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Patient Information Combined for the Assessment of Surgical Outcomes in Breast Cancer

Breast Cancer Workshop
June 19th, 2013 Porto, Portugal

INESC Porto

VCMI – Visual Computing and Machine Intelligence

- Main Lines of Activity
  - Computer Vision
  - Machine Learning
  - Decision Support Systems

Under these topics we favour more specific domains. Image and video processing focuses on medical images, documents with handwritten content and video object tracking for applications such as surveillance and sports. Our work on machine learning cares mostly with the adaptation of learning to the challenging conditions presented by visual data. The particular emphasis of the work in decision support systems goes to medical applications, always anchored in the automatic analysis of visual data.

Research Areas

Medical Image Processing

Video Object Tracking
(Surveillance, Sport analysis, high level behaviour analysis, industrial applications)

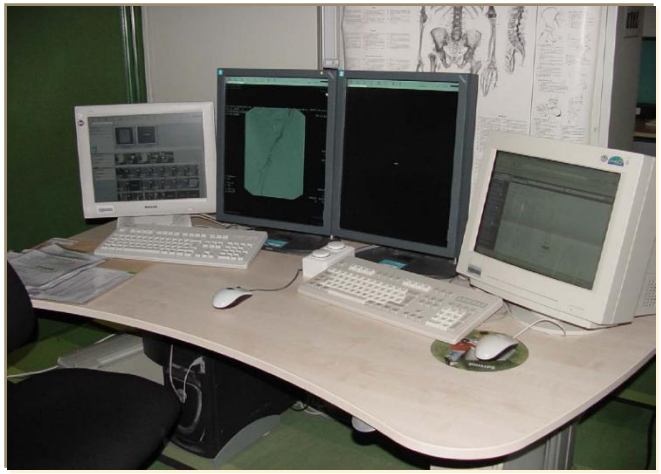
Biometrics / Unconstrained Pattern Recognition

