding	33	1,405,366 (44.2)
Practice setting		
Metropolitan	41	1,971,543 (62.0)
Suburban	35	961,418 (30.2)
Rural	14	248,476 (7.8)
Census region[b]		
Northeast	29	735,278 (23.1)
Midwest	31	1,095,366 (34.4)
South	13	593,101 (18.6)
West	17	757,692 (23.8)
Annual volume[b]		
<5000	22	159,034 (5.0)
5000–10,000	22	456,466 (14.3)
10,000–30,000	39	1,776,732 (55.8)
>30,000	7	789,205 (24.8)

[a]A total of 107 facilities contributing data during the study period of 2008–2012, but 17 facilities contributed data for less than 1 year and were excluded from this analysis.
[b]Percentages do not total 100% because of rounding.

TABLE 2: Patient Demographic Characteristics in the National Mammography Database Study Population

Patient Characteristic	No. of Examinations (%)	No. of Women (%)
Total no.	3,181,437	1,865,300
Age (y)		
0–29	1796 (0.1)	1627 (0.1)
30–39	68,557 (2.2)	59,641 (3.2)
40–49	828,738 (26.0)	541,179 (29.0)
50–59	983,178 (30.9)	570,585 (30.6)
60–69	765,311 (24.1)	416,088 (22.3)
70–74	238,316 (7.5)	122,310 (6.6)
75–79	156,669 (4.9)	80,669 (4.3)
80–84	93,750 (2.9)	49,068 (2.6)
85–89	37,507 (1.2)	19,974 (1.1)
90+	7614 (0.2)	4158 (0.2)
Missing information	1 (0.0)	1 (0.0)
Race[a]		
White	1,122,167 (35.3)	581,346 (31.2)
Black or African American	121,057 (3.8)	74,236 (4.0)
Asian	23,454 (0.7)	11,921 (0.6)
Native Hawaiian or Pacific Islander	7193 (0.2)	1567 (0.1)
American Indian or Alaska Native	38,731 (1.2)	25,403 (1.4)
Other	115,003 (3.6)	60,483 (3.2)
Missing information	1,753,832 (55.1)	1,110,344 (59.5)
Breast density		
Almost entirely fatty	244,116 (7.7)	140,059 (7.5)
Scattered fibroglandular density	1,079,729 (33.9)	586,383 (31.4)
Heterogeneous	948,733 (29.8)	528,953 (28.4)
Extremely dense	122,823 (3.9)	74,366 (4.0)
Missing information	786,036 (24.7)	535,539 (28.7)
Personal history of breast cancer		
Yes	111,283 (3.5)	56,267 (3.0)
No	2,597,500 (81.6)	1,554,934 (83.4)
Missing information	472,654 (14.9)	254,099 (13.6)

[a]Percentages for race in number of examinations do not total 100% because of rounding.

Statistical and epidemiological studies

Published OnlineFirst January 6, 2017; DOI: 10.1158/1055-9965.EPI-16-0499

Research Article

Cancer Epidemiology, Biomarkers & Prevention

Longitudinal Study of Mammographic Density Measures That Predict Breast Cancer Risk

Kavitha Krishnan[1], Laura Baglietto[1,2,3,4], Jennifer Stone[1,5], Julie A. Simpson[1], Gianluca Severi[6], Christopher F. Evans[1], Robert J. MacInnis[1,2], Graham G. Giles[1,2,7], Carmel Apicella[1], and John L. Hopper[1,8,9]

Abstract

Background: After adjusting for age and body mass index (BMI), mammographic measures—dense area (DA), percent dense area (PDA), and nondense area (NDA)—are associated with breast cancer risk. Our aim was to use longitudinal data to estimate the extent to which these risk-predicting measures track over time.

Methods: We collected 4,320 mammograms (age range, 24–83 years) from 970 women in the Melbourne Collaborative Cohort Study and the Australian Breast Cancer Family Registry. Women had on average 4.5 mammograms (range, 1–14). DA, PDA, and NDA were measured using the Cumulus software and normalized using the Box–Cox method. Correlations in the normalized risk-predicting measures over time intervals of different lengths were estimated using nonlinear mixed-effects modeling of Gompertz curves.

Results: Mean normalized DA and PDA were constant with age to the early 40s, decreased over the next two decades, and were almost constant from the mid-60s onward. Mean normalized NDA increased nonlinearly with age. After adjusting for age and BMI, the within-woman correlation estimates for normalized DA were 0.94, 0.93, 0.91, 0.91, and 0.91 for mammograms taken 2, 4, 6, 8, and 10 years apart, respectively. Similar correlations were estimated for the age- and BMI-adjusted normalized PDA and NDA.

Conclusions: The mammographic measures that predict breast cancer risk are highly correlated over time.

Impact: This has implications for etiologic research and clinical management whereby women at increased risk could be identified at a young age (e.g., early 40s or even younger) and recommended appropriate screening and prevention strategies.

Cancer Epidemiol Biomarkers Prev; 26(4); 651–60. ©2017 AACR.

Statistical and epidemiological studies

American Journal of Epidemiology Advance Access published October 28, 2013

American Journal of Epidemiology

DOI: 10.1093/aje/kwt260

Original Contribution

Associations of Mammographic Dense and Nondense Areas and Body Mass Index With Risk of Breast Cancer

Laura Baglietto, Kavitha Krishnan, Jennifer Stone, Carmel Apicella, Melissa C. Southey, Dallas R. English, John L. Hopper*, and Graham G. Giles

Statistical and epidemiological studies

Mammographic Breast Density as a General Marker of Breast Cancer Risk

Celine M. Vachon,[1] Kathleen R. Brandt,[1] Karthik Ghosh,[1] Christopher G. Scott,[1] Shaun D. Maloney,[1] Michael J. Carston,[1] V. Shane Pankratz,[1] and Thomas A. Sellers[2]

[1]Mayo Clinic College of Medicine, Rochester, Minnesota and [2]H. Lee Moffitt Cancer Center and Research Institute, Tampa, Florida

Cancer Epidemiol Biomarkers Prev 2007;16(1). January 2007

Abstract

Mammographic breast density is a strong risk factor for breast cancer but whether breast density is a general marker of susceptibility or is specific to the location of the eventual cancer is unknown. A study of 372 incident breast cancer cases and 713 matched controls was conducted within the Mayo Clinic mammography screening practice. Mammograms on average 7 years before breast cancer were digitized, and quantitative measures of percentage density and dense area from each side and view were estimated. A regional density estimate accounting for overall percentage density was calculated from both mammogram views. Location of breast cancer and potential confounders were abstracted from medical records. Conditional logistic regression was used to estimate associations, and C-statistics were used to evaluate the strength of risk prediction. There were increasing trends in breast cancer risk with increasing quartiles of percentage density and dense area, irrespective of the side of the breast with cancer ($P_{trends} < 0.001$). Percentage density from the ipsilateral side [craniocaudal (CC): odds ratios (ORs), 1.0 (ref), 1.7, 3.1, and 3.1; mediolateral oblique (MLO): ORs, 1.0 (ref), 1.5, 2.2, and 2.8] and the contralateral side [CC: ORs, 1.0 (ref), 1.8, 2.2, and 3.7; MLO: ORs, 1.0 (ref), 1.6, 1.9, and 2.5] similarly predicted case-control status (C-statistics, 0.64-65). Accounting for overall percentage density, density in the region where the cancer subsequently developed was not a significant risk factor [CC: 1.0 (ref), 1.3, 1.0, and 1.2; MLO: 1.0 (ref), 1.1, 1.0, and 1.1 for increasing quartiles]. Results did not change when examining mammograms 3 years on average before the cancer. Overall mammographic density seems to represent a general marker of breast cancer risk that is not specific to breast side or location of the eventual cancer. (Cancer Epidemiol Biomarkers Prev 2007;16(1):43–9)

Development and validation of software analysis tools

- CAD (Computer Aided Detection/Diagnosis) systems (more than 1000 pubblications)
  - Microcalcification clusters
  - Tumour masses

- Density assessment
  - BIRADS classes
  - Segmentation

CAD systems: first attempts

J Thorac Imaging. 1990 Jan;5(1):67-76.

Computer-aided diagnosis in chest radiology.

MacMahon H[1], Doi K, Chan HP, Giger ML, Katsuragawa S, Nakamori N.

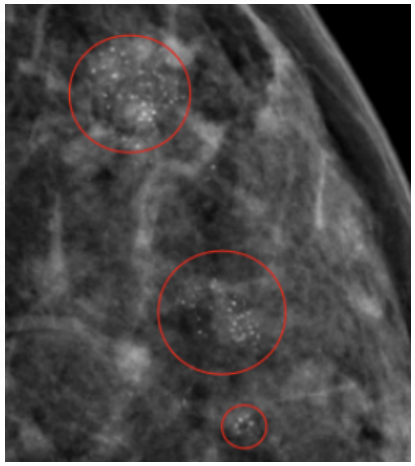
Author information

Abstract

Digital radiography offers several important advantages over conventional systems, including abilities for image manipulation, transmission, and storage. In the long term, however, the unique ability to apply artificial intelligence techniques for automated detection and quantitation of disease may have an even greater impact on radiologic practice. Although CAD is still in its infancy, the results of several recent studies clearly indicate a major potential for the future. The concept of using computers to analyze medical images is not new, but recent advances in computer technology together with progress in implementing practical digital radiography systems have stimulated research efforts in this exciting field. Several facets of CAD are presently being developed at the University of Chicago and elsewhere for application in chest radiology as well as in mammography and vascular imaging. To date, investigators have focused on a limited number of subjects that have been, by their nature, particularly suitable for computer analysis. There is no aspect of radiologic diagnosis that could not potentially benefit from this approach, however. The ultimate goal of these endeavors is to provide a system for comprehensive automated image analysis, the results of which could be accepted or modified at the discretion of the radiologist.

CAD systems: first attempts

Microcalcification clusters



Invest Radiol. 1990 Oct;25(10):1102-10.

Improvement in radiologists' detection of clustered microcalcifications on mammograms. The potential of computer-aided diagnosis.

Chan HP[1], Doi K, Vyborny CJ, Schmidt RA, Metz CE, Lam KL, Ogura T, Wu YZ, MacMahon H.

Author information

Abstract

Relatively simple, but important, detection tasks in radiology are nearing accessibility to computer-aided diagnostic (CAD) methods. The authors have studied one such task, the detection of clustered microcalcifications on mammograms, to determine whether CAD can improve radiologists' performance under controlled but generally realistic circumstances. The results of their receiver operating characteristic (ROC) study show that CAD, as implemented by their computer code in its present state of development, does significantly improve radiologists' accuracy in detecting clustered microcalcifications under conditions that simulate the rapid interpretation of screening mammograms. The results suggest also that a reduction in the computer's false-positive rate will further improve radiologists' diagnostic accuracy, although the improvement falls short of statistical significance in this study.

CAD systems: first attempts

Microcalcification clusters

Med Phys. 1993 Nov-Dec;20(6):1661-6.

Computer-aided detection of clustered microcalcifications: an improved method for grouping detected signals.

Nishikawa RM[1], Giger ML, Doi K, Vyborny CJ, Schmidt RA.

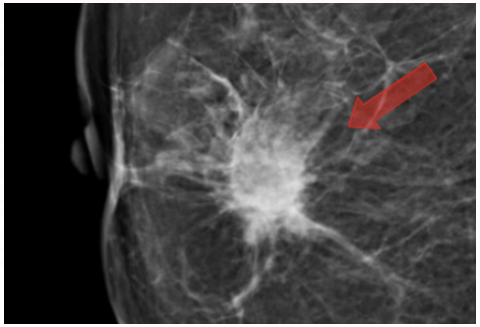
Author information

Abstract

A computerized scheme for the automated detection of clustered microcalcifications from digital mammograms is being developed. This scheme is one part of an overall package for computer-aided diagnosis (CAD), the purpose of which is to assist radiologists in detecting and diagnosing breast cancer. One important step in the computer detection scheme is to group or cluster microcalcifications, since clustered microcalcifications are more clinically significant than are isolated microcalcifications. Previously a "growing" technique in which signals (possible microcalcifications) were clustered by grouping those that were within some predefined distance from the center of the growing cluster was used. In this paper, a new technique for grouping signals, which consists of two steps, is introduced. First, signals that may be several pixels in area are reduced to single pixels by means of a recursive transformation. Second, the number of signals (nonzero pixels) within a small region, typically 3.2 x 3.2 mm, are counted. Only if three or more signals are present within such a region are they preserved in the output image. In this way, isolated signals are eliminated. Furthermore, this method can eliminate falsely detected clusters, which were identified by a previous detection scheme, based on the spatial distribution of signals within the cluster. The differences in performance of the CAD scheme for detecting clustered microcalcifications using the old and new clustering techniques was measured using 78 mammograms, containing 41 clusters.(ABSTRACT TRUNCATED AT 250 WORDS).

CAD systems: first attempts

Tumour masses



Acad Radiol. 1995 Nov;2(11):959-66.

Computerized detection of masses in digitized mammograms using single-image segmentation and a multilayer topographic feature analysis.

Zheng B[1], Chang YH, Gur D.

