ENHANCEMENT OF ACCURACY IN MAMMOGRAMS INTERPRETATION
USING ONTOLOGY-DRIVEN EDITOR FOR LESIONS DESCRIPTION AND CAD TOOL
– PRELIMINARY RESULTS

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Medical Informatics & Technologies

Agenda

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- **Radiologist's errors (perception and interpretation), types and features of most commonly missed lesions**

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- **MammoEdit - ontology-driven editor for mmg lesion interpretation improvement**

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- **Conclusions**

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Introduction

- **Mammography** − the most effective tool for early detection of breast cancer, still the only technique that can detect breast cancer in a preinvasive stage

- **Diagnostic value of mammography** − limited by significant and high, up to 25% rate of missed breast cancers

- **Main, human-oriented causes lowering diagnostic value of mammography** − radiologists' perception and interpretation errors

- **Strategies, means and tools to reduce radiologists' errors are essential to improve diagnostic effectiveness in mammography**

- **Methods described**: continuing education and training, prospective double reading, retrospective evaluation of missed cases, and use of computer-aided detection (CAD)

- **Our proposal**: *MammoViewer* - *a CAD tool for radiologists' perception improvement and MammoEdit ontology-driven editor for mammograms description and interpretation*

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Radiologist's errors
Commonly missed lesions - types and features

- **Main causes of missed cancers** - radiologist's errors, poor technical conditions

- **Type of radiologist's errors** – perception and interpretation errors

- **Lesions most frequently misinterpreted or overlooked**

  - small cluster of microcalcifications (**perception and interpretation errors**)

  - lesions with benign appearance (**masses and clusters of microcalcifications - interpretation error**)

  - small masses (**perception error**)

  - assymetric densities (**perception and interpretation errors**)

  - architectural distortion (**perception error**)   Wróblewska

MammoViewer - a CAD tool for radiologists' perception improvement
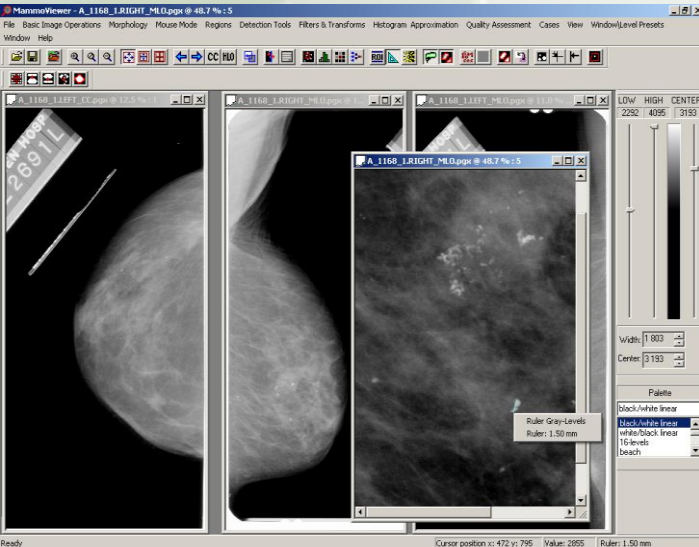
✓ **advanced viewer dedicated to medical images**

✓ effective methods of presentation, processing, analysis and interpretation of images

✓ widespread imaging options: measuring structures, operating in regions of interests, defining parameters of a sliding window, setting the range of the shown pixel values

✓ scientific software package - variety of methods to process medical images

✓ processing in multiresolution wavelet domain - particularly useful in mammography
✓ mammogram preprocessing - enhance perception of pathologies, provide more conspicuous pathology signs for radiologists interpreting mammograms

✓ achived by :
- denoising
- local contrast enhancement – amplifying contours of lesions, emphasizing other diagnostically important lesion features like texture inside pathologies

MammoViewer test - organization, case sample

Test Case Sample: 16 mammograms with lesions from DDSM digitized at a pixel size of 43.5 and 50 microns with a 12-bit grayscale: each lesion in 2 projections (8 cases)

Test Organization: Radiologist compared processed images with original ones: in each pair he observed image quality, tissue structure and signs of pathologies.

| Mark scale	Wordy description of diagnostic image quality
+3	definitely (arbitrarily) better
+2	better
+1	slightly better
0	comparable with the original
-1	slightly worse
-2	worse
-3	definitely (arbitrarily) worse