Learning

Structured Handwritten Document Analysis

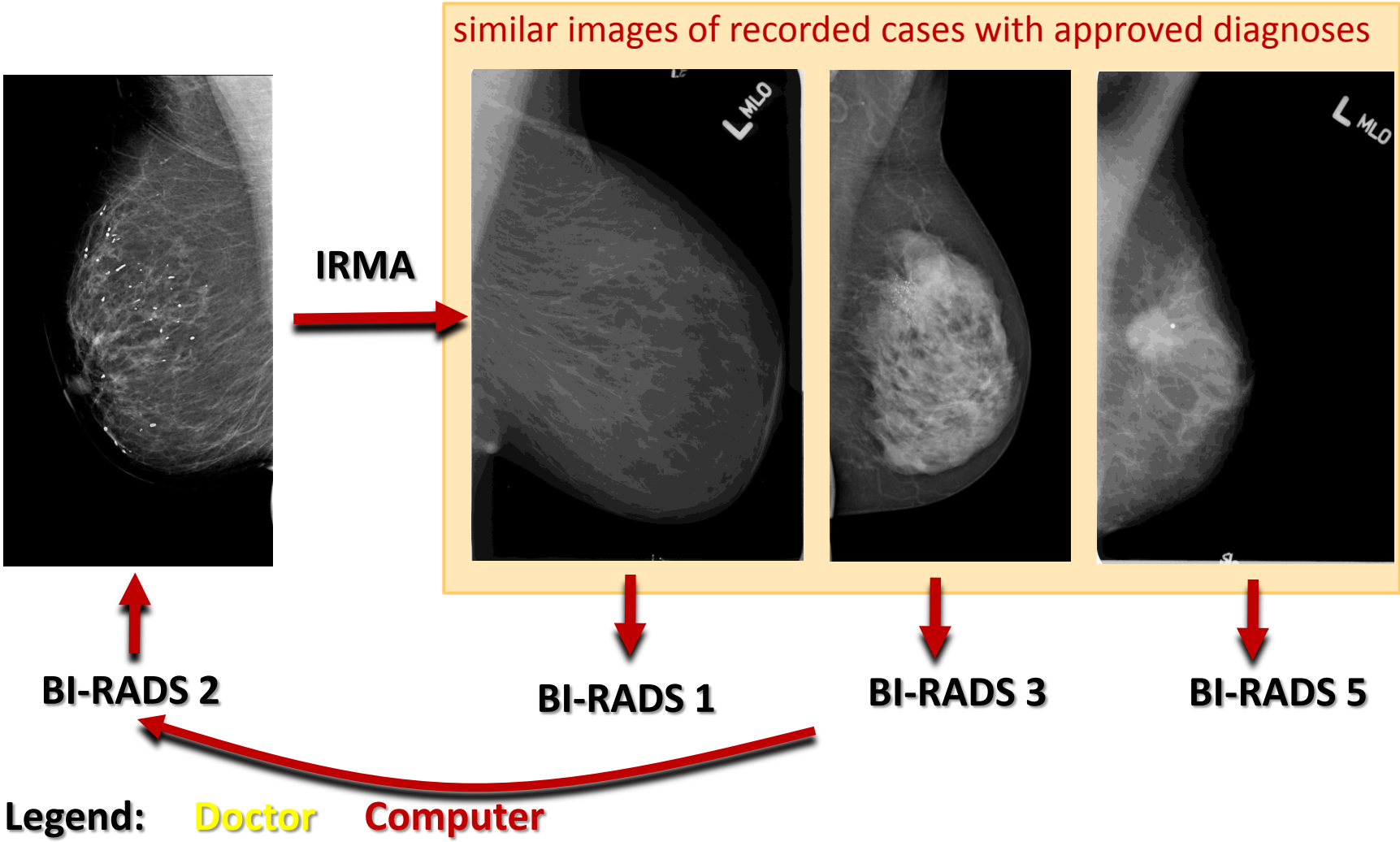
Semantic PACS

- Integration of Content-based Image Access in the image management of radiological routine
  - Image management of radiological routine
    - PACS – Picture Archiving and Communication System
  - Content-based Image Access
    - IRMA – Image Retrieval in Medical Applications
- Current PACS lack support to:
  - Diagnose
  - Case-based reasoning
  - Teaching / learning