Author information

Abstract

RATIONALE AND OBJECTIVES: We developed and evaluated a computer-aided detection (CAD) scheme for masses in digitized mammograms.

METHODS: A multistep CAD scheme was developed and tested. The method uses a technique of single-image segmentation with Gaussian bandpass filtering to yield a high sensitivity for mass detection. A rule-based multilayer topographic feature analysis method is then used to classify suspected regions. A set of 260 cases, including 162 verified masses, was divided into two subsets; one set was used to set the rule-based classification and one was used to test the performance of the scheme.

RESULTS: In a preliminary clinical study, the implemented detection scheme yielded 98% sensitivity with a false-positive detection rate of less than one false-positive region per image.

CONCLUSION: Single-image segmentation methods seem to have high sensitivity in selecting true-positive mass regions in the first stage of a CAD scheme. A multilayer topographic image feature analysis method in the second stage of a CAD scheme has the potential to significantly reduce the false-positive detection rate.

CAD systems: first attempts with MIAS database

Phys Med Biol. 1997 Dec;42(12):2577-89.

Automated detection of clustered microcalcifications on mammograms: CAD system application to MIAS database.

Ibrahim N[1], Fujita H, Hara T, Endo T.

Author information

Abstract

To investigate the detection performance of our automated detection scheme for clustered microcalcifications on mammograms, we applied our computer-aided diagnosis (CAD) system to the database of the Mammographic Image Analysis Society (MIAS) in the UK. Forty-three mammograms from this database were used in this study. In our scheme, the breast regions were firstly extracted by determining the skinline. Histograms of the original images were used to extract the high-density area within the breast region as the segmentation from the fatty area around the skinline. Then the contrast correction technique was employed. Gradient vectors of the image density were calculated on the contrast corrected images. To extract the specific features of the pattern of the microcalcifications, triple-ring filter analysis was employed. A variable-ring filter was used for more accurate detection after the triple-ring filter. The features of the detected candidate areas were then characterized by feature analysis. The areas which satisfied the characteristics and specific terms were classified and displayed as clusters. As a result, the sensitivity was 95.8% with the false-positive rate at 1.8 clusters per image. This demonstrates that the automated detection of clustered microcalcifications in our CAD system is reliable as an aid to radiologists.

CAD systems today: recent work with mini-MIAS database

Comput Methods Programs Biomed. 2018 Oct;164:131-142. doi: 10.1016/j.cmpb.2018.07.005. Epub 2018 Jul 18.

Mammographic mass segmentation using fuzzy contours.

Hmida M[1], Hamrouni K[2], Solaiman B[3], Boussetta S[4].

Author information

Abstract

BACKGROUND AND OBJECTIVE: Accurate mass segmentation in mammographic images is a critical requirement for computer-aided diagnosis systems since it allows accurate feature extraction and thus improves classification precision.

METHODS: In this paper, a novel automatic breast mass segmentation approach is presented. This approach consists of mainly three stages: contour initialization applied to a given region of interest; construction of fuzzy contours and estimation of fuzzy membership maps of different classes in the considered image; integration of these maps in the Chan-Vese model to get a fuzzy-energy based model that is used for final delineation of mass.

RESULTS: The proposed approach is evaluated using mass regions of interest extracted from the mini-MIAS database. The experimental results show that the proposed method achieves an average true positive rate of 91.12% with a precision of 88.08%.

CONCLUSIONS: The achieved results show high accuracy in breast mass segmentation when compared to manually annotated ground truth and to other methods from the literature.

CAD systems today: deep learning based

Sci Rep. 2018 Mar 15;8(1):4165. doi: 10.1038/s41598-018-22437-z.

Detecting and classifying lesions in mammograms with Deep Learning.

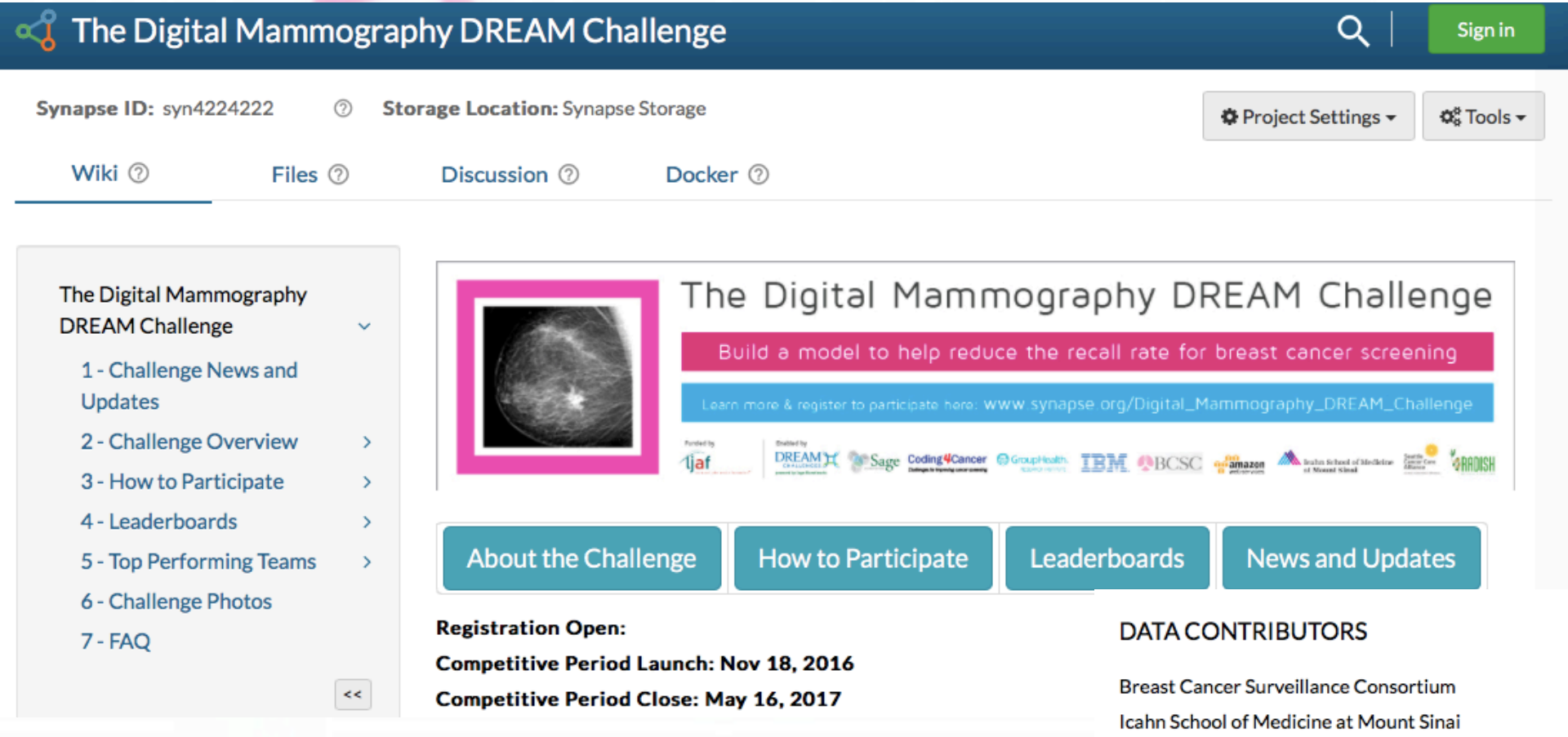
Ribli D[1], Horváth A[2], Unger Z[3], Pollner P[4], Csabai I[5].

⊕ Author information

Abstract

In the last two decades, Computer Aided Detection (CAD) systems were developed to help radiologists analyse screening mammograms, however benefits of current CAD technologies appear to be contradictory, therefore they should be improved to be ultimately considered useful. Since 2012, deep convolutional neural networks (CNN) have been a tremendous success in image recognition, reaching human performance. These methods have greatly surpassed the traditional approaches, which are similar to currently used CAD solutions. Deep CNN-s have the potential to revolutionize medical image analysis. We propose a CAD system based on one of the most successful object detection frameworks, Faster R-CNN. The system detects and classifies malignant or benign lesions on a mammogram without any human intervention. The proposed method sets the state of the art classification performance on the public INbreast database, AUC = 0.95. The approach described here has achieved 2nd place in the Digital Mammography DREAM Challenge with AUC = 0.85. When used as a detector, the system reaches high sensitivity with very few false positive marks per image on the INbreast dataset. Source code, the trained model and an OsiriX plugin are published online at https://github.com/riblidezso/frcnn_cad .

CAD systems today: DREAM challenge



First classified: Yaroslav Nikulin THERAPIXEL (French company) and and Yuanfang Guan (Dept. of Computational Medicine and Bioinformatics, University of Michigan).

CAD systems today: DREAM challenge

OVERVIEW

The Digital Mammography DREAM Challenge will attempt to improve the predictive accuracy of digital mammography for the early detection of breast cancer. The primary benefit of this Challenge will be to establish new quantitative tools - machine learning, deep learning or other - that can help decrease the recall rate of screening mammography, with a potential impact on shifting the balance of routine breast cancer screening towards more benefit and less harm. **Participating teams will be asked to submit predictive models based on over 640,000 de-identified digital mammography images from over 86000 subjects, with corresponding clinical variables.**

CHALLENGE ORGANIZERS

Sage Bionetworks
IBM Research
Kaiser Permanente Washington Health Research Institute
Icahn School of Medicine at Mount Sinai
Seattle Cancer Care Alliance
U.S. Food & Drug Administration

Radish Medical Solutions
National Cancer Institute

FUNDERS AND SPONSORS

Laura and John Arnold Foundation
Coding4Cancer
White House Office of Science and Technology Policy

CLOUD COMPUTING SPONSORS

IBM SoftLayer
Amazon Web Services

CAD systems today: syntetic images

Clin Radiol. 2018 Jun 30. pii: S0009-9260(18)30221-6. doi: 10.1016/j.crad.2018.05.028. [Epub ahead of print]

Evaluation of a computer-aided detection (CAD)-enhanced 2D synthetic mammogram: comparison with standard synthetic 2D mammograms and conventional 2D digital mammography.

James JJ[1], Giannotti E[2], Chen Y[3].

Author information

Abstract

AIM: To evaluate the diagnostic performance of computer-aided detection (CAD)-enhanced synthetic mammograms in comparison with standard synthetic mammograms and full-field digital mammography (FFDM).

MATERIALS AND METHODS: A CAD-enhanced synthetic mammogram, a standard synthetic mammogram, and FFDM were available in 68 breast-screening cases recalled for soft-tissue abnormalities (masses, parenchymal deformities, and asymmetric densities). Two radiologists, blinded to image type and final assessment outcome, retrospectively read oblique and craniocaudal projections for each type of mammogram. The resulting 204 pairs of 2D images were presented in random order and scored on a five-point scale (1, normal to 5, malignant) without access to the Digital breast tomosynthesis (DBT) slices. Receiver operating characteristic (ROC) curve analysis was performed.

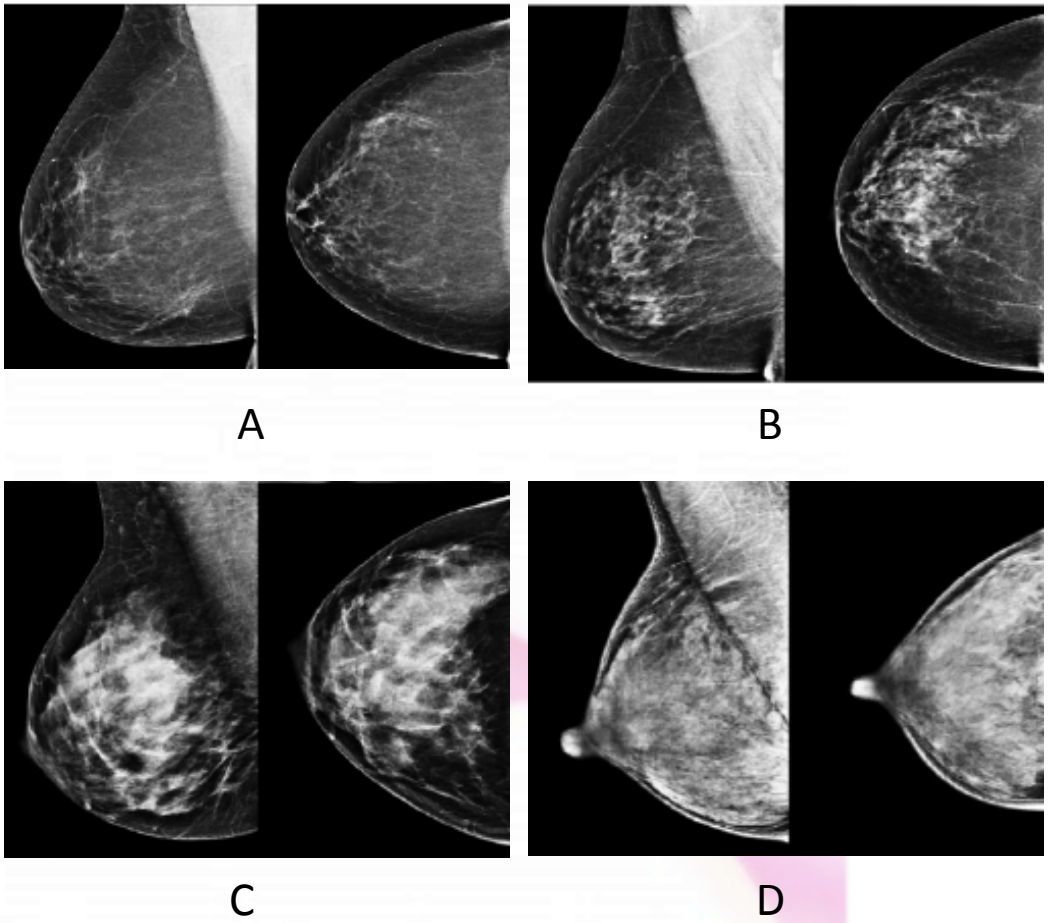
RESULTS: There were 34 biopsy-proven malignancies and 34 normal/benign cases. Diagnostic accuracy was significantly improved for the CAD-enhanced synthetic mammogram compared to the standard synthetic mammogram (area under the ROC curve [AUC]=0.846 and AUC=0.683 respectively, p=0.004) and compared to the conventional 2D FFDM (AUC=0.724, p=0.027). The CAD-enhanced synthetic mammogram had the highest diagnostic accuracy for all soft-tissue abnormalities, and for malignant lesions sensitivity was not affected by tumour size. For all 68 cases, there was an average of 3.2 areas enhanced per image. For the 34 cancer cases, 97.4% of lesions were correctly enhanced, with 2.1 false areas enhanced per image.