Test results - improvement of lesions perception

Types of lesions	All types	Spiculated masses	Spiculated masses without microcals	Microcals within masses	Circumscribed masses
Number of images	16	14	10	4	2
Average subtlety (visibility of lesions: 1-the weakest lesions, 5-the most obvious cases)	3.4	3.21	3.3	3	5
Mean breast density	2.38	2.57	2.2	3.5	1
Mean radiologist's mark	+2.5	+2.57	+2.6	+2.75	+2

Subtlety	1-2 (the weakest signs of pathology)	3	5 (the more obvious lesions)
Number of images	3	7	6
Mean radiologist's mark	+2	+2.71	+2.5

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# Perception improvement using MammoViewer
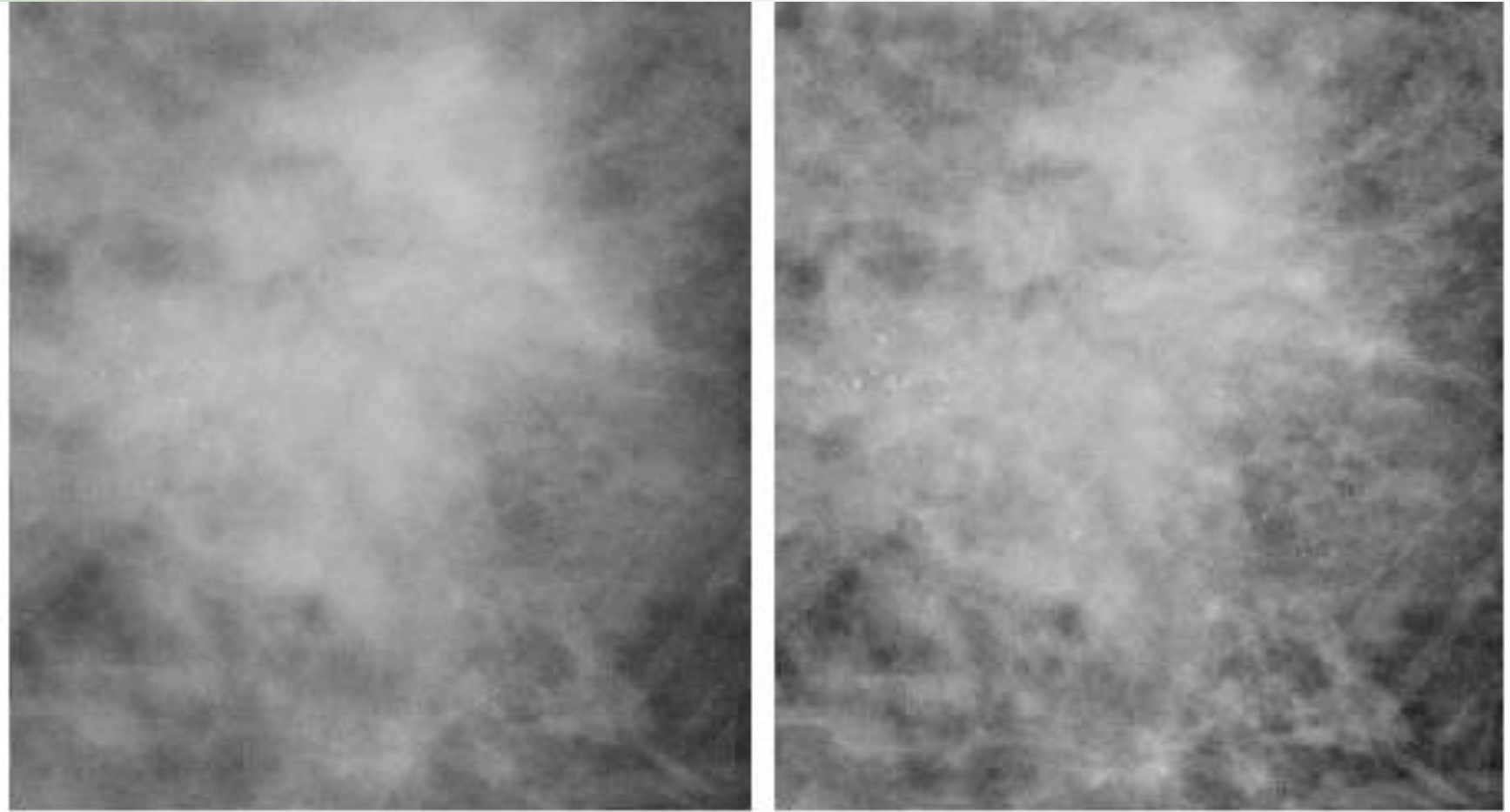
Spiculated mass with microcalcifications. On the left - original image and on the right - processed one. Diagnostically important lesion features – spiculated margin and inner microcalcifications – are better visible in the processed image.

MammoEdit - ontology-driven editor for mmg lesion description and interpretation
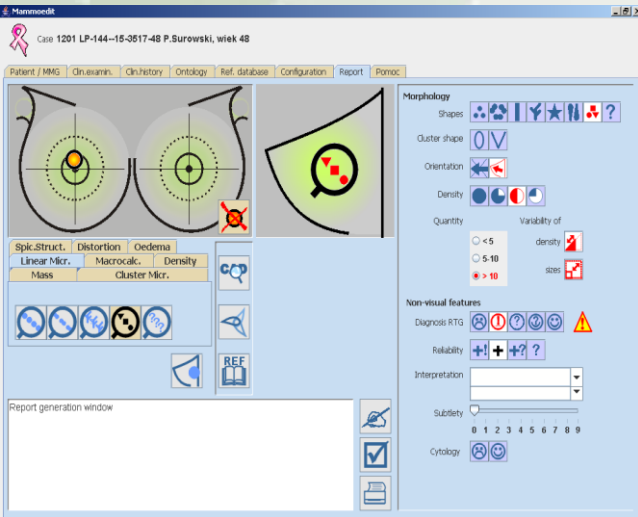
- ✓ **assumption - using reliable domain knowledge representation to design and control mammographic data entry has the potential to improve their semantics (meaning, significance) and completness thus improving lesion diagnosis**

- ✓ ontological model of the domain - basis for mammogarphic lesion definition and partial set of design assumptions for graphical editor for mammograms description

- ✓ The ontology has been formalized using ontology editor Protégé-2000 version 3.1, frame knowledge representation

- ✓ concepts necessary for mmg lesions description are represented by graphical primitives – icons

- ✓ icons represent features in a symbolic and simplified way

- ✓ icons colours provide information about diagnostic importance of selected features

- ✓ intuitive design of icons and other graphical components

MammoEdit test - organiztion case sample, results

Test Case Sample – 23 lesions: 11 masses, 9 microcalcification clusters, 3 cases of microcalcifications in linear distrbution. Average breast density – 2,8 Bi-rads, average lesion subtlety 2,7 DDSM

Test Organization

    First stage – mammograms were described using MammoViewer as a medical image viewer (without scientific methods), reports dictated

    Second stage - both tools MammoViewer and MammoEdit used for lesions assessment.

Results - diagnosis improvement in 23 cases of misdiagnosed pathologies

Two Result Categories:

    Initial diagnosis - benign or probably benign lesion (2 or 3 Bi-Rads, 9 cases)

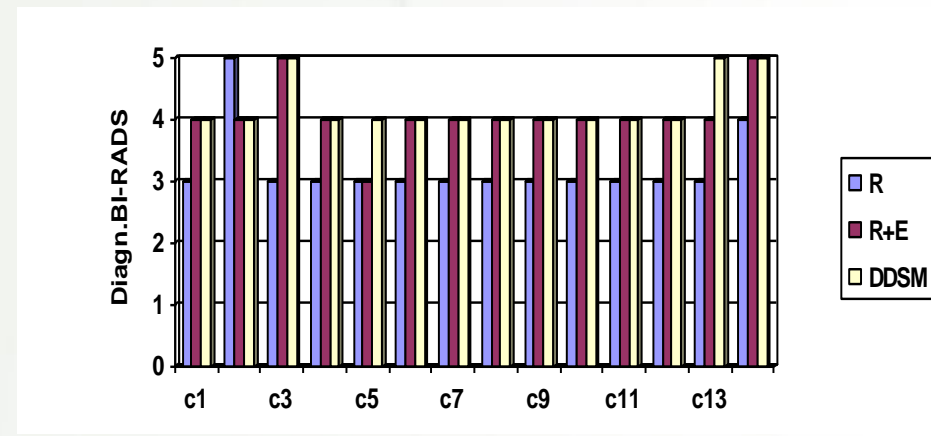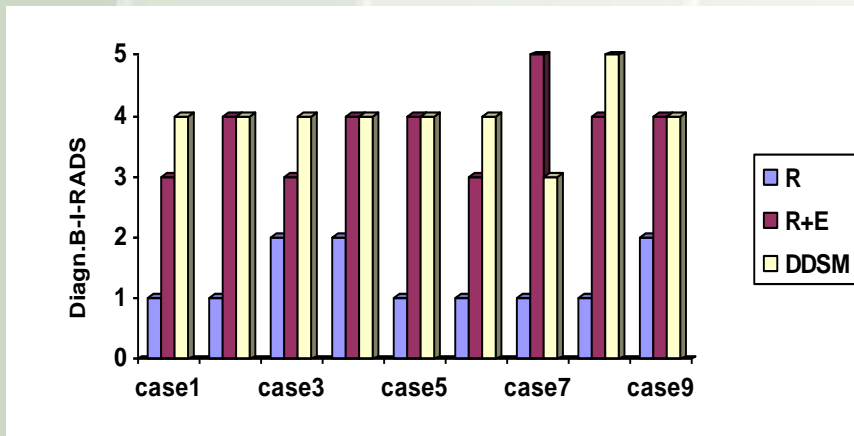   Initial diagnosis - additional exams or suspicious lesion (0 or 4 Bi-Rads , 14 cases)

Test results - correction of misdiagnosis using MammoEdit

Fault diagnosis – **benign lesion**

Substantial diagnosis correction using editor

Fault diagnosis - **additional exams, or suspicious lesion**

**Improvement of diagnosis consistency using editor**

- **R** – lesion diagnosis when radiologist uses CAD tool as medical viewer , report dictated
- **R+E** – lesion diagnosis when radiologist uses CAD tool as medical viewer and editor for lesion description and assessment
- **DDSM** – lesion diagnosis in a reference database.

Diagnosis improvement using MammoEdit - example of perfectly visible but misinterpreted pathology
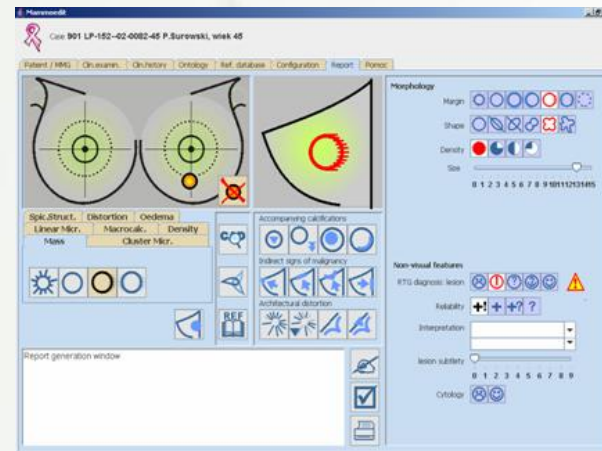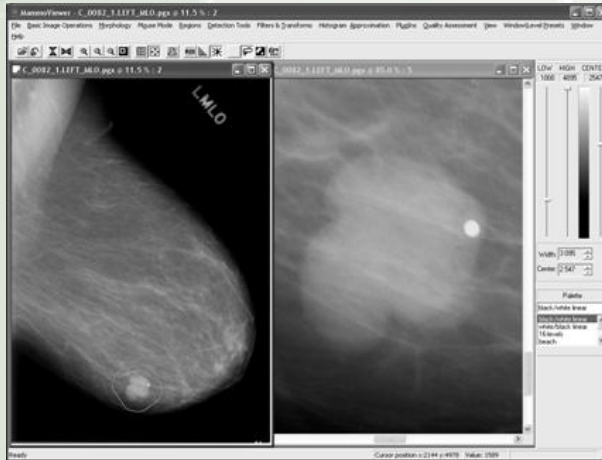
- On the left - apparently benign mass, perfectly visible in fatty breasts and additionally marked (left panel, gray outline). In the first round of the test, the mass has been described by radiologist in the dictated report as "lobulated, well-defined - benign". The radiologist erroneously judged the lesion by its most benign features. However, the mass presents three suspected features: high density , partially ill-defined margin (right panel) and shape lobulated (with more than two lobulation) not taken into account by radiologist in first test round. On the right - description of the same lesion using editor is presented, souspicious features are presented in red, diagnosis correct.

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CONCLUSIONS

PERCEPTION IMPROVEMENT - results confirmed the effectiveness of the used processing methods. The methods of perception improvement not only make the pathologies better visible but enhance their morphological features as well

DIAGNOSIS IMPROVEMENT - change was substantial when initial, fault diagnosis was benign or probably benign (BI-RADS 1, 2 for 3,4 and 5) – the mistakes were previously made even for lesions that were very easy to capture (subtlety 5). The second effect was the improvement of diagnosis consistency where further diagnostic process was more appropriate.

THERE IS A NEED TO USE BOTH TOOLS - CAD tool and ontology-driven editor for inexperienced radiologist.

FUTUTRE WORKS - clinical tests with a greater number of cases and with cooperation of 3 radiologists with different levels of expertise.

Thank you

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