Semantic PACS

- CAD – Computer-aided Diagnosis



PICTURE

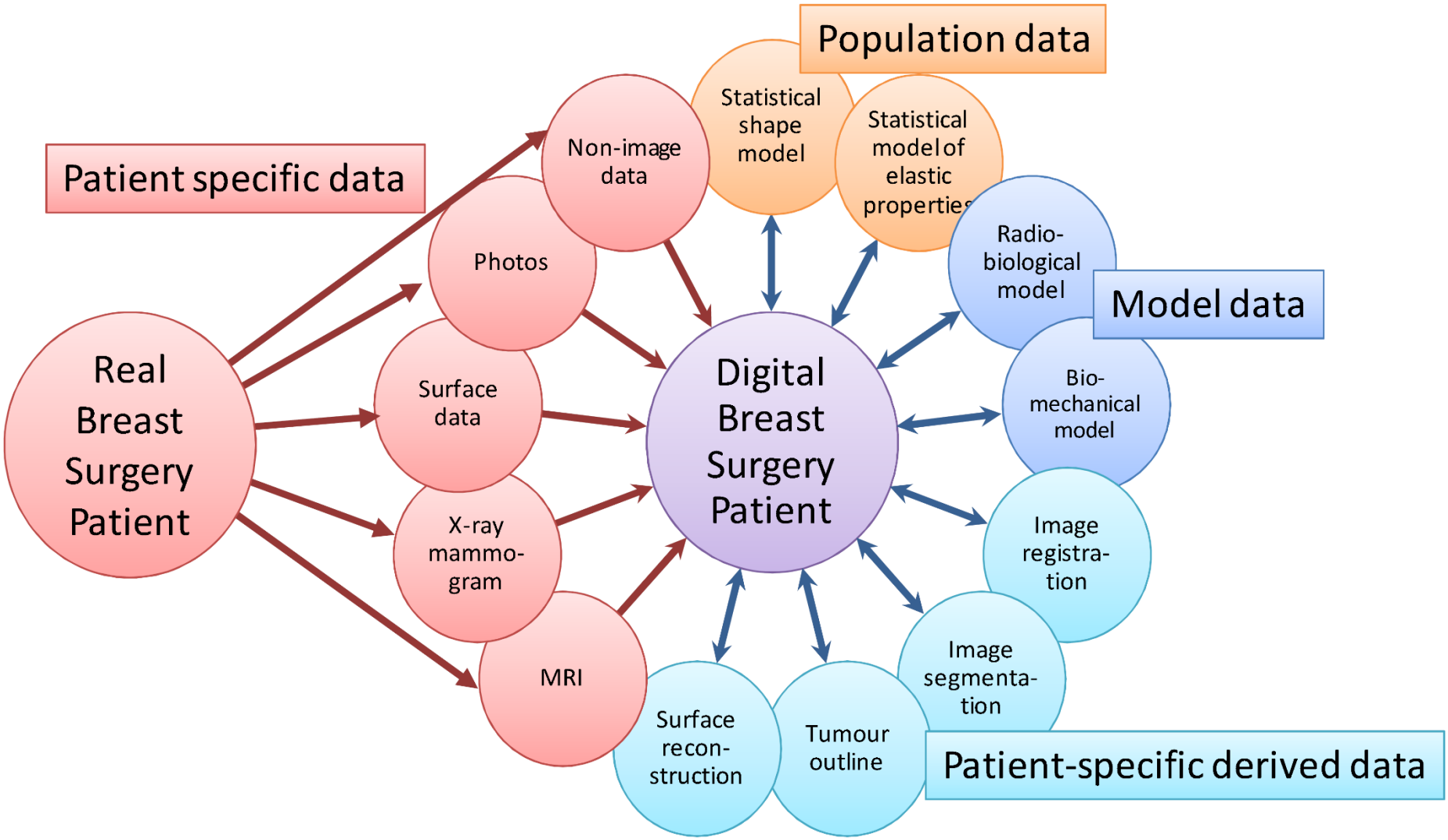
- **P**atient **I**nformation **C**ombined for local **T**herapy o**U**tcome assessment in b**RE**ast cancer
- EU FP7 project
- Partners:
  - Philips Technologie GmbH
  - University College London
  - INESC Porto
  - Leiden University Medical Center
  - Institut National de la Santé et de la Recherche Médicale (INSERM)

The Clinical Need

In breast-conserving surgery, there is evidence that approximately 30% of women receive a suboptimal or poor aesthetic outcome; however there is currently no standardised method of identifying these women.