CONCLUSIONS: CAD enhancement significantly improves performance of synthetic 2D mammograms and also exhibits improved diagnostic accuracy compared to conventional 2D FFDM.

Density assessment

Table 1: Breast Composition Categories (BI-RADS Fifth Edition)

Category A: The breasts are almost entirely fatty
Category B: There are scattered areas of fibroglandular density (an optional description of a few or moderate scattered areas of density can be included in a second sentence)
Category C: The breasts are heterogeneously dense, which may obscure small masses (if the dense tissue is localized to one area of the breast, the location of the dense tissue can be included in a second sentence: "The dense tissue is located anteriorly in both breasts, and the posterior portions are mostly fatty" or "Primarily dense tissue is located in the upper outer quadrants of both breasts; scattered areas of fibroglandular tissue are present in the remainder of the breasts")
Category D: The breasts are extremely dense, which lowers the sensitivity of mammography



ACR (American College of Radiology) breast imaging reporting and data system (BIRADS)

Density assessment

Radiology. 2015 May;275(2):366-76. doi: 10.1148/radiol.15141686. Epub 2015 Feb 25.

Reliability of automated breast density measurements.

Alonzo-Proulx O[1], Mawdsley GE, Patrie JT, Yaffe MJ, Harvey JA.

Author information

Abstract

PURPOSE: To estimate the reliability of a reference standard two-dimensional area-based method and three automated volumetric breast density measurements by using repeated measures.

MATERIALS AND METHODS: Thirty women undergoing screening mammography consented to undergo a repeated left craniocaudal examination performed by a second technologist in this prospective institutional review board-approved HIPAA-compliant study. Breast density was measured by using an area-based method (Cumulus ABD) and three automated volumetric methods (CumulusV [University of Toronto], Volpara [version 1.4.5; Volpara Solutions, Wellington, New Zealand), and Quantra [version 2.0; Hologic, Danbury, Conn]). Discrepancy between the first and second breast density measurements (Δ1-2) was obtained for each algorithm by subtracting the second measurement from the first. The Δ1-2 values of each algorithm were then analyzed with a random-effects model to derive Bland-Altman-type limits of measurement agreement.

RESULTS: Variability was higher for Cumulus ABD and CumulusV than for Volpara or Quantra. The within-breast density measurement standard deviations were 3.32% (95% confidence interval [CI]: 2.65, 4.44), 3.59% (95% CI: 2.86, 4.48), 0.99% (95% CI: 0.79, 1.33), and 1.64% (95% CI: 1.31, 1.39) for Cumulus ABD, CumulusV, Volpara, and Quantra, respectively. Although the mean discrepancy between repeat breast density measurements was not significantly different from zero for any of the algorithms, larger absolute breast density discrepancy (Δ1-2) values were associated with larger breast density values for Cumulus ABD and CumulusV but not for Volpara and Quantra.

CONCLUSION: Variability in a repeated measurement of breast density is lowest for Volpara and Quantra; these algorithms may be more suited to incorporation into a risk model.

Segmentation: density

1322 IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 35, NO. 5, MAY 2016

Unsupervised Deep Learning Applied to Breast Density Segmentation and Mammographic Risk Scoring

Michiel Kallenberg*, Kersten Petersen, Mads Nielsen, Andrew Y. Ng, Pengfei Diao, Christian Igel, Celine M. Vachon, Katharina Holland, Rikke Rass Winkel, Nico Karssemeijer, and Martin Lillholm

Abstract—**Mammographic risk scoring has commonly been automated by extracting a set of handcrafted features from mammograms, and relating the responses directly or indirectly to breast cancer risk. We present a method that learns a feature hierarchy from unlabeled data. When the learned features are used as the input to a simple classifier, two different tasks can be addressed: i) breast density segmentation, and ii) scoring of mammographic texture. The proposed model learns features at multiple scales. To control the models capacity a novel sparsity regularizer is introduced that incorporates both lifetime and population sparsity. We evaluated our method on three different clinical datasets. Our state-of-the-art results show that the learned breast density scores have a very strong positive relationship with manual ones, and that the learned texture scores are predictive of breast cancer. The model is easy to apply and generalizes to many other segmentation and scoring problems.**

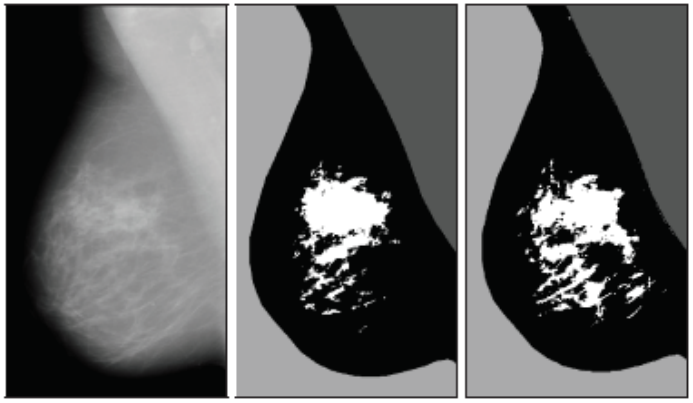


Fig. 3. Automated MD thresholding. Depicted are (a) original image, (b) dense tissue according to expert Cumulus-like threshold, and (c) dense tissue according to CSAE.

Contents and requirements

- Case Selection
- Ground Truth
- Associated Informations
- Requirements of the Digitizers
  (digital images characteristics)
- Organization
- Distribution

Contents and requirements

COMPLIANCE OF PUBLICLY AVAILABLE MAMMOGRAPHIC DATABASES WITH ESTABLISHED CASE SELECTION AND ANNOTATION REQUIREMENTS

Inês C. Moreira[1,2,3,4], Gustavo Bacelar-Silva[1,2,5] and Pedro Pereira Rodrigues[1,5]

[1]*Faculty of Medicine of the University of Porto, Al. Prof. Hernâni Monteiro, Porto, Portugal*

[2]*Faculty of Sciences of the University of Porto, Rua do Campo Alegre, Porto, Portugal*

[3]*Superior School of Health Technology of Porto, Rua Valente Perfeito, Vila Nova de Gaia, Portugal*

[4]*INESC Porto, Faculty of Engineering of University of Porto, Rua Dr. Roberto Frias, Porto, Portugal*

[5]*CINTESIS, Al. Prof. Hernâni Monteiro, Porto, Portugal*

In Proceedings of the International Conference on Health Informatics (HEALTHINF-2012), pages 337-340

Case Selection

The database should include various cases with images with none and all types of findings, and also all types of breast density.

Normal images with structures that may be misleading (e.g. superimposed tissue that looks like a mass) are important in order to make the classifiers more robust.

The cases should be collected by a specialist experienced in mammography, and each case should contain the four standard views, unless it is a case from a patient with one breast only.

It is considered that for each 100 cases, approximately 200 images should contain a lesion.

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It is considered that for each 100 cases, approximately 200 images should contain a lesion.

Ground Truth

Biopsy proof for all cases should be available, and for cases in which a biopsy is not recommended, the mammography should have the same BI-RADS for at least three years.

Annotations should include the "ground truth" concerning the degree of malignancy, the location and the boundary of the lesion and this outline should be performed by a specialist.

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STILL VALID

Associated Information

Clinical history, age, family history, previous biopsies.

Requirements of the digitizer

This is still a point of controversy, but one common approach is to digitalize at a very small pixel size, for example, at 25 microns.

Organization of Database

A specific file format for digital mammograms does not exist. Medical images are usually saved in the DICOM (Digital Imaging and Communications in Medicine) format that gathers not only the image but also some related metadata.

Distribution of Database

The database should be available, preferentially over the World Wide Web. Continuous user support is also indispensable.

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Examples of public research databases

- MIAS (Mammographic Image Analysis Society)
  mini-MIAS
- DDSM (Digital Database for Screening Mammography)
  CBIS-DDSM (Curated Breast Imaging Subset of DDSM)
- MAGIC-5
- BancoWeb LAPIMO
- BCDR (Breast Cancer Digital Repository)
- INbreast
- LLNL/UCSF
- MammoGrid Project
- AMDI (Indexed Atlas of Digital Mammograms)
- IRMA (Image Retrieval in Medical Applications)
- DBMS (DataBase Management System)

MIAS database

- Mammographic Image Analysis Society.
- One center (UK), National Breast Screening Programme.
- 322 screening images (161 pairs), only MLO view.
- Digitized films (50 μm, 8 bit, PGM).
- Info about density and abnormaities (no BIRADS).
- Various releases (different format, pixel size).
  from 1998 to 2015.

F - Fatty
G - Fatty-glandular
D - Dense-glandular

CALC - Calcification
CIRC - Well-defined/circumscribed masses
SPIC - Spiculated masses
MISC - Other, ill-defined masses
ARCH - Architectural distortion
ASYM - Asymmetry
NORM - Normal

B - Benign
M - Malignant

MIAS database

Mammographic Image Analysis Society (MIAS) database v1.21

Mostra/Apri

00README.pdf and original article in PDF format Digital mammograms are in PGM format (application/zip, 1Gb)

Citation

Suckling, J., Parker, J., Dance, D., Astley, S., Hutt, I., Boggis, C., Ricketts, I., et al. (2015). *Mammographic Image Analysis Society (MIAS) database v1.21* [Dataset]. https://www.repository.cam.ac.uk/handle/1810/250394

Description

The Mammographic Image Analysis Society database of digital mammograms (v1.21). Contains the original 322 images (161 pairs) at 50 micron resolution in "Portable Gray Map" (PGM) format and associated truth data.

This record will be updated with publication details.

https://www.repository.cam.ac.uk/handle/1810/250394

mini-MIAS database

The mini-MIAS database of mammograms

By popular request, the original MIAS Database (digitised at 50 micron pixel edge) has been reduced to 200 micron pixel edge and clipped/padded so that every image is 1024 × 1024 pixels. You are free to use the database in your scientific research but you must abide by the licence agreement when using the imagery.

Credits

Organiser:
J Suckling
Truth-Data:
C R M Boggis and I Hutt
Co-Workers:
S Astley, D Betal, N Cerneaz, D R Dance, S-L Kok, J Parker, I Ricketts, J Savage, E Stamatakis and P Taylor
Special Thanks:
N Karrsemeijer
PEIPA Maintainer:
A Clark
Reference:
J Suckling *et al* (1994): *The Mammographic Image Analysis Society Digital Mammogram Database* Exerpta Medica. International Congress Series 1069 pp375-378.

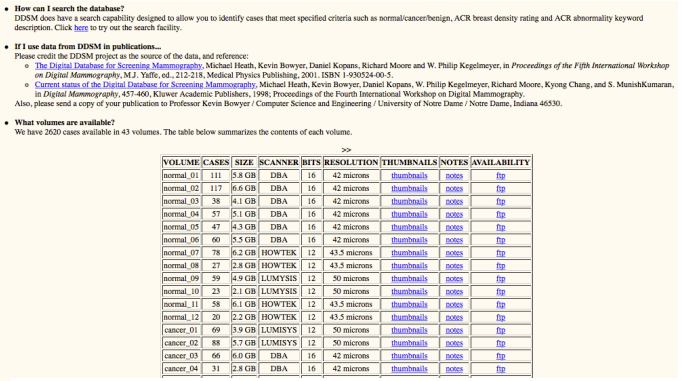
http://peipa.essex.ac.uk/info/mias.html

DDSM database

- Digital Database for Screening Mammography.
- Multicentric (US): Massachusetts General Hospital, University of South Florida, Sandia National Laboratories (1988-1999).
- 2620 screening exams, 4 views/exam.
- Digitized films (42,0, 43,5, 50,0 μm, 8/16 bit, PGM, TIFF, non standard lossless JPEG).
- Info about density and normal/benign/cancer (ACR-BIRADS).
- Various releases (different format, SW tools) from 1999.

