Classification of Confocal Laser Endomicroscopic Images of the Oral Cavity to Distinguish Pathological from Healthy Tissue

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Structure

- Motivation
- Background
- Data & Methods
- Experiments and Results
- Summary & Conclusion

Motivation

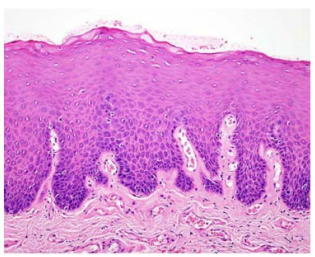
Motivation – Cancer of the Oral Cavity

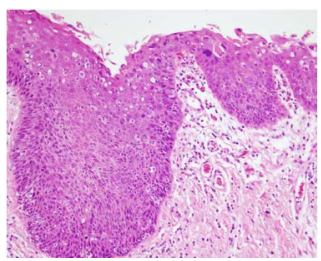
Sixth most common kind of cancer

Problems of diagnosis

- subjectivity of physician
- histological analysis
- surgical resection

Early diagnosis $\Rightarrow$ difficult!





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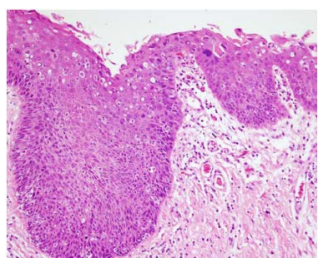

$\Rightarrow$other solutions?

Motivation – Initial Problem

Motivation – Objective

Overall: separate patholgical from healthy images

Benefits:

- objective method to support the physician
- supports diagnosis & finding of the resection site
- time-saving and less harmful for the patient

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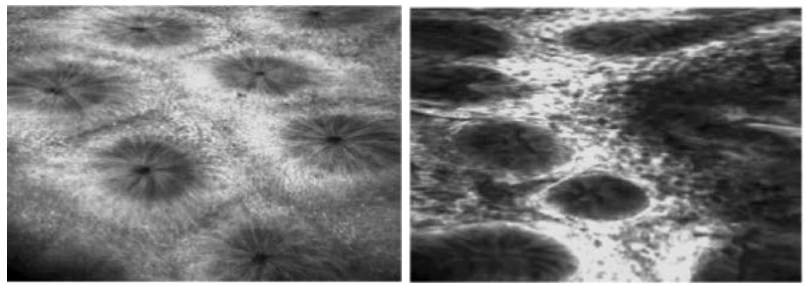
Three problems:

1. creation of image database ✓
2. annotation of images ✓
3. classification of images todays topic

Motivation – State of the Art

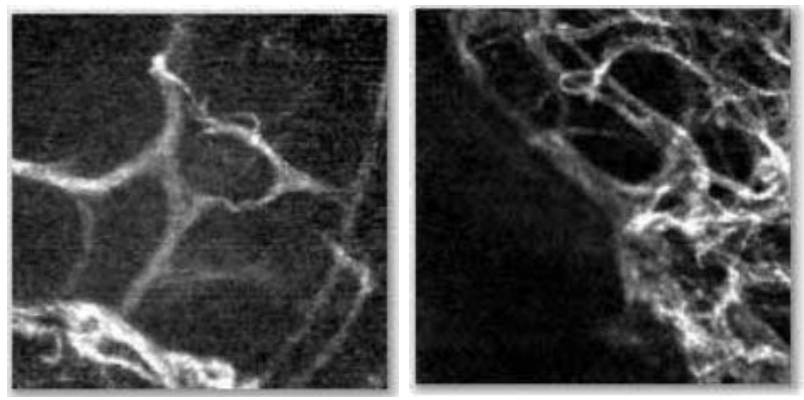
Couceiro et al. [Couceiro, 2012]

- gastrointestinal tract
- arrangement of glands
- Scale Invariant Feature Transform (SIFT)



Désir et al. [Désir, 2012]