PICTURE

PICTURE

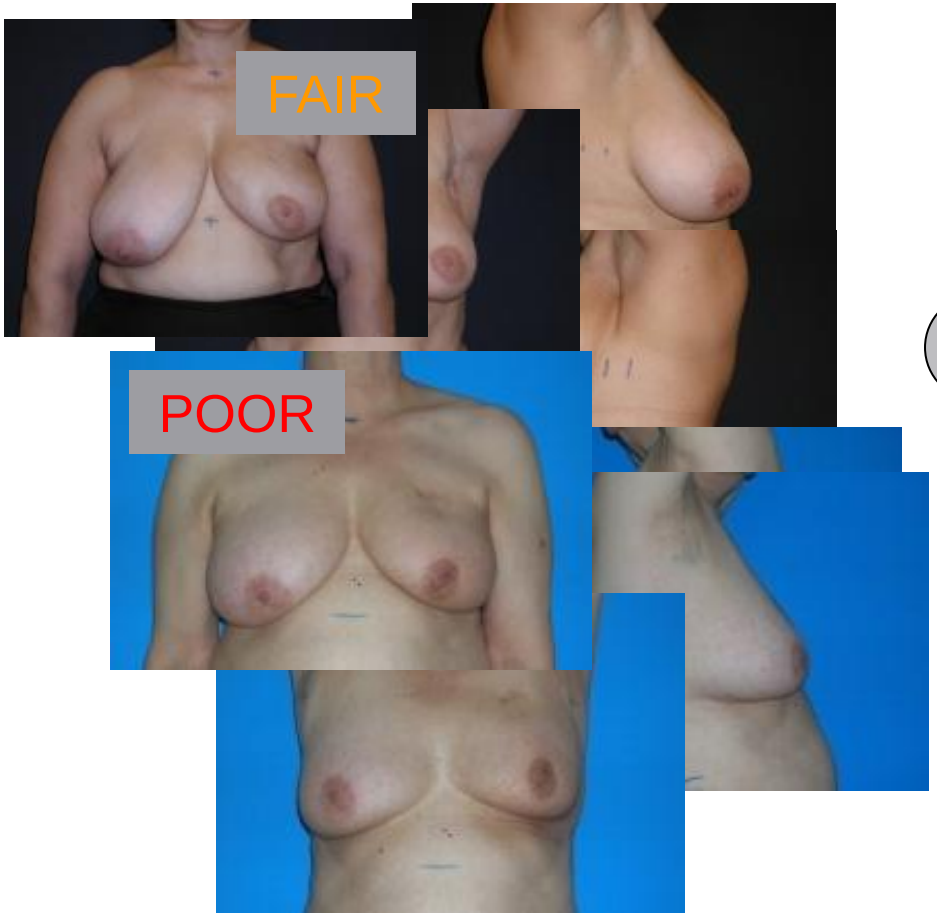

Population data
Statistical shape model
Statistical model of elastic properties
Non-image data
Patient specific data
Photos
Radio-biological model
Model data
Real Breast Surgery Patient
Surface data
Digital Breast Surgery Patient
Bio-mechanical model
X-ray mammo-gram
Image registra-tion
MRI
Image segmenta-tion
Surface recon-struction
Tumour outline
Patient-specific derived data

Objective evaluation of the aesthetic result

✓ Design a computer-aided medical system to objectively and automatically perform the aesthetic evaluation of the result of the BCCT

- Goal: imitate the evaluation as provided by experts
- It should be
  - Low cost solution
  - Easy to perform by surgeons /clinics
  - Objective, reproducible

The input to software development



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Consensus evaluation of a panel of experts:

- Excellent (14)
- Good (64)
- Fair (24)
- Poor (11)

Methodology

1. Find a suitable set of features (=characteristics) measured on the digital images
2. Find the best relationship between features to discriminate among the four classes ‘excellent’, ‘good’, ‘fair’ and ‘poor’