DDSM database

University of South Florida Digital Mammography Home Page



- **How can I search the database?**
  DDSM does have a search capability designed to allow you to identify cases that meet specified criteria such as normal/cancer/benign, ACR breast density rating and ACR abnormality keyword description. Click here to try out the search facility.
- **If I use data from DDSM in publications...**
  Please credit the DDSM project as the source of the data, and reference:
  - The Digital Database for Screening Mammography, Michael Heath, Kevin Bowyer, Daniel Kopans, Richard Moore and W. Philip Kegelmeyer, in *Proceedings of the Fifth International Workshop on Digital Mammography*, M.J. Yaffe, ed., 212-218, Medical Physics Publishing, 2001. ISBN 1-930524-00-5.
  - Current status of the Digital Database for Screening Mammography, Michael Heath, Kevin Bowyer, Daniel Kopans, W. Philip Kegelmeyer, Richard Moore, Kyong Chang, and S. MunishKumaran, in *Digital Mammography*, 457-460, Kluwer Academic Publishers, 1998; Proceedings of the Fourth International Workshop on Digital Mammography.

  Also, please send a copy of your publication to Professor Kevin Bowyer / Computer Science and Engineering / University of Notre Dame / Notre Dame, Indiana 46530.
- **What volumes are available?**
  We have 2620 cases available in 43 volumes. The table below summarizes the contents of each volume.

>>

VOLUME	CASES	SIZE	SCANNER	BITS	RESOLUTION	THUMBNAILS	NOTES	AVAILABILITY
normal_01	111	5.8 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_02	117	6.6 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_03	38	4.1 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_04	57	5.1 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_05	47	4.3 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_06	60	5.5 GB	DBA	16	42 microns	thumbnails	notes	ftp
normal_07	78	6.2 GB	HOWTEK	12	43.5 microns	thumbnails	notes	ftp
normal_08	27	2.8 GB	HOWTEK	12	43.5 microns	thumbnails	notes	ftp
normal_09	59	4.9 GB	LUMYSIS	12	50 microns	thumbnails	notes	ftp
normal_10	23	2.1 GB	LUMYSIS	12	50 microns	thumbnails	notes	ftp
normal_11	58	6.1 GB	HOWTEK	12	43.5 microns	thumbnails	notes	ftp
normal_12	20	2.2 GB	HOWTEK	12	43.5 microns	thumbnails	notes	ftp
cancer_01	69	5.9 GB	LUMISYS	12	50 microns	thumbnails	notes	ftp
cancer_02	88	5.7 GB	LUMISYS	12	50 microns	thumbnails	notes	ftp
cancer_03	66	6.0 GB	DBA	16	42 microns	thumbnails	notes	ftp
cancer_04	31	2.8 GB	DBA	16	42 microns	thumbnails	notes	ftp

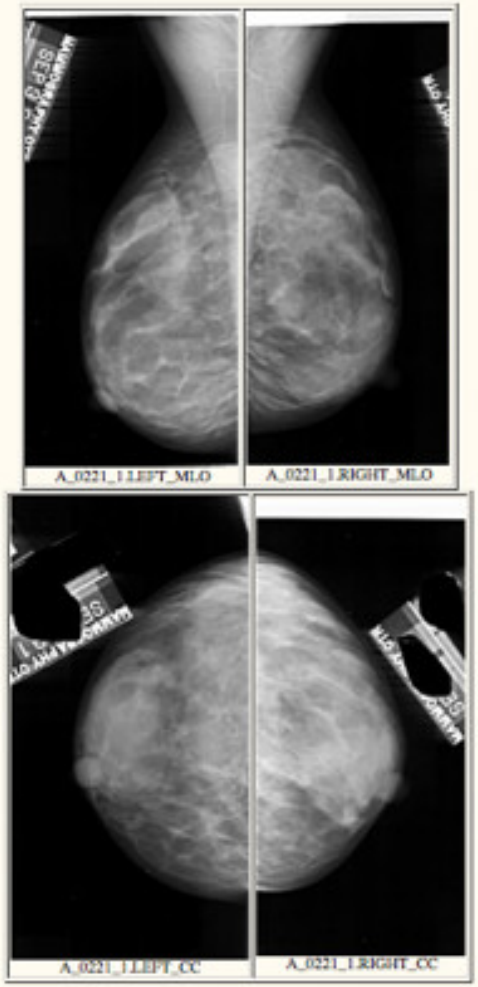
DDSM: Digital Database for Screening Mammography

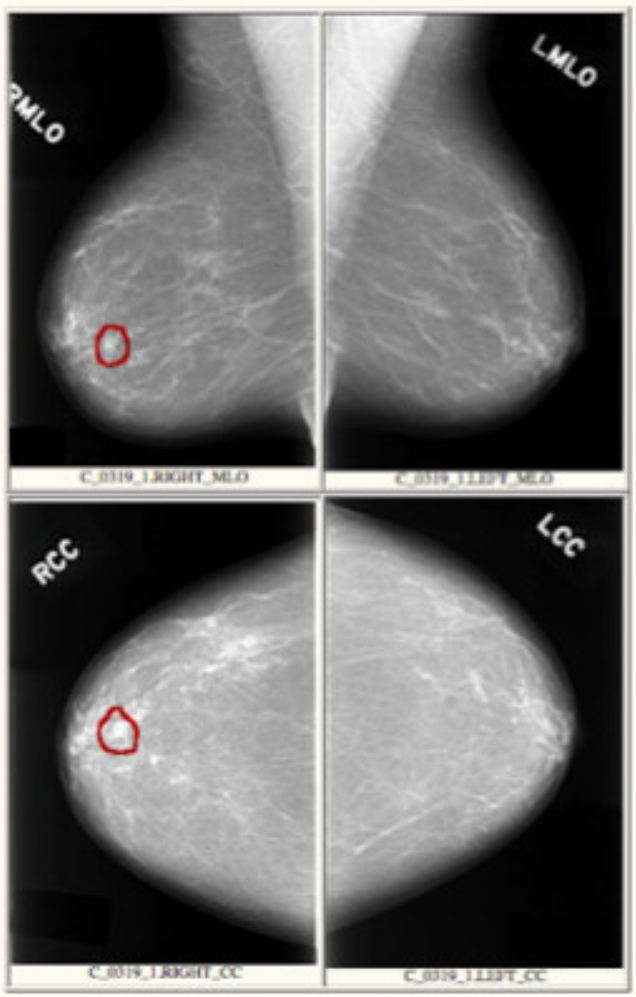
- **What software is available for working with this data?**

Link	Description
software_v1.1.tar.Z	Software for viewing cases in the DDSM database. This code is somewhat outdated. You might try using the software in heathusf_v1.1.0.html for decompressing and converting images and ground truth to other formats.
Manual.html	Documentation on the use of the viewing software.
JpegInfo.html	Source code from the Portable Video Research Group for the lossless JPEG compression program.
heathusf_v1.1.0.html	Source code for software that that can be used to extract images and ground truth from DDSM cases. It also includes a mass detection algorithm and performance assessment software. Version 1.1.0 was made available on August 3, 2000. It contains additional source code for a program to display mammography images in X-Windows. IWDM 2000 paper outlining use of software. M. D. Heath and K. W. Bowyer, "Mass detection by Relative Image Intensity", in The Proceedings of the 5th International Conference on Digital Mammography (Toronto, Canada, June 2000), Medical Physics Publishing (Madison, WI), ISBN 1-930524-00-5.

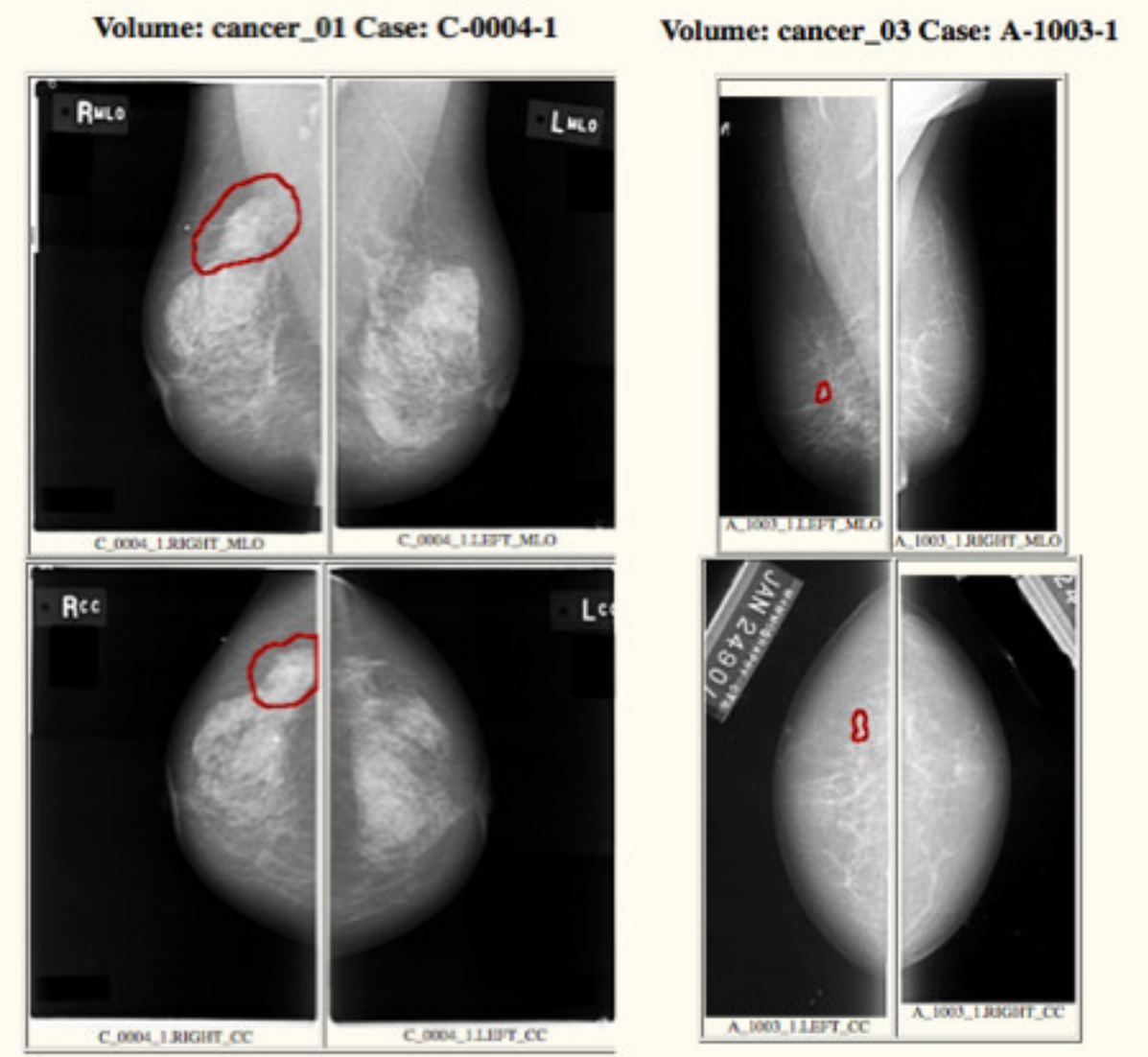
http://marathon.csee.usf.edu/Mammography/Database.html

DDSM database





DDSM database



CBIS-DDSM (Curated Breast Imaging Subset of DDSM)