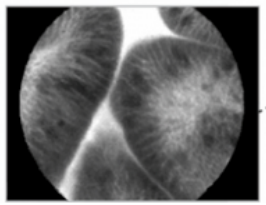
- distal lung
- texture description
- Local Binary Patterns (LBP), SIFT



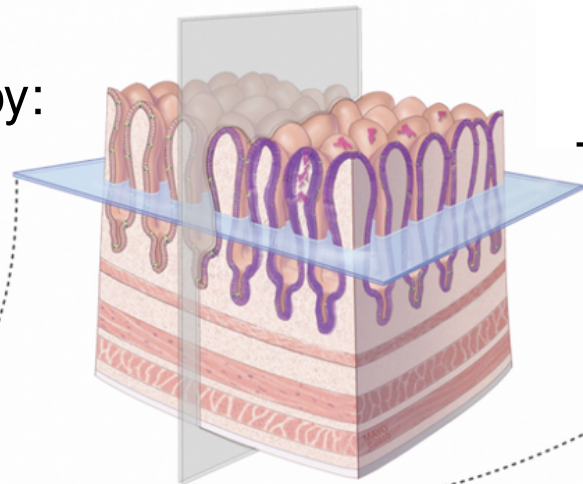
Background

Background – Optical Biopsy

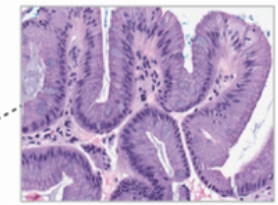
In vivo
confocal microscopy:
en face view



Example of
Optical Biopsy



Conventional
histology:
Transvers section

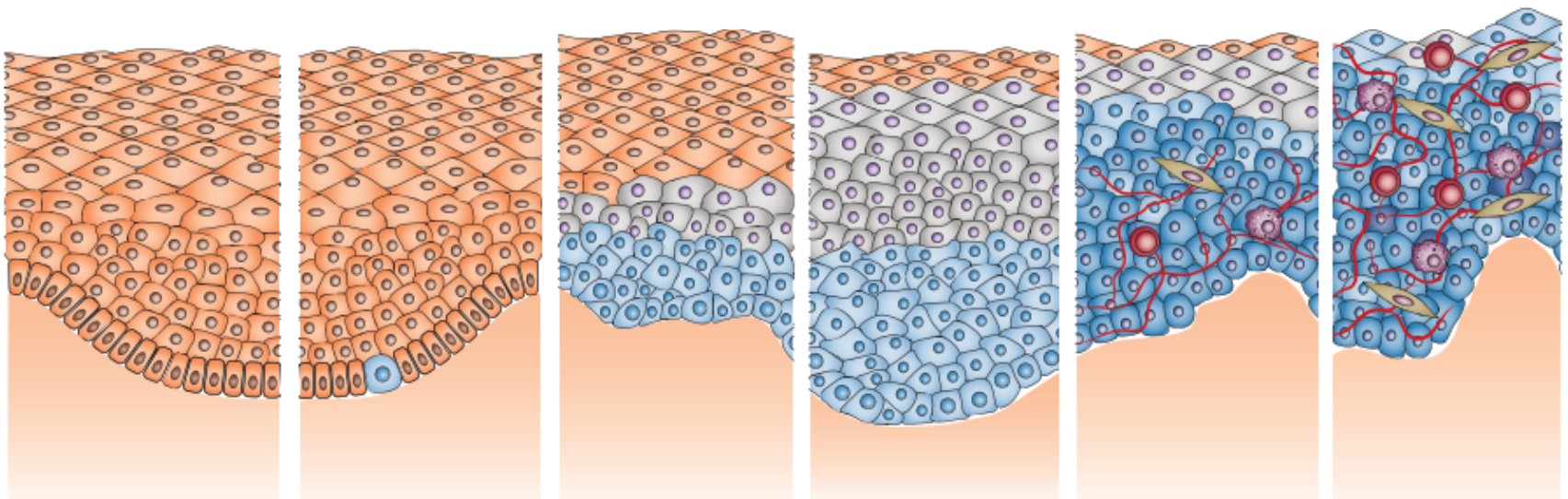


Example of Physical
Biopsy Image

Confocal LaserEndomicroscopy (CLE) allows real time visualization of epithelial layer **in vivo**!