Factors contributing to the final aesthetical result

Asymmetry

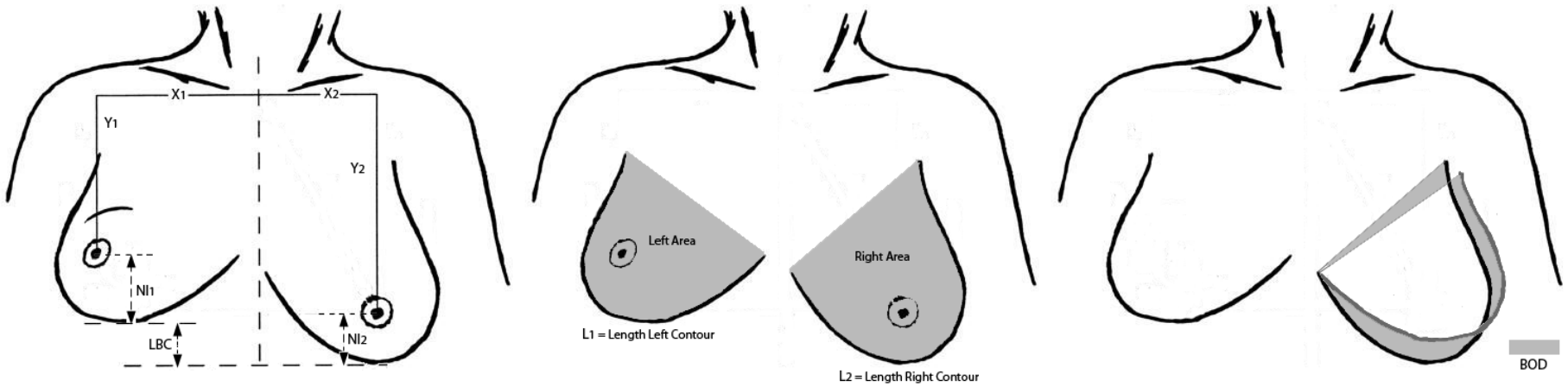
Scar

Colour

Feature Selection

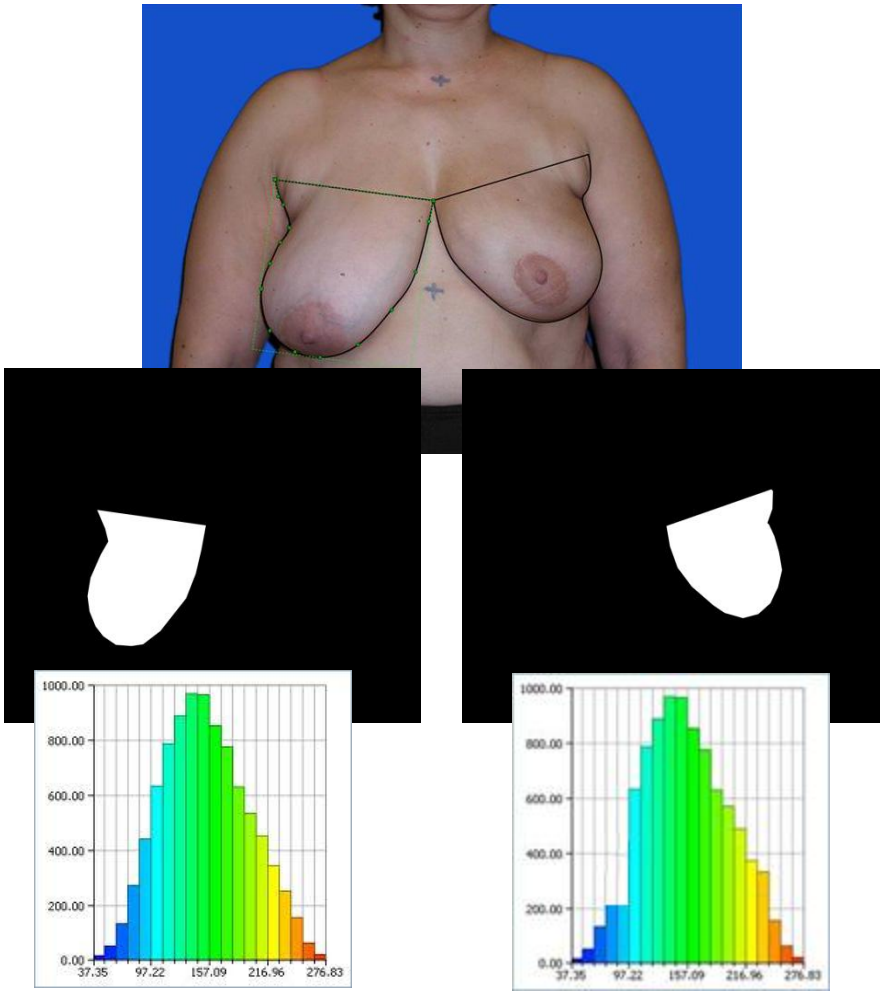
- Asymmetry is a key factor in the overall result
  - Select features capturing asymmetry
- Scar visibility is a key factor in the overall result
  - Select features capturing scar
- Skin colour change is a key factor in the overall result
  - Select features capturing colour