SCIENTIFIC DATA

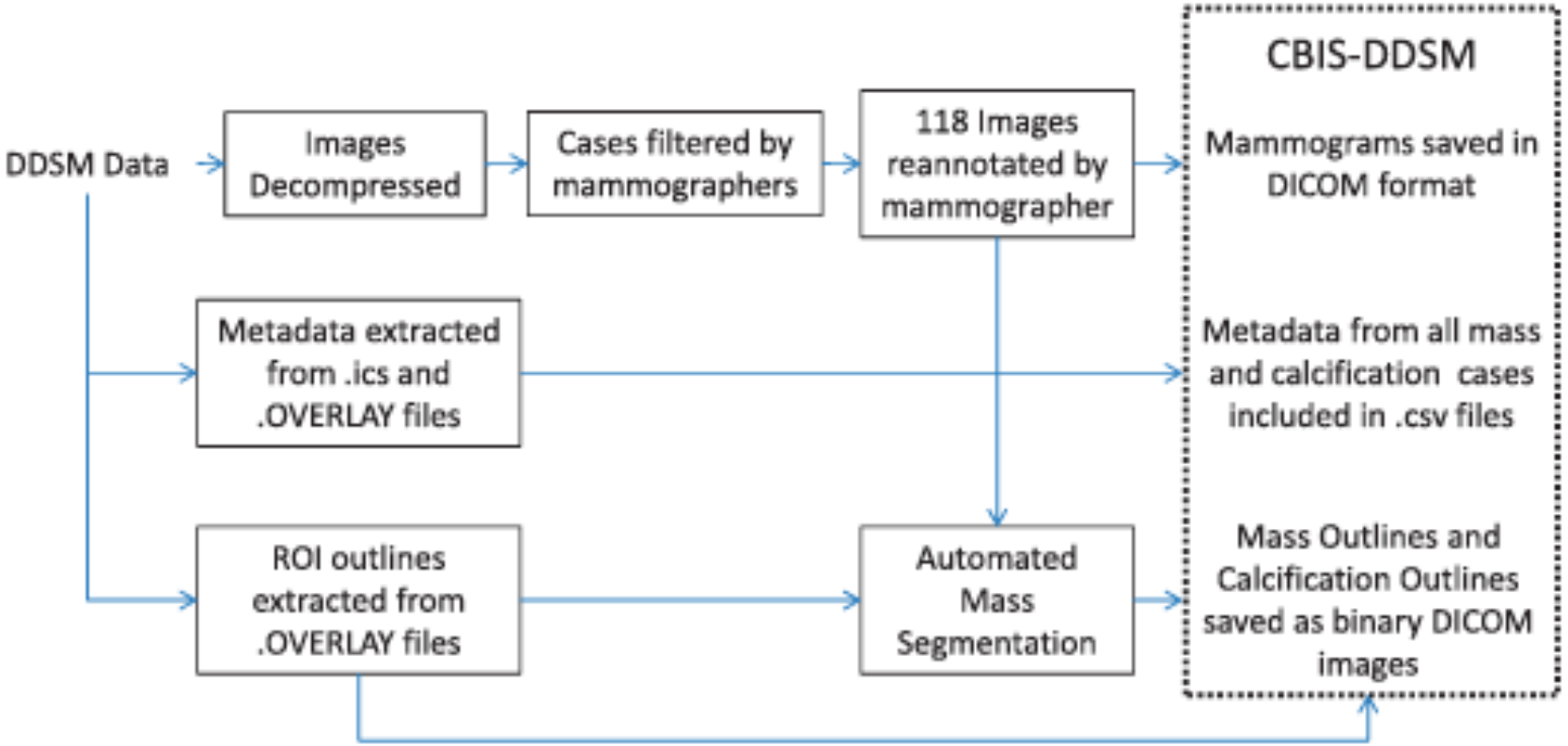
Data Descriptor | OPEN | Published: 19 December 2017

A curated mammography data set for use in computer-aided detection and diagnosis research

Rebecca Sawyer Lee, Francisco Gimenez, Assaf Hoogi, Kanae Kawai Miyake, Mia Gorovoy & Daniel L. Rubin

Scientific Data **4**, Article number: 170177 (2017) | Download Citation

CBIS-DDSM (Curated Breast Imaging Subset of DDSM)



MAGIC-5 database

- Medical Applications in a Grid Infrastructure Connection.
- Multicentric (IT): hospitals of Bari, Udine, Palermo, Firenze, Torino, Napoli, Sassari (1999-2003).
- 967 screening and clinical exams, 3369 images.
- Digitized films (85 μm, 12 bit, DICOM).
- Info about density (3 classes) and normal/benign/cancer (ACR).

Radiol Med. 2008 Jun;113(4):477-85. doi: 10.1007/s11547-008-0282-5. Epub 2008 Jun 6.

MAGIC-5: an Italian mammographic database of digitised images for research.

[Article in English, Italian]

Tangaro S[1], Bellotti R, De Carlo F, Gargano G, Lattanzio E, Monno P, Massafra R, Delogu P, Fantacci ME, Retico A, Bazzocchi M, Bagnasco S, Cerello P, Cheran SC, Lopez Torres E, Zanon E, Lauria A, Sodano A, Cascio D, Fauci F, Magro R, Raso G, Ienzi R, Bottigli U, Masala GL, Oliva P, Meloni G, Caricato AP, Cataldo R.

BancoWeb LAPIMO database

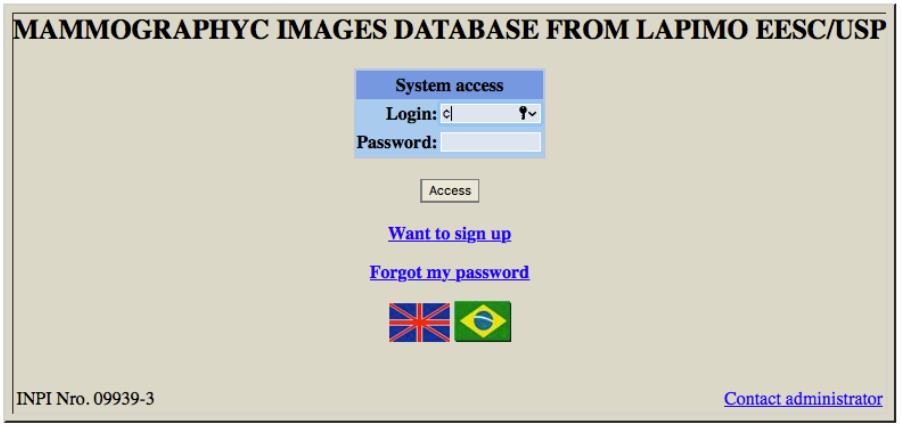
- Two centers (BR): San Paulo University (2011).
- 320 most screening exams, 1400 images.
- Digitized films (85, 150 μm, 12 bit, TIFF).
- Info about density and pathology (BIRADS).

LAPIMO
LABORATÓRIO DE ANÁLISE E PROCESSAMENTO DE IMAGENS MÉDICAS E ODONTOLÓGICAS

J Digit Imaging. 2011 Jun; 24(3): 500–506.
Published online 2010 May 18. doi: 10.1007/s10278-010-9297-2
PMCID: PMC3092049
PMID: 20480383

Online Mammographic Images Database for Development and Comparison of CAD Schemes

Bruno Roberto Nepomuceno Matheus and Homero Schiabel



BCDR database

- Breast Cancer Digital Repository
- Multicenter (PT and SP): Centro Hospitalar São João, University of Porto, CETA-CIEMAT, Aviero University (2009-2013).
- Digitized films (FM, Film Mammography) and DM (Digital Mammography).
- FM: 1010 patients, 1125 exams, 3703 images. Matrices: 720x1168, 8 bits, TIFF.
- DM: 724 patients, 1042 exams, 3612 images. Matrices: 3328x4084 or 2560x3328 pixels, 14 bits, TIFF.
- Info about pathology (BIRADS) and related clinical data.

BCDR database

https://bcdr.ceta-ciemat.es

INbreast database

Get INbreast Database

We appreciate your interest in the INbreast database.

The INbreast database is a mammographic database, with images acquired at a Breast Centre, located in a University Hospital (Hospital de São João, Breast Centre, Porto, Portugal). INbreast has a total of 115 cases (410 images) of which 90 cases are from women with both breasts (4 images per case) and 25 cases are from mastectomy patients (2 images per case). Several types of lesions (masses, calcifications, asymmetries, and distortions) are included. Accurate contours made by specialists are also provided in XML format.

However, the INbreast Database is no longer being support by our group. Please contact inesdomingues <AT> gmail.com if you are interested in using the INbreast Database.

Released in 2012, similar to BCDM-DR

2nd International Conference on Electrical and Information Technologies ICEIT'2016

Features fusion for characterizing INBREAST-Database masses

Nadia El Atlas[#1], Abdelmajid Bybi[*2], Hilal Drissi[#1]

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[*2]*LEME- Laboratoire Energétique Matériaux et Environnement*
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http://medicalresearch.inescporto.pt/breastresearch/index.php/Get_INbreast_Database

LLNL/UCSF

- Multicenter (US): Lawrence Livermore National Laboratories, University of California at San Francisco (UCSF) Radiology Deartment (2016).
- Digitized films, 35 μm, 12 bits, .
- 50 cases, 198 images.
- 5 normal cases, 5 normal but difficult, 20 of obviously benign microcalcifications, 12 of suspicious, benign microcalcifications, and 8 with malignant cluster of microcalcifications.

http://marathon.csee.usf.edu/Mammography/OtherResources.html

The set is available via anonymous ftp: *ftp://gdo-biomed.ucllnl.org/pub/mammo-db/*
(Go to "bundled" for zipped volumes, or go to "unbundled" for individual files.)

For more information on the database, send e-mail to *mammo-db-help@llnl.gov*

MAMMOGRID

Project ID: IST-2001-37614
Funded under: FP5-IST

European federated mammogram database implemented on a GRID structure

From 2002-09-01 **to** 2005-08-31 | MAMMOGRID Website

As grid computing promised to resolve many of the difficulties in facilitating medical image analysis to allow clinicians to collaborate without having to co-locate, the MammoGrid project has investigated the feasibility of developing a Grid-enabled European database of mammograms so that a set of important healthcare applications using a mammographic database have been enabled and the potential of the Grids has been harnessed to support co-working between healthcare professionals across the EU.

MammoGrid Project

Database: part of MAGIC-5 (Udine and Torino hospitals) and Cambridge University.

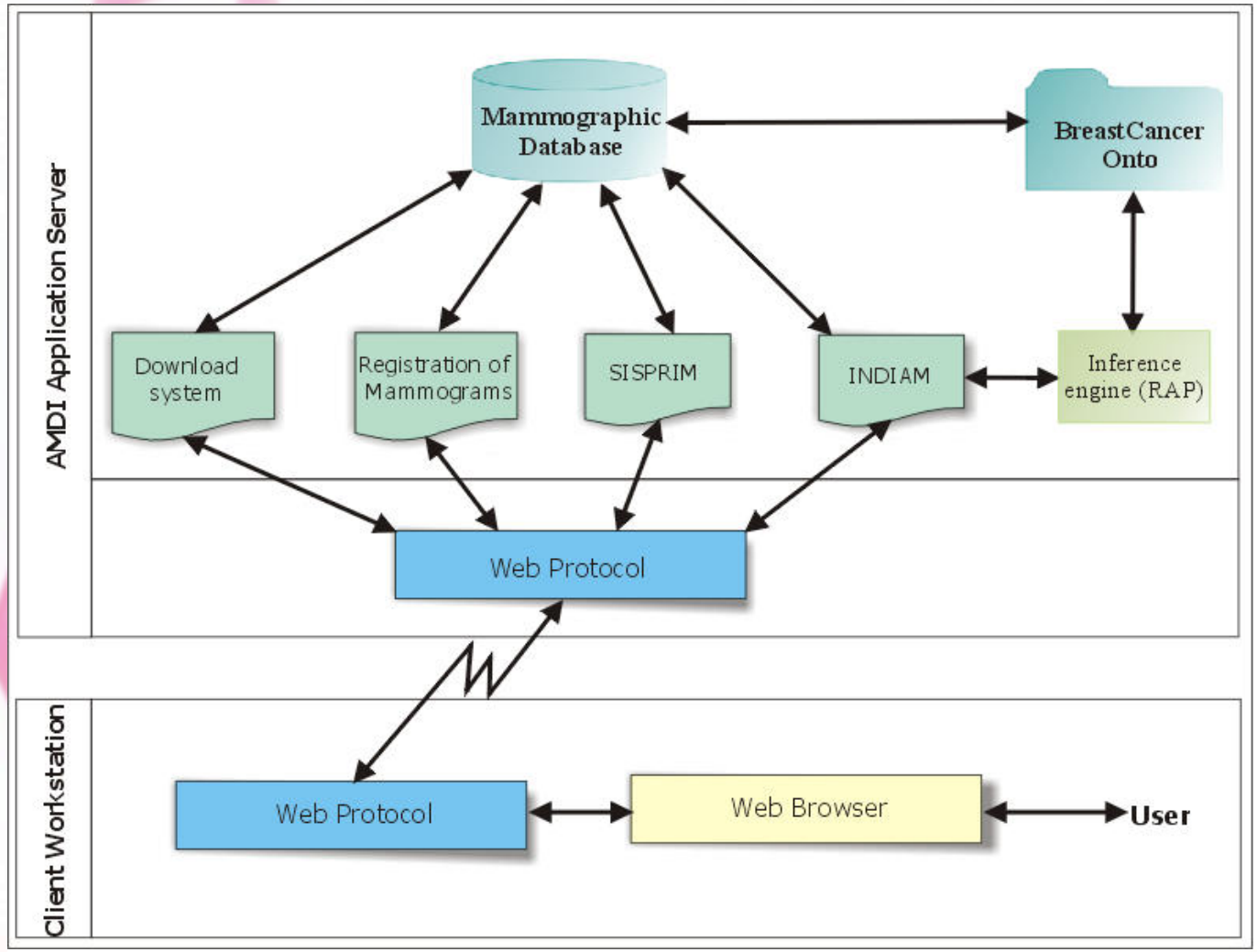
AIMS:

- to evaluate Grid technologies in implementing a mammographic database using novel Grid-compliant;
- to provide improved access to distributed data and allow rapid deployment of software packages;
- to operate on locally stored information;
- to deploy a standardization system (SMF, Standard Mammogram Form) that enables comparison of mammograms in terms of intrinsic tissue properties independently of scanner settings;
- to develop software tools to automatically extract image information that can be used to perform quality controls on the acquisition);
- to develop software tools to automatically extract tissue information that can be used to perform clinical studies.