Background – Carcinogenesis

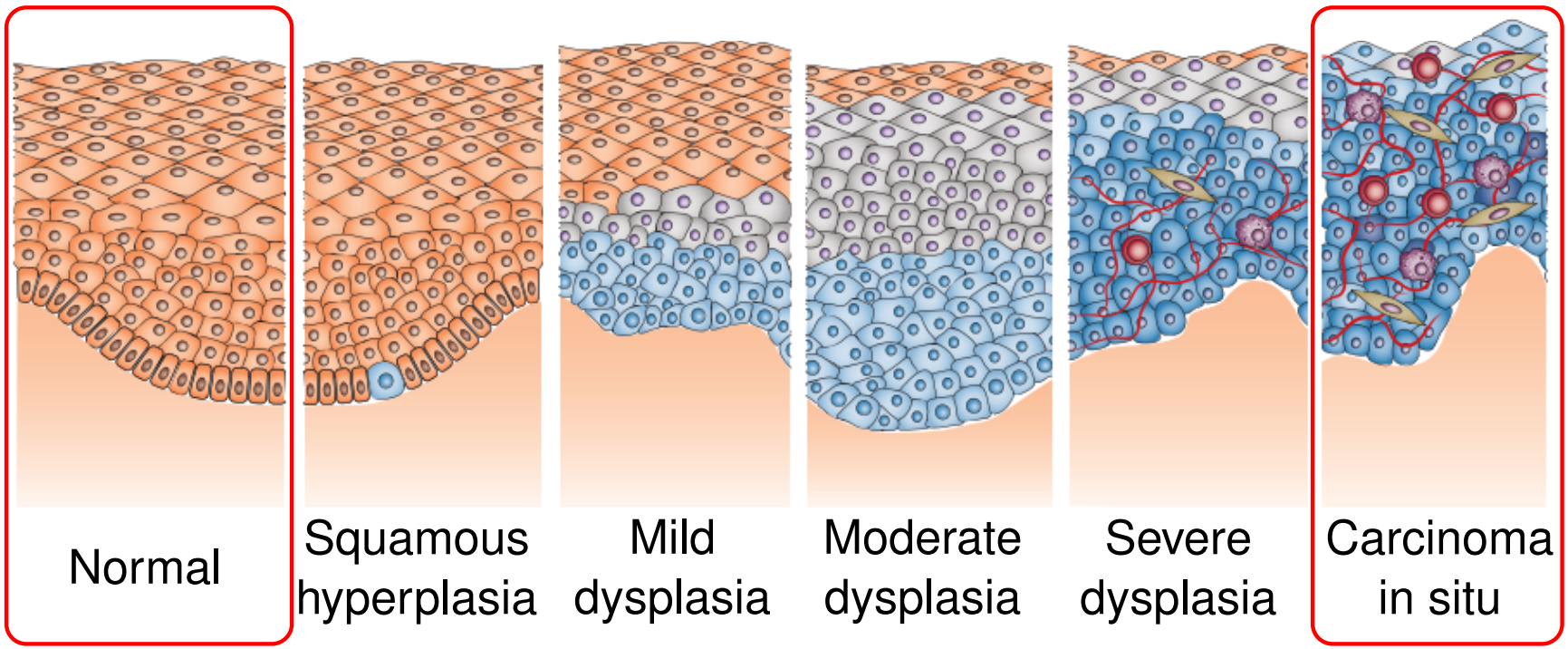
Development stages of oral cancer



Normal | Squamous hyperplasia | Mild dysplasia | Moderate dysplasia | Severe dysplasia | Carcinoma in situ