Asymmetry Features



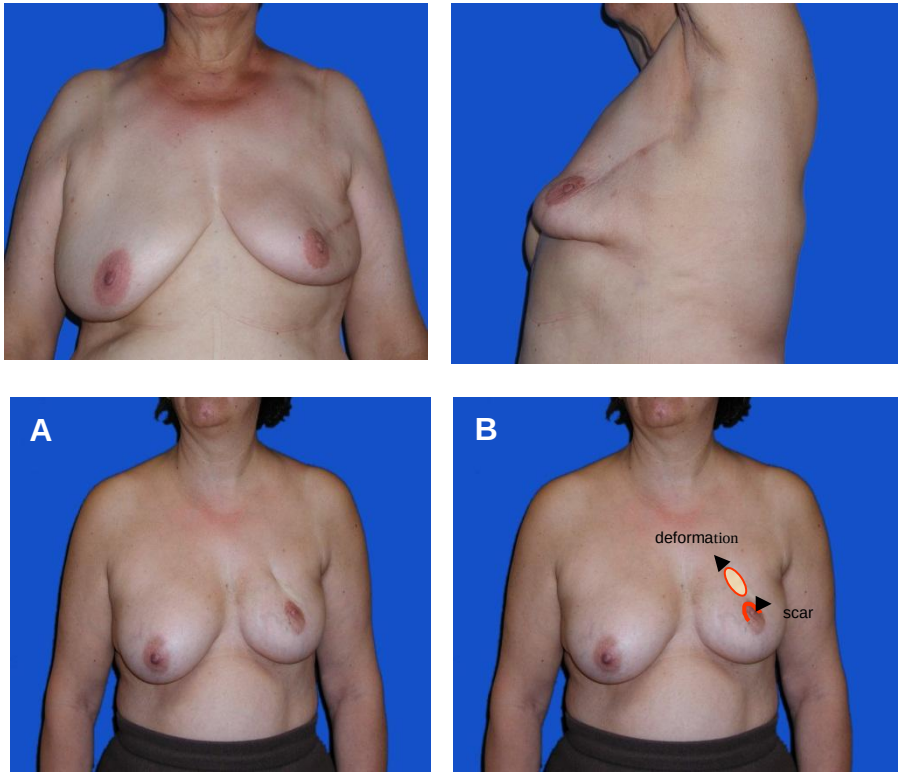
Breast retraction assessment; lower breast contour; upward nipple retraction; breast compliance evaluation; breast contour difference; breast area difference; breast overlap difference

How to measure colour change?



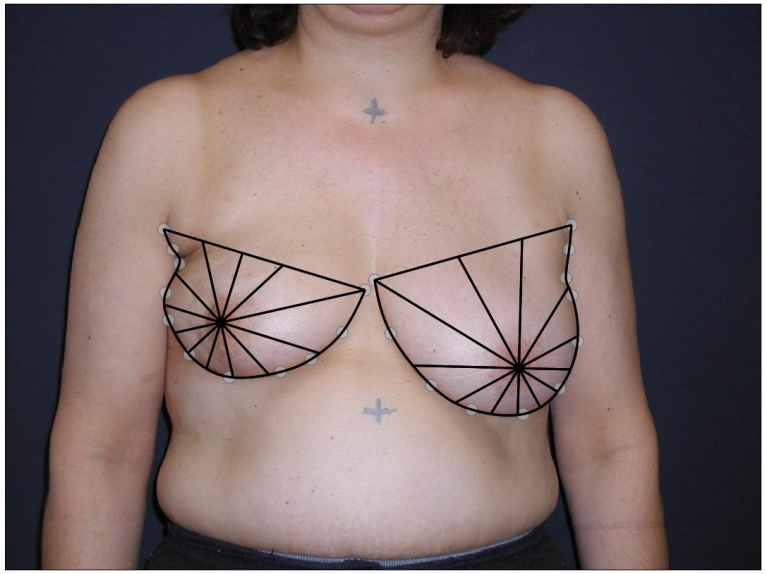
- Measure the dissimilarity between the colour of the two breasts
  - Compute the histogram of colours for each breast
  - Compare histograms
    - EMD (earth movers distance)
    - Chi-square