AMDI system

- Indexed Atlas of Digital Mammograms
- Hospital de clinicas de Uberlandia (BR) and Instituto Victorio Valeri de diagnosticos medicos (Brazil)
- Based on an eXtension Relational Database Management System (XRDBMS)
- Includes SISPRIM (Sistema de Pesquisa para Recuperação de Imagens Mamográficas), a Research System for Retrieval of Mammographic Images for statistical studies.
- Includes INDIAM (INterpretation and DIAgnosis of Mammograms) for e-learning, comprising a module to simulate the analysis and diagnosis of breast cancer and a module for training the student in the interpretation of mammograms .

AMDI system


AMDI Application Server
Mammographic Database
BreastCancer Onto
Download system
Registration of Mammograms
SISPRIM
INDIAM
Inference engine (RAP)
Web Protocol
Client Workstation
Web Protocol
Web Browser
User

IRMA project

- Departments of Diagnostic Radiology and of Medical Informatics, Aachen University of Technology.
- Aim: development and implementation of high-level methods for content-based image retrieval with prototypical application to medico-diagnostic tasks on a radiologic image archive.
- Includes: 10509 images (MIAS, DDSM, LLNL databases and images from the Rheinisch-WestfÃlische Technische Hochschule, Aachen) and standardized coding of tissue type, tumor staging, and lesion description according to the ACR tissue codes and BIRADS.
- It can be extended easily with further cases imported from a picture archiving and communication system (PACS).

DBMS (DataBase Management System)

- University of South Florida (DDSM), University of Mississippi Medical Center (UMMC).
- ACR standard BIRADS and Facility Oncology Registry Data Standards by the Commission on Cancer (FORDS) .
- Hierarchical architecture, able to combine cancer registry data with the clinical radiology image and reporting categories.
- Capability for the database system to store and retrieve data for cancer registration, annotation, statistic analysis, research, teaching, etc.

DBMS (DataBase Management System)

Top level: general information collected from the cancer registry (information on patient, cancer identification, co morbidities, staging and treatment, etc.).
Middle level: the information on breast cancer, reporting, pathology and scanning. At this level the information becomes more specific and narrowed down to each case of breast cancer,
Lowest level: entities related to image and pathology of three lesion types, architecture distortion, calcification and mass. Each case has four scanned images. The information held at this level is specific to each image, such as laterality, view, shape, distribution, boundary of annotation, number of abnormalities, etc.

DBMS (DataBase Management System)

International Journal of Managing Information Technology (IJMIT), Vol.2, No.2, May 2010

INTELLIGENT MAMMOGRAPHY DATABASE MANAGEMENT SYSTEM FOR A COMPUTER AIDED BREAST CANCER DETECTION AND DIAGNOSIS

Isaac Adusei, Ognjen Kuljaca, Kwabena Agyepong

Alcorn State University, System Research Institute

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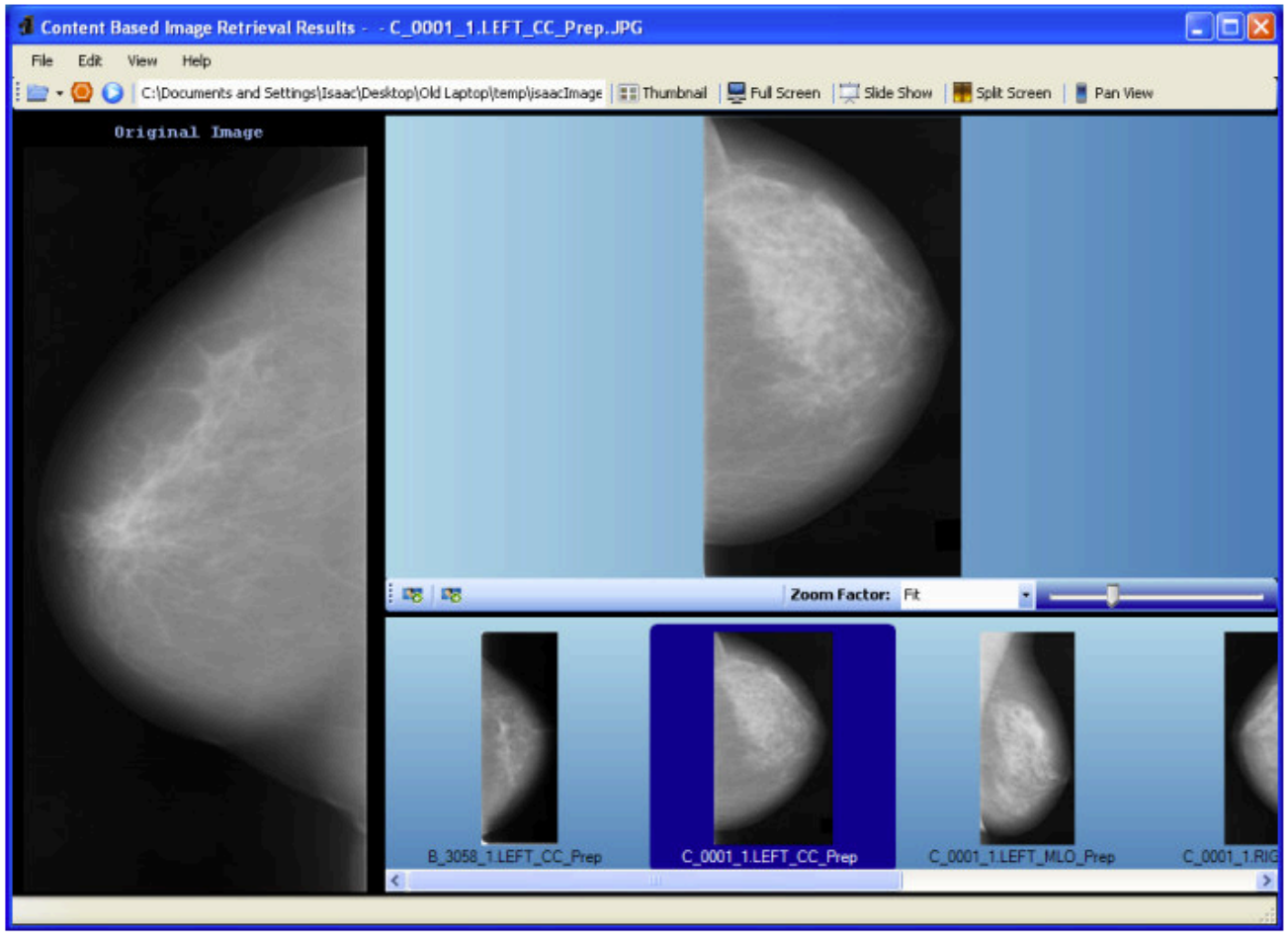
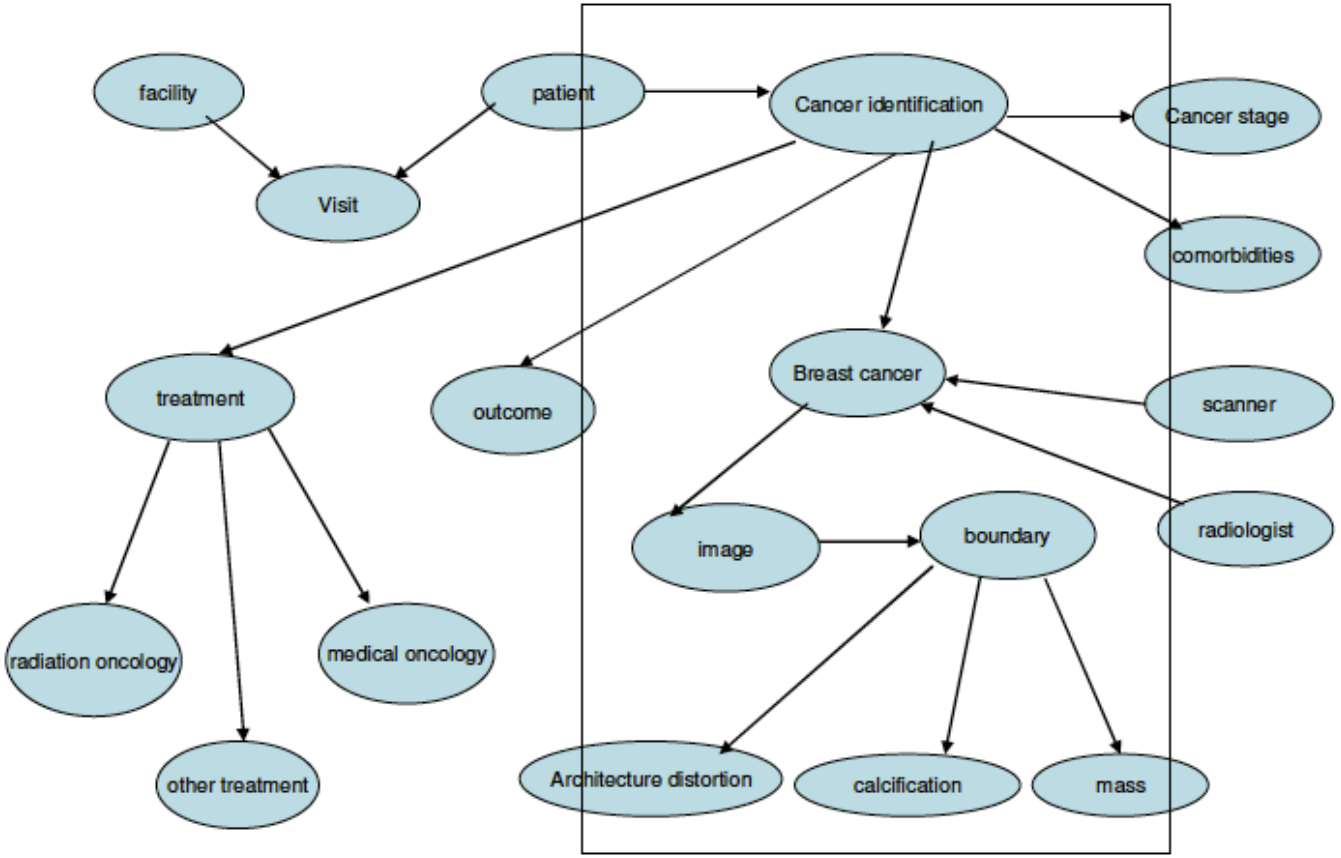
ABSTRACT

To efficiently and intelligently archive, retrieve, and analyze digitized mammogram images in breast cancer detection, a robust knowledge based system needs to be developed to provide decision support to radiologists and researchers. A Mammography database is therefore designed for the development of a knowledge base to support the detection and diagnosis as well as research in mammography. The system also has implemented Computer Aided Detection (CAD) and Diagnosis (CADx) information system of digitized mammogram images to aid in breast cancer detection. In this paper, we will outline the architectural design for the CAD/CADx system and then focus primarily on the design and modeling of the mammography database. The database design combined two standards, the Breast Imaging Reporting and Data System (BI-RADS) by American College of Radiology and the Facility Oncology Registry Data Standards (FORDS) by the Commission on Cancer standards. The complete system is in final development and debugging phase.

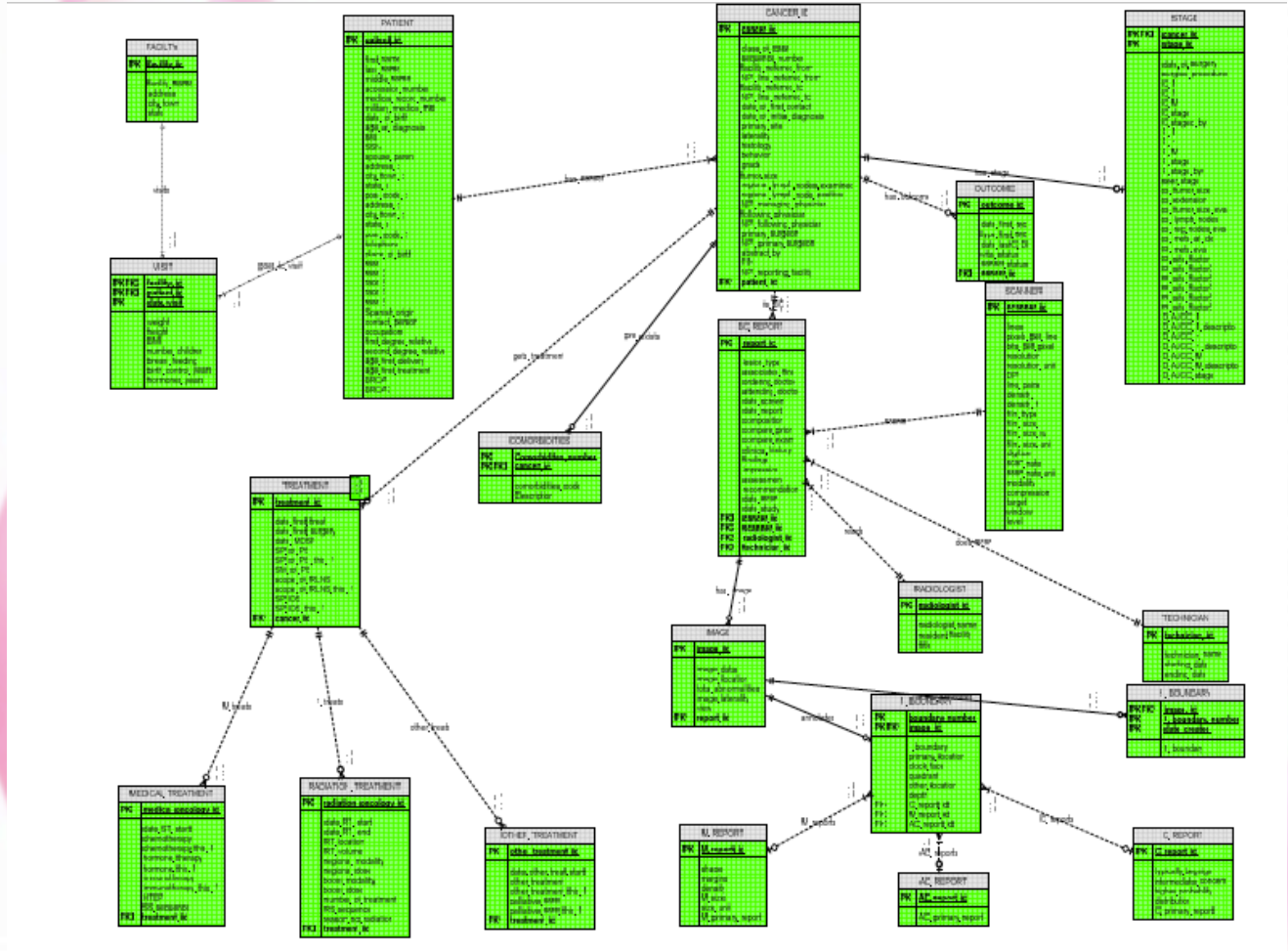
DBMS (DataBase Management System)



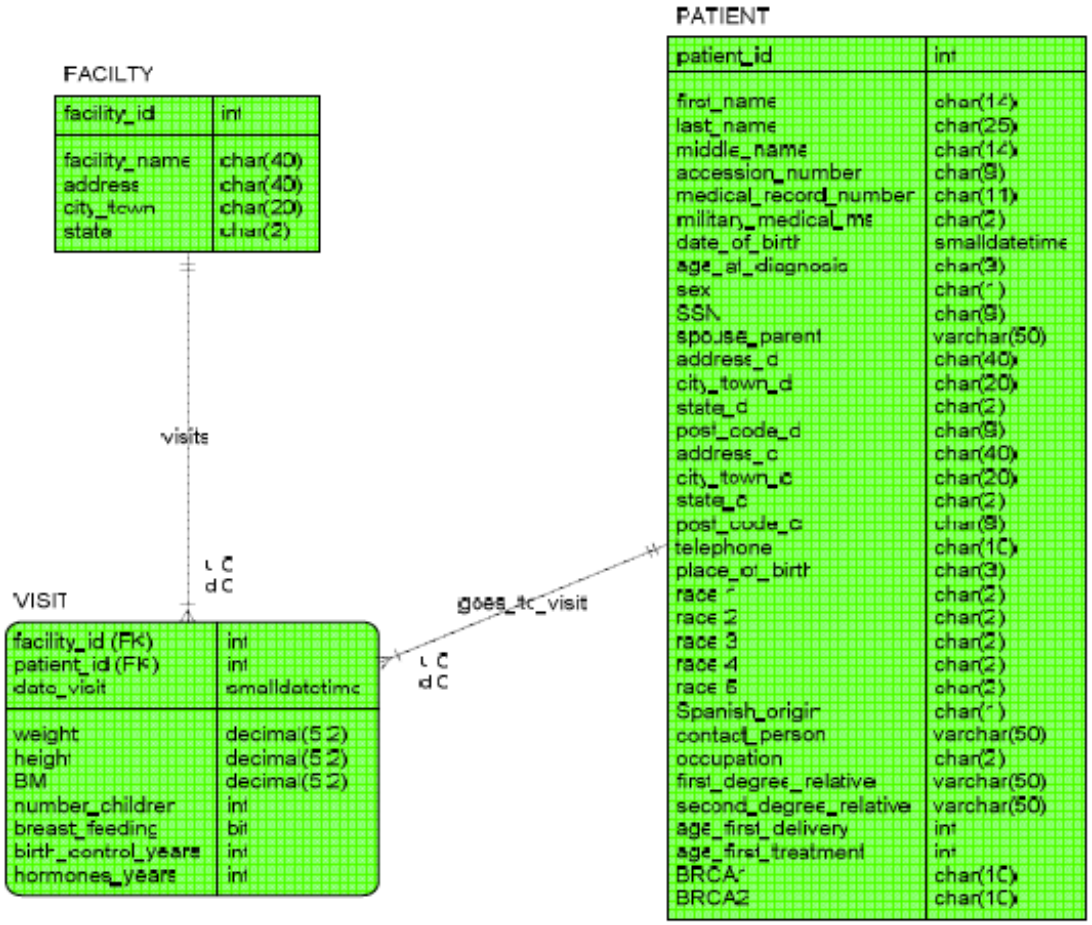
DBMS (DataBase Management System)



DBMS (DataBase Management System)



DBMS (DataBase Management System)



Conclusions ("personal")

- 2018: need of a dataset of FFDM (Full Field Digital Mammography) normal images to develop a deep-learning based system for automatic assessment of breast density … not found!

- Datasets available for analysis SW development and validation: still consisting mainly of digitized films.
- Datasets used for statistical and epidemiological studies: non publicly available.

- 2D sysnthetic images from DBT (Digital Breast Tomosynthesis) to be considered.

Conclusions ("personal")

- Realization of a new database of clinical 2D FFDM images acquired at AOUP (Azienda Ospedaliera Universitaria Pisana).
  Work in progress, 1962 exams (4 views/each case).

- Realization of a new database of clinical DBT images acquired at AOUP (Azienda Ospedaliera Universitaria Pisana).
  Work in progress, 50 cases.

- Project of a new multicentric database of screening FFDM (with clinical and family history informations) in collaboration with ATNO (Azienda USL Toscana Nord Ovest).

Conclusions ("personal")

AOUP FFDM exams:

Imaging system	Number of exams
GIOTTO IMAGE SDL	230
SELENIA DIMENSIONS	50
GE Senograph DS ADS_54.11	121
GE Senograph DS ADS_53.40	1561
TOTAL	1962

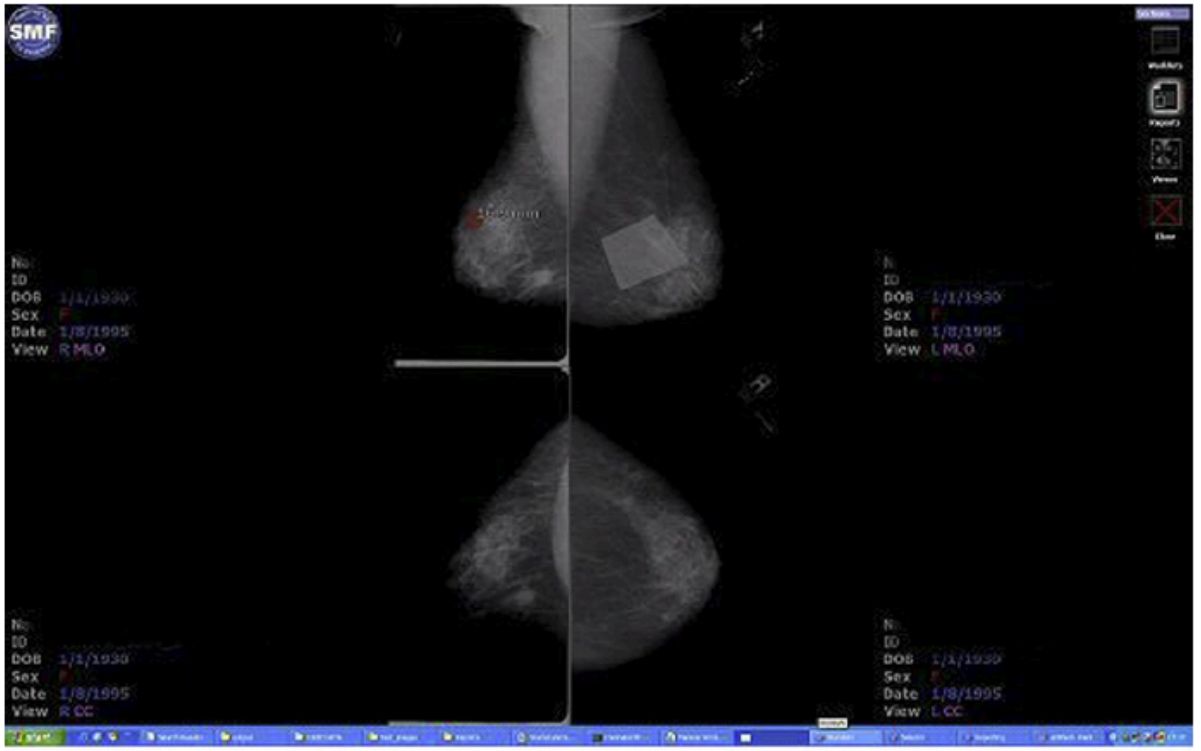
	A	B	C	D
N. of exams	264	611	888	199
Average age	67.6	63.7	58.1	53.0
St. deviation (age)	11.3	11.5	9.5	6.7
Median age	68	62	56	52

Perspectives

- Application of Standard Mammographic Form to FFDM.
- Realization of synthetic images from clinical data (breast CT, breast MRI) or by hybrid approaches and 3D anatomic models.
- Histopathological images and images acquired with other diagnostic modalities (DBT, breast CT, PET/CT, breast MRI.

Perspectives

The SMF tool is a fully automated, objective measurement tool to estimate the volume of glandular tissue in the breast from a mammogram which also compensates for variations in X-ray imaging techniques and is able to standardize image scanned on different film digitizers. It explicitly considers breast compression, exposure and tube voltage and incorporates a full physics model.



(a)

(b)

Perspectives

Production of synthetic mammograms

Med Phys. 2002 Sep;29(9):2131-9.

Mammogram synthesis using a 3D simulation. I. Breast tissue model and image acquisition simulation.

Bakic PR[1], Albert M, Brzakovic D, Maidment AD.

Med Phys. 2002 Sep;29(9):2140-51.

Mammogram synthesis using a 3D simulation. II. Evaluation of synthetic mammogram texture.

Bakic PR[1], Albert M, Brzakovic D, Maidment AD.

Med Phys. 2003 Jul;30(7):1914-25.

Mammogram synthesis using a three-dimensional simulation. III. Modeling and evaluation of the breast ductal network.

Bakic PR[1], Albert M, Brzakovic D, Maidment AD.

Perspectives

With quantitative analysis of clinical images (CT)

Med Phys. 2009 Jul;36(7):3122-31.

Methodology for generating a 3D computerized breast phantom from empirical data.

Li CM[1], Segars WP, Tourassi GD, Boone JM, Dobbins JT 3rd.

Med Phys. 2011 Apr;38(4):2180-91.

The characterization of breast anatomical metrics using dedicated breast CT.

Huang SY[1], Boone JM, Yang K, Packard NJ, McKenney SE, Prionas ND, Lindfors KK, Yaffe MJ.

With quantitative analysis of clinical images (MR)

Phys Med Biol. 2010 Jul 21;55(14):4153-68. doi: 10.1088/0031-9155/55/14/013. Epub 2010 Jul 5.

Computational simulation of breast compression based on segmented breast and fibroglandular tissues on magnetic resonance images.

Shih TC[1], Chen JH, Liu D, Nie K, Sun L, Lin M, Chang D, Nalcioglu O, Su MY.

Perspectives

3D anatomic breast model for generation of synthetic mammograms and tomograms

Phys Med Biol. 2003 Nov 21;48(22):3699-719.

A three-dimensional breast software phantom for mammography simulation.

Bliznakova K[1], Bliznakov Z, Bravou V, Kolitsi Z, Pallikarakis N.

Med Phys. 2010 Nov;37(11):5604-17.

Evaluation of an improved algorithm for producing realistic 3D breast software phantoms: application for mammography.

Bliznakova K[1], Suryanarayanan S, Karellas A, Pallikarakis N.

Med Phys. 2011 Jun;38(6):3165-76.

Development and characterization of an anthropomorphic breast software phantom based upon region-growing algorithm.

Bakic PR[1], Zhang C, Maidment AD.

Perspectives

CT anatomic models including pathological strutures of regular shapes

Phys Med Biol. 2017 Jul 20;62(16):6446-6466. doi: 10.1088/1361-6560/aa6ca3.

Evaluation of the BreastSimulator software platform for breast tomography.

Mettivier G[1], Bliznakova K, Sechopoulos I, Boone JM, Di Lillo F, Sarno A, Castriconi R, Russo P.

Inclusion of spiculated tumour masses

22 March 2016

Simulation of spiculated breast lesions

Premkumar Elangovan; Faisal Alrehily; R. Ferrari Pinto; Alaleh Rashidnasab; David R. Dance; Kenneth C. Young; Kevin Wells

Author Affiliations +

Proceedings Volume 9783, Medical Imaging 2016: Physics of Medical Imaging; 97832E (2016)
https://doi.org/10.1117/12.2216227
Event: SPIE Medical Imaging, 2016, San Diego, California, United States

Phys Med Biol. 2017 Apr 7;62(7):2778-2794. doi: 10.1088/1361-6560/aa622c.

Design and validation of realistic breast models for use in multiple alternative forced choice virtual clinical trials.

Elangovan P[1], Mackenzie A, Dance DR, Young KC, Cooke V, Wilkinson L, Given-Wilson RM, Wallis MG, Wells K.

Perspectives

Other breast cancer databases

IEEE Trans Biomed Eng. 2016 Jul;63(7):1455-62. doi: 10.1109/TBME.2015.2496264. Epub 2015 Oct 30.

A Dataset for Breast Cancer Histopathological Image Classification.

Spanhol FA, Oliveira LS, Petitjean C, Heutte L.

Abstract

Today, medical image analysis papers require solid experiments to prove the usefulness of proposed methods. However, experiments are often performed on data selected by the researchers, which may come from different institutions, scanners, and populations. Different evaluation measures may be used, making it difficult to compare the methods. In this paper, we introduce a dataset of 7909 breast cancer histopathology images acquired on 82 patients, which is now publicly available from http://web.inf.ufpr.br/vri/breast-cancer-database. The dataset includes both benign and malignant images. The task associated with this dataset is the automated classification of these images in two classes, which would be a valuable computer-aided diagnosis tool for the clinician. In order to assess the difficulty of this task, we show some preliminary results obtained with state-of-the-art image classification systems. The accuracy ranges from 80% to 85%, showing room for improvement is left. By providing this dataset and a standardized evaluation protocol to the scientific community, we hope to gather researchers in both the medical and the machine learning field to advance toward this clinical application.

AJR:206, April 2016

Perspectives

Other breast cancer databases

http://www.cancerimagingarchive.net https://wiki.nci.nih.gov/#all-updates

Perspectives

RIDER

Created by Kirby, Justin (NIH/NCI) [C], last modified by Klinger, Carolyn (NIH/NCI) [C] on Oct 06, 2016

Note: These collections have been migrated to The Cancer Imaging Archive (TCIA) with the exception of RIDER Pilot. Visit the TCIA RIDER Collections wiki page to learn more.

Summary

The Reference Image Database to Evaluate Therapy Response (RIDER) database is a targeted data collection for the purpose of generating an initial consensus on how to harmonize data collection and analysis for quantitative imaging methods as applied to measure the response to drug or radiation therapy. The long term goal is to provide a resource to permit harmonized methods for data collection and analysis across different commercial imaging platforms, as required to support multi-site clinical trials, using imaging as a biomarker for therapy response. Thus the database should permit an objective comparison of methods for data collection and analysis as a national and international resource as described in the first RIDER white paper report (2006):

- **RIDER White Paper: Executive Summary**
- **RIDER White Paper: Editorial in Nature.com**

All the image data are DICOM compliant and the image, annotations and meta data formats meets all the requirements for caBIG and the NBIA. The data collection has two phases as described below, which have resulted in several distinct image Collections.

https://wiki.nci.nih.gov/display/cip/rider

Perspectives

RIDER Breast MRI

Creato da pcomme01, ultima modifica di tracyn il mag 25, 2017

Summary

Ideally a patient's response to neoadjuvant chemotherapy could be observed noninvasively, in the first 2-3 weeks of treatment using an imaging to provide feedback related to the effectiveness of the chosen chemotherapy regimen. This capability would permit individuation of patient care by supporting the opportunity to tailor chemotherapy to a each patient's response. Functional diffusion mapping (fDM), now called Parametric Response Mapping (PRM) has been proposed as an MRI imaging biomarker for quantifying early brain tumor response to therapy [1-3]. This approach quantifies local apparent diffusion coefficient (ADC) changes in tumors using a voxel-based analysis implemented by rigid registration of the patient's head between interval exams. The RIDER Breast MRI data set extended this approach by demonstrating ADC changes in 3 of 5 primary breast cancer patients measured in response to onset of neoadjuvant chemotherapy from interval exams separated by only 8-11 days.

This ISMRM 2009 poster demonstrates how each of the "coffee break" exams were used as an estimate of each patient's null hypothesis, i.e. distribution associated with no change, and thus supports the estimate of the nulls 97.5 percentile for subsequent estimation of early response to neoadjuvant chemotherapy on an individual patient basis.

https://wiki.nci.nih.gov/display/cip/rider

Dashboard / Wiki / Collections

BREAST-DIAGNOSIS

Creato da jfreymann, ultima modifica di tracyn il feb 23, 2018

Summary

The Breast-Diagnosis collection contains cases that are high-risk normals, DCIS, fibroids and lobular carcinomas.Each case has 3 or more distinct MR pulse sequences from a Phillips 1.5 T (usual sequences are labeled T2, STIR and BLISS but may occasionally include other pulse sequences and digital mammogram of tumor specimen). Multiple time point studies on the same patient are possible.

The following is relevant to analyzing the contrast dynamics of the BLISS pulse sequences. The pulse sequence parameters (repetition, echo time, etc.) can be extracted from the DICOM tags. The contrast aspects are as follows: The volume of Magnevist (Bayer) gadolinium contrast injected into the brachial vein is based on a rule of thumb which in ml's is 10% of the patient weight in POUNDS (NOT kilograms as is recorded in the DICOM patient weight tag. Hence the injected volume for a 150 lb patient is 15 ml. (the DICOM tag entry on that patient will read "68"). The injection itself is 6 or 7 seconds, at a rate of 3cc per second. The first dynamic sequence is started 1 minute after the injection is started. Slice and pulse parameters are accessible in the DICOM tags.

Dashboard / Wiki / Collections

Breast-MRI-NACT-Pilot

Creato da ksmith01, ultima modifica di tracyn il gen 31, 2017

Summary

This collection contains longitudinal DCE MRI studies of 64 patients undergoing neoadjuvant chemotherapy (NACT) for invasive breast cancer.

Perspectives

ISPY1

Creato da jfreymann, ultima modifica di newitt il set 20, 2017

Summary

ACRIN 6657 was designed as a prospective study to test MRI for ability to predict response to treatment and risk-of-recurrence in patients with stage 2 or 3 breast cancer receiving neoadjuvant chemotherapy (NACT). ACRIN 6657 was conducted as a companion study to CALGB 150007, a correlative science study evaluating tissue-based biomarkers in the setting of neoadjuvant treatment of breast cancer. Collectively, CALGB 150007 and ACRIN 6657 formed the basis of the multicenter **I**nvestigation of **S**erial Studies to **P**redict **Y**our **T**herapeutic **R**esponse with **I**maging and mo**L**ecular **A**nalysis (I-SPY TRIAL) breast cancer trial, a study of imaging and tissue-based biomarkers for predicting pathologic complete response (pCR) and recurrence-free survival (RFS).Participant Eligibility and Enrollment: Criteria for inclusion were patients enrolling on CALGB 150007 with T3 tumors measuring at least 3 cm in diameter by clinical exam or imaging and receiving neoadjuvant chemotherapy with an anthracycline-cyclophosphamide regimen alone or followed by a taxane. Pregnant patients and those with ferromagnetic prostheses were excluded from the study. The study was open to enrollment from May 2002 to March 2006. 237 patients were enrolled, of which 230 met eligibility criteria.

https://
wiki.cancerimagingarchive.net/
display/Public/ISPY1

Perspectives

Dashboard / Wiki / Collections

ACRIN-FLT-Breast

Creato da tracyn, ultima modifica di kirbyju il ago 28, 2018

Summary

The objective of the ACRIN 6688 multi-center clinical trial was to correlate changes measured by ^{18}F-FLT PET imaging, a measure of cellular proliferation, in the primary tumor early during NAC (neo-adjuvant chemotherapy) with pCR (pathologic complete response) in locally advanced breast cancer patients. The trial also examined both pre-therapy and post-therapy association of ^{18}F-FLT uptake with the tissue proliferative marker Ki-67 to compare ^{18}F-FLT PET/CT against an accepted reference standard for cellular proliferation. The trial protocol is graphically described in the figure below, and appears online in the trial protocol

https://wiki.cancerimagingarchive.net/display/Public/ACRIN-FLT-Breast

Perspectives

QIN-Breast

Creato da kirbyju, ultima modifica di Sullyb il lug 27, 2016

Summary

This collection contains longitudinal PET/CT and quantitative MR images collected for the purpose of studying treatment assessment in breast cancer in the neoadjuvant setting. Images were acquired at three time points: prior to the start of treatment (t1), after the first cycle of treatment (t2), and either after the second cycle of treatment or at the completion of all treatments (prior to surgery) (t3). The PET/CT images were acquired with a support device built in-house to allow the patient to be in the prone position to facilitate registration with the MRI data. The value of this collection is to provide clinical imaging data for the development and evaluation of quantitative imaging methods for treatment assessment early in the course of therapy for breast cancer. Data is provided by Vanderbilt University, PI Dr. Thomas E. Yankeelov.PET/CT data were acquired with a GE Discovery STE scanner (GE Healthcare, Waukesha, WI, USA). A low-mAs CT scan was acquired for attenuation correction of the emission data. The acquisition parameters for the transmission CT scan were the following: the tube current was 80 mAs for a 70-kg patient and scaled accordingly for all patients, the tube voltage was 120 KVp, and the pitch was 1.675/1. The activity of FDG administered was approximately 370 MBq (10 mCi) for a 70-kg patient and scaled according to weight. FDG was administered intravenously via an antecubital vein contra-lateral to the affected breast. After 60 min, emission data was collected in 3D mode for 2 min per bed position. The emission scan was first collected in the prone position over the breast only, and then in the supine position from the skull to mid-femurs. Standard-of-care supine images and research prone images were acquired at times t1 and t3, while only the prone images were acquired at t2.

https://wiki.cancerimagingarchive.net/display/Public/QIN-Breast

Perspectives

The MRI data consist of diffusion-weighted images (DWIs), dynamic contrast-enhanced (DCE) images, and multi-flip data for T1-mapping. The MRIs were obtained using a dedicated 16-channel bilateral breast coil at 3.0T (Philips Achieva with the MammoTrak table). DWIs were acquired with a single-shot spin echo (SE) echo planar imaging (EPI) sequence in three orthogonal diffusion encoding directions (x, y, and z). For 14 patients, b = 0 and 500 s/mm2, TR/TE = 2500 ms/45 ms Δ = 21.4 ms, δ = 10.3 ms and 10 signal acquisitions were acquired. For 19 patients, b = 0 and 600 s/mm2, TR/TE = "shortest" (range = 1800 - 3083 ms/43 - 60 ms) Δ = 20.7 - 29 ms, δ = 11.4 - 21 ms and 10 signal acquisitions were acquired. For four patients, b = 50 and 600 s/mm2 for two patients), TR/TE = "shortest" (range = 1840 - 3593 ms/43 - 60 ms) Δ = 20.6 - 29 ms, δ = 11.5 - 21 ms and 10 signal acquisitions were acquired. Prior to the DCE-MRI acquisition, data for constructing a T1 map were acquired with an RF-spoiled 3D gradient echo multi-flip angle approach with ten flip angles from 2 to 20 degrees in 2o increments. For both the T1 map and DCE scans, TR = 7.9 ms, TE = 4.6 ms, and the acquisition matrix was 192x192x20 (full-breast) over a sagittal square field of view (22 cm2) with slice thickness of 5 mm. For the DCE study, each 20-slice set was collected in 16 seconds at 25 time points for just under seven minutes of dynamic scanning. A catheter placed within an antecubital vein delivered 0.1 mmol/kg (9 – 15 mL, depending on patient weight) of gadopentetate dimeglumine, Gd-DTPA, (Magnevist, Wayne, NJ) at 2 mL/sec (followed by a saline flush) via a power injector (Medrad, Warrendale, PA) after the acquisition of the first three dynamic scans (baseline).

https://wiki.cancerimagingarchive.net/display/Public/QIN-Breast

Perspectives

TCGA-BRCA

Creato da kirbyju, ultima modifica il lug 25, 2017

Summary

The Cancer Genome Atlas Breast Invasive Carcinoma (TCGA-BRCA) data collection is part of a larger effort to build a research community focused on connecting cancer phenotypes to genotypes by providing clinical images matched to subjects from The Cancer Genome Atlas (TCGA). Clinical, genetic, and pathological data resides in the Genomic Data Commons (GDC) Data Portal while the radiological data is stored on The Cancer Imaging Archive (TCIA).

Matched TCGA patient identifiers allow researchers to explore the TCGA/TCIA databases for correlations between tissue genotype, radiological phenotype and patient outcomes. Tissues for TCGA were collected from many sites all over the world in order to reach their accrual targets, usually around 500 specimens per cancer type. For this reason the image data sets are also extremely heterogeneous in terms of scanner modalities, manufacturers and acquisition protocols. In most cases the images were acquired as part of routine care and not as part of a controlled research study or clinical trial.

https://wiki.cancerimagingarchive.net/display/Public/TCGA-BRCA

Conclusions

- Real esigence of reliable databases of (not only) mammographic images.
- Technological progress in acquisition instruments.
- Increasing availability of storage and computing power.
- Characteristics and quantities requested by (non only) the new analysis tecnniques.
- A lot of efforts in various research fields related to this topic.

Thank you for your attention

maria.evelina.fantacci@unipi.it