Background – Carcinogenesis

Development stages of oral cancer



Data & Methods

Data – Patient & Image Database

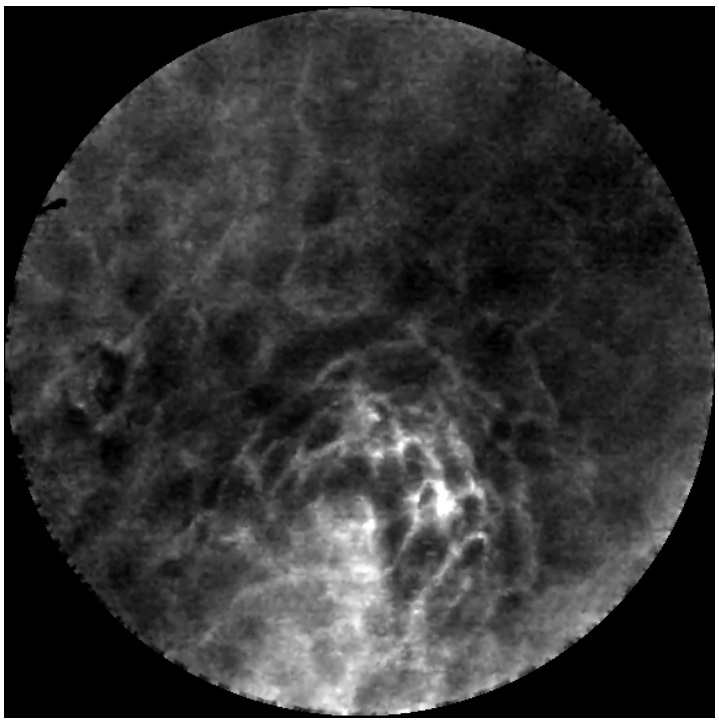
Patient Data

	Control Group	Patient Group
Gender (m/f)	1/-	1/1
Age (years)	30	63.5 ± 2.1

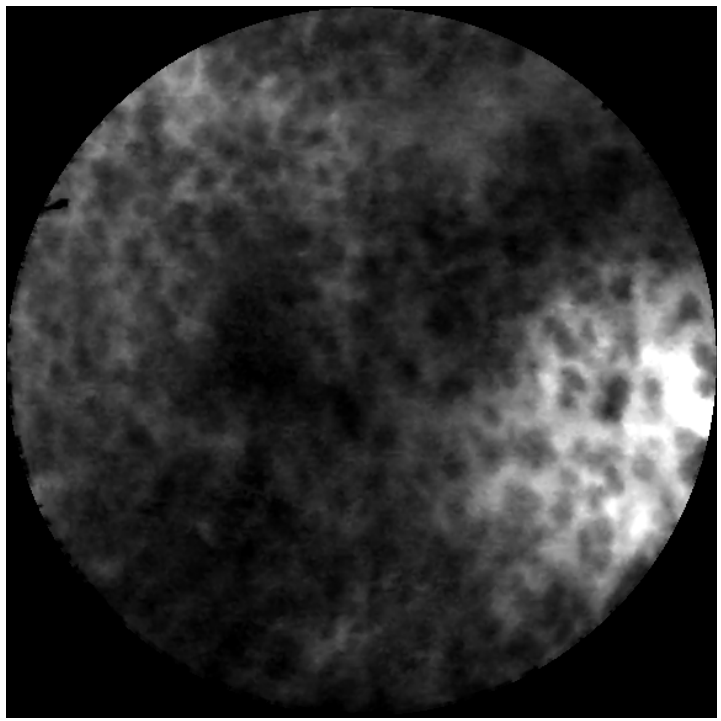
Image Database

Location	Control	Patient 1	Patient 2
Alveolar Ridge (h/c)	71/-	94/45	41/-
Buccal mucosa (h/c)	-/-	32/15	-/-
Lingual mucosa (h/c)	-/-	-/-	29/27

Data – Image Examples



(a) Healthy



(b) Carcinoma

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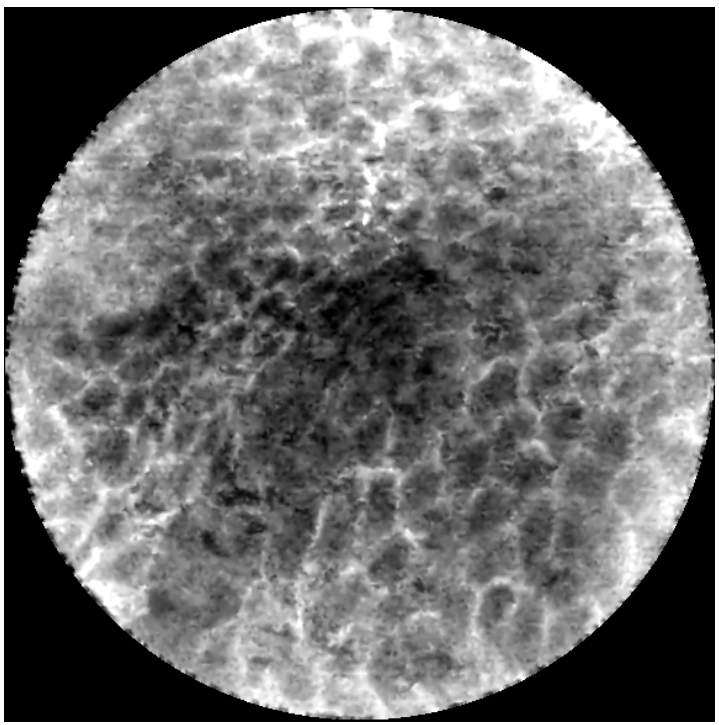

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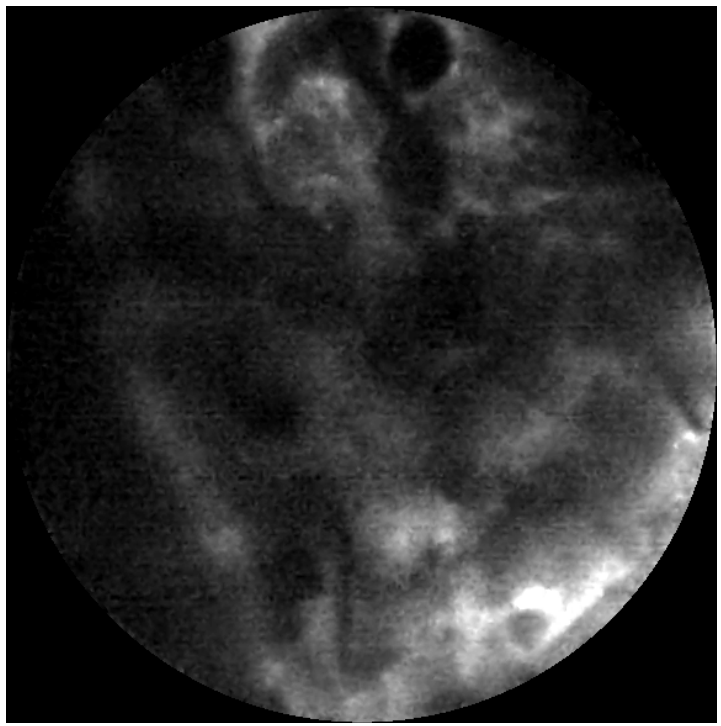
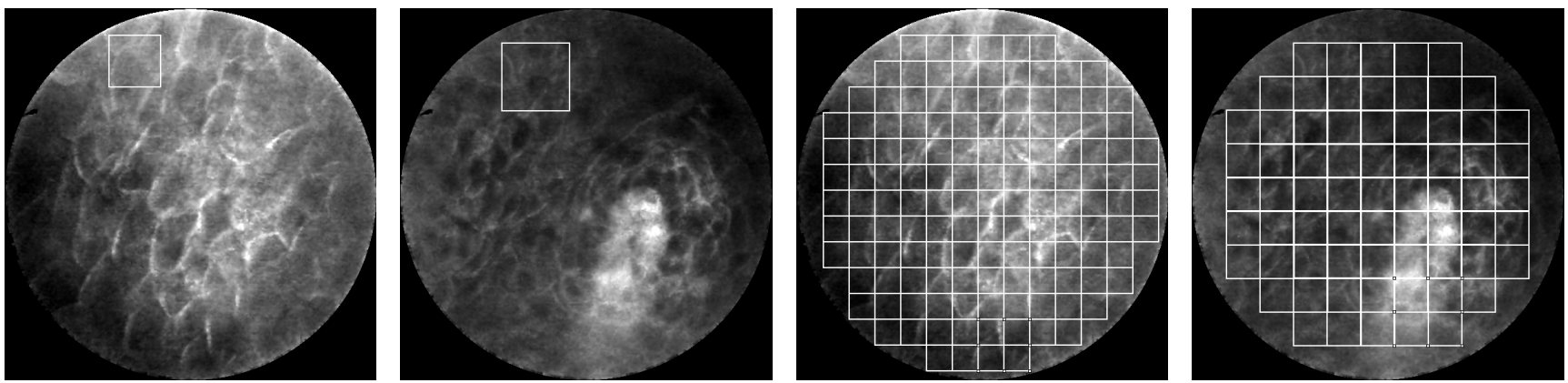


(b) Carcinoma

Methods – Classification Algorithm

Subdivide images

- 110/51 rectangular patches $\Rightarrow$ precalculated coordinates
- sidelength 80/105 px
- step length 0.5 $\times$ side length $\Rightarrow$ 50 % overlap in x-direction



(a) 1 $\times$ 80 (b) 1 $\times$ 105 (c) 110 $\times$ 80 (d) 51 $\times$ 105

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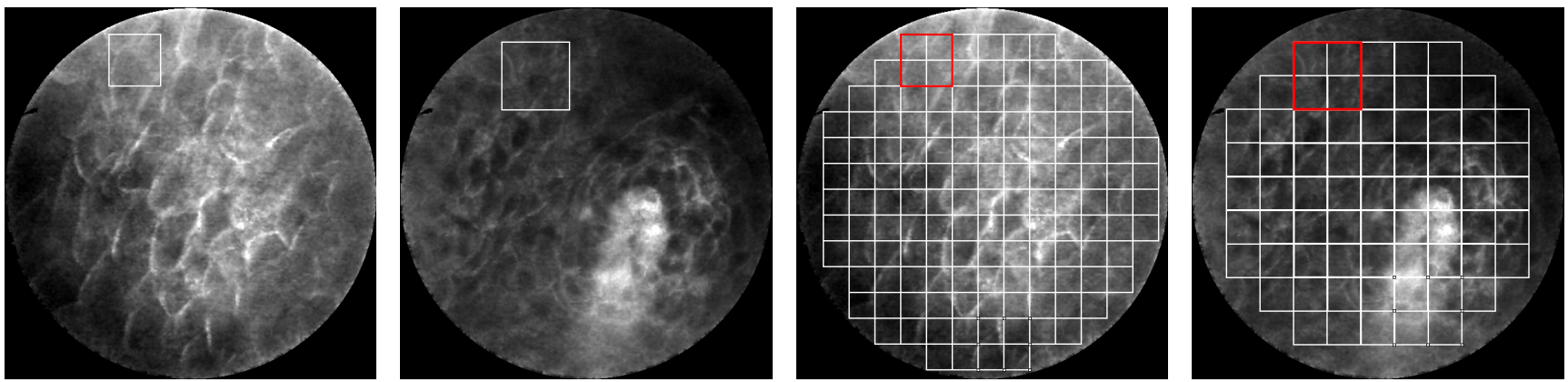

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