Scar visibility



- Size
- Contrast
- Shape
- Localization
- Deformations resulting from scars

Scar visibility



- Scar visibility as a local (colour) change
- Breast divided in sectors
  - Corresponding sectors are compared

Learning From the Experience

```
If pLBC is less than 0,1 and ...
Then overall result is excellent
...
```

Computers Get Help from the Human Brain

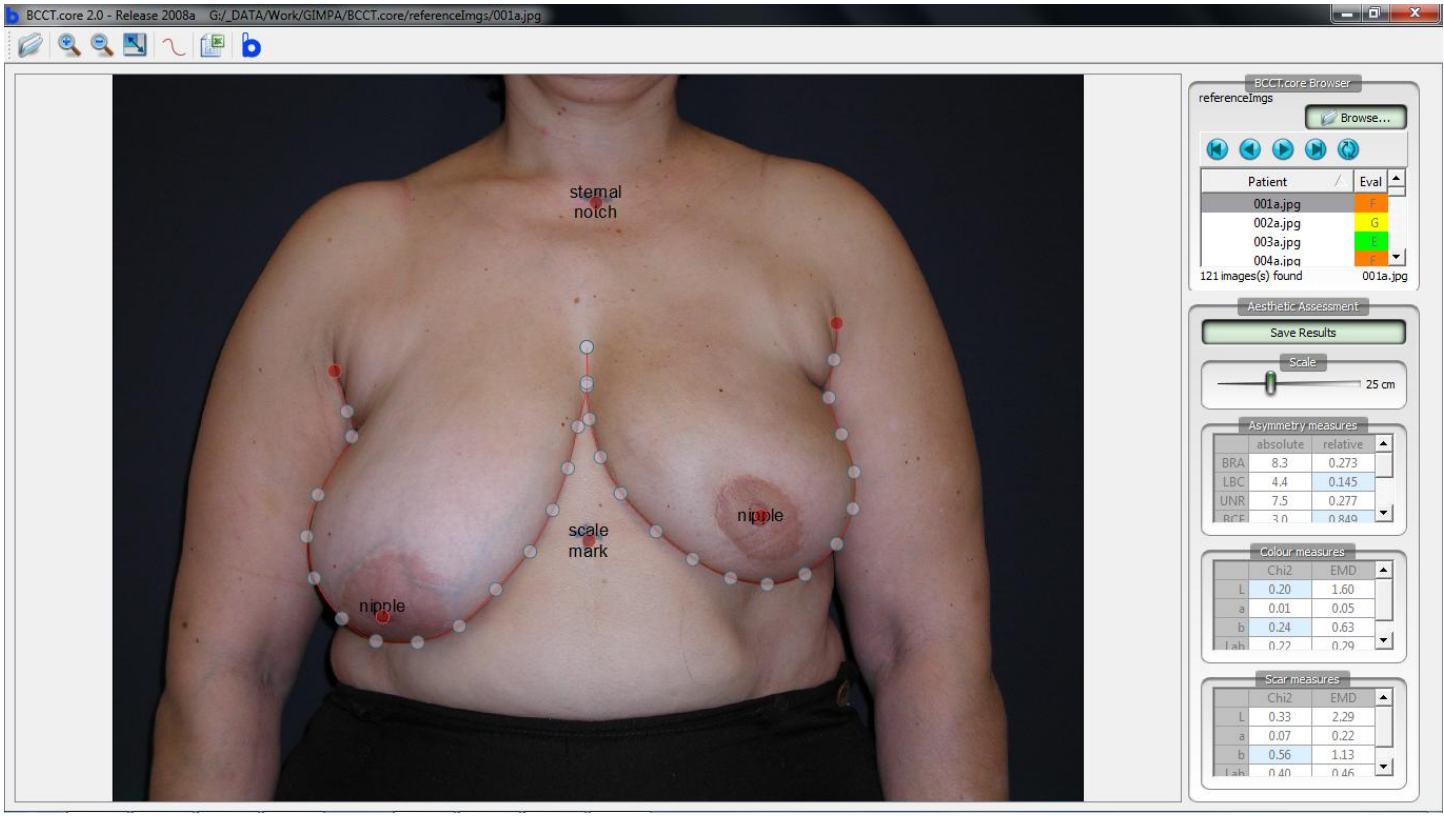
```
If 0,39 pLBC + 0,13 cEMDL + ... <= 0.09
then overall result is excellent
.
.
.
If ...
then overall result is poor
```

Aesthetical Assessment of Breast Cancer Conservative Treatment

- BCCT.core

Output:

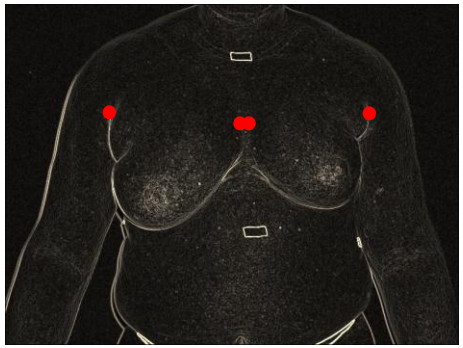
- Excellent
- Good
- Fair
- Poor



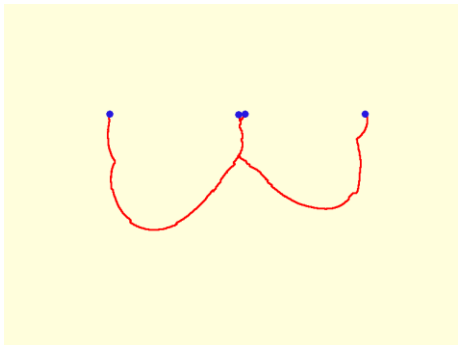
BCCT.core, is being used by 50+ international groups in prospective studies: Nottingham Breast Institute, UK; Leiden University Medical Centre, The Netherlands; Cancer Care Center, Sydney, Australia; University of Heidelberg, Breast Center, Heidelberg, Germany; Medical University, Vienna, Austria; etc.

Automatic Detection of Breast Contour

Original photo

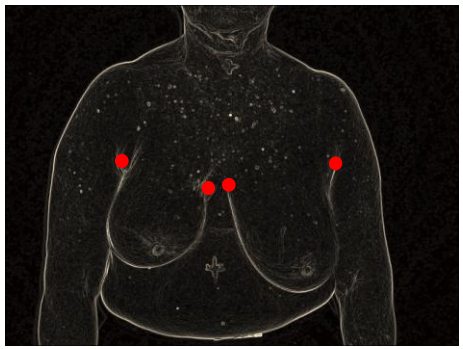


Gradient

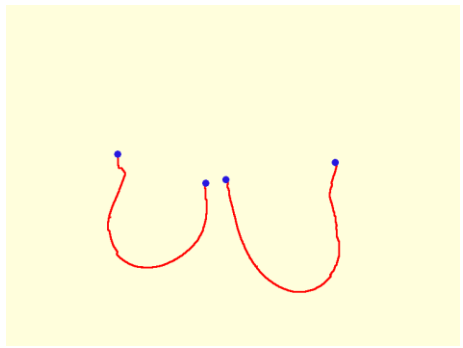


Model output

Original photo



Gradient



Model output

From BCCT.core 1.0 to BCCT.core 2.0

- Better automation
- Improved overall prediction
- Improved robustness

The path ahead

- Include volumetric information

Motivation

Currently methods are insufficient for the complete evaluation:

- Subjective evaluation
- Evaluation using bi-dimensional images

3D or 2.5D is needed

Currently 3D information is acquired based on equipment and software with high cost

This equipment is only operated by specialized operators

Kinect Based Method

Hardware developed for the X-BOX console

RGB camera and a depth sensor (infrared laser projector + monochrome CMOS sensor)

Kinect Based Method

Depth Data

Colour Data

3D Features

2D Features

Classifier

Breast Research Group

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OBRIGADO

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