FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Automatic Breast Lesion Examination of DCE-MRI Data Based on Fourier Analysis

Masterstudium:
Visual Computing

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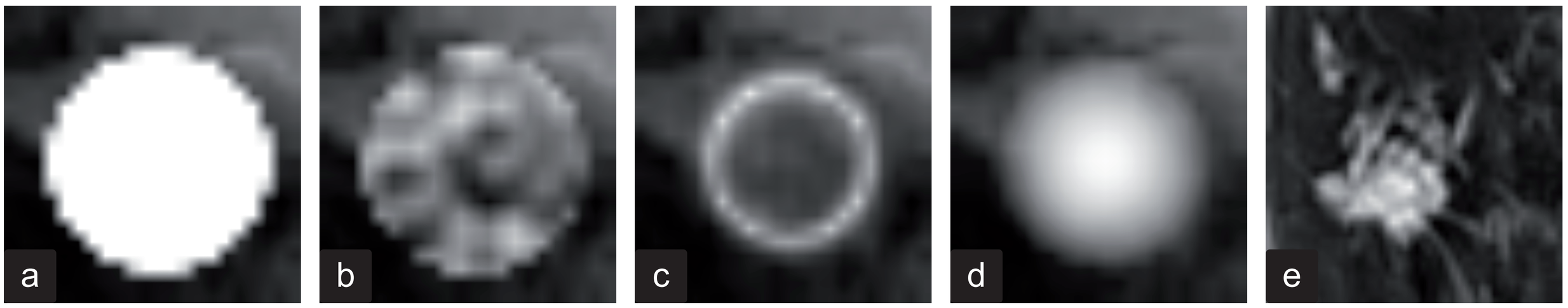
Problem Statement and Motivation

Breast cancer death is the second most common cancer death among women. Statistics show that an early cancer diagnosis is the key fact in reducing the breast cancer mortality rate. Imaging methods like X-ray mammography, mammosonography and breast MRI are used for the diagnosis of breast cancer. MRI is getting more important because of it is insensitive to breast tissue density. Moreover, MRI acquires volumetric data, meaning it is three-dimensional (3D).
We present an automatic breast lesion examination of Dynamic Contrast Enhanced MRI (DCE-MRI) data based on Fourier analysis. The results are presented in a novel and normalized visualization based on well established medical grading scheme, the Göttinger score.

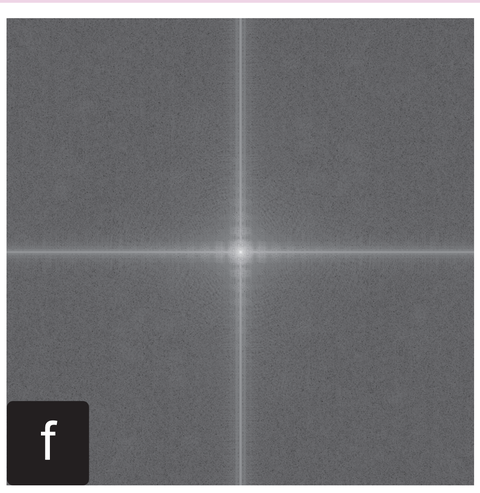
Breast Cancer Classification: Göttinger Score

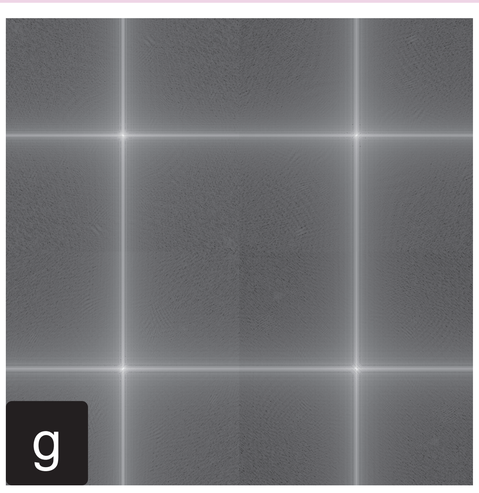
Morphologic Features			Kinetic Features	
Internal Enhancement	Boundary	Shape	Initial Signal Increase	Post-Initial Signal
0: homogeneous (a) 1: heterogeneous (b) 2: rim-enhanced (c) *Distribution of the contrast agent withing a lesion.*	0: smooth (a) 1: blurred (d) *The transition of the lesion to the surrounding tissue.*	0: round/oval (d) 1: irregular (e) *Defines the spatial extent of the lesion.*	0: slow 1: moderate 2: fast *The ISI is the enhancement of a lesion in the early phase after contrast agent injection.*	0: continuous 1: plateau 2: wash-out *The PIS is the enhancement of a lesion after the initial phase.*



Göttinger Score: Feature Computation

Internal Enhancement	Boundary	Shape	Initial Signal Increase	Post-Initial Signal
Mean diagonal elements of $\boldsymbol{J}$ are used for classification. The amount of high frequency energy is analyzed.	Mean diagonal elements of $\mu(\boldsymbol{J}_i)$ are used for classification. The amount of high frequency energy is analyzed.	Distribution of spectral energy is evaluated of the $\mu(\boldsymbol{J}_i)$ and for each $\boldsymbol{J}_i$ - $\mu(\boldsymbol{J}_i)$. If spectral elements are distributed equally in $\mu(\boldsymbol{J}_i)$ and planar in $\boldsymbol{J}_i$ - $\mu(\boldsymbol{J}_i)$, shape is round/oval.	Relative enhancement (RE) is computed using pre-contrast and early post-contrast volume on per-voxel basis. RE < 0.5: slow RE < 1.0: moderate RE > 1.0: fast	Relative enhancement is computed using early post-contrast and late post-contrast volume on per-voxel basis. RE > 0.1: continuous RE > -0.1: plateau RE < -0.1: wash-out



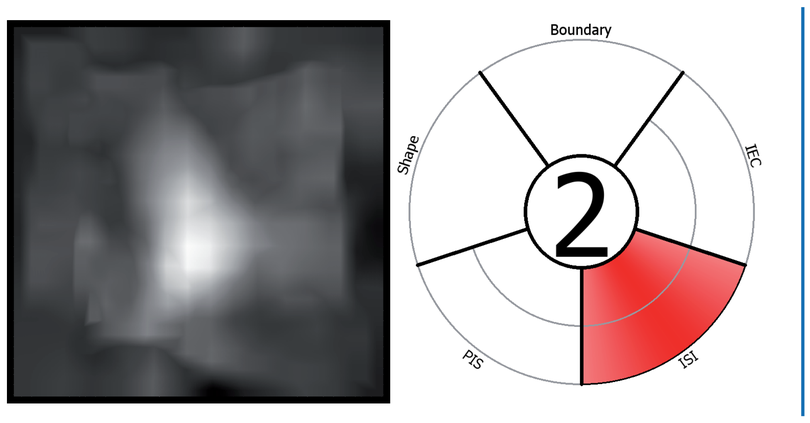


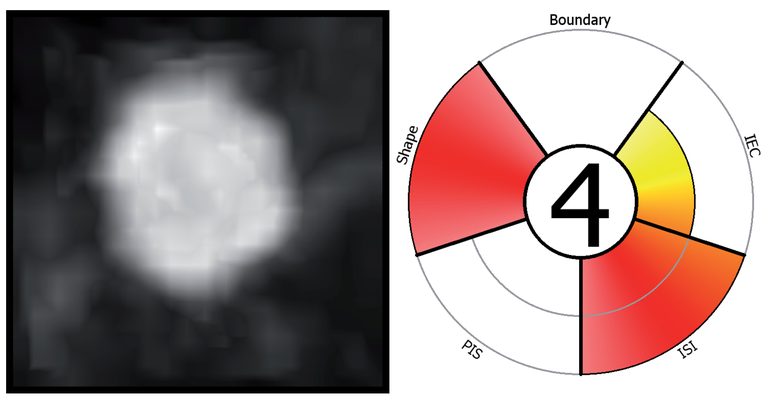
Inertia tensor $\boldsymbol{J}$ is computed using the magnitudes of the Fourier transformed entire volume (f).
The volume is split into eight equally sized sub-volumes and inertia tensors $\boldsymbol{J}_i$ are computed for each of the magnitudes of the Fourier transformed sub-volumes (g).
$\mu(\boldsymbol{J}_i)$ is the mean tensor and is computed by averaging all inertia tensors $\boldsymbol{J}_i$.

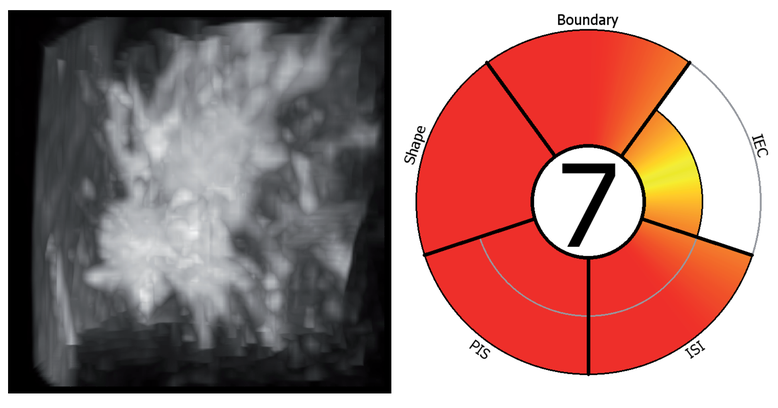
$$\boldsymbol{J} = \begin{pmatrix} J_{xx} & J_{xy} & J_{xz} \\ J_{yx} & J_{yy} & J_{yz} \\ J_{zx} & J_{zy} & J_{zz} \end{pmatrix}$$

Malignancy Area Plot

All the features of the Göttinger score are combined in a normalized visualization called Malignancy Area Plot (MAP). In the center 0 points are assigned to the feature, the border represents the feature's maximum value. The number in the middle represents the overall Göttinger score. High numbers indicate a high likelihood of a lesion being malignant and the color-coded area increases with the likelihood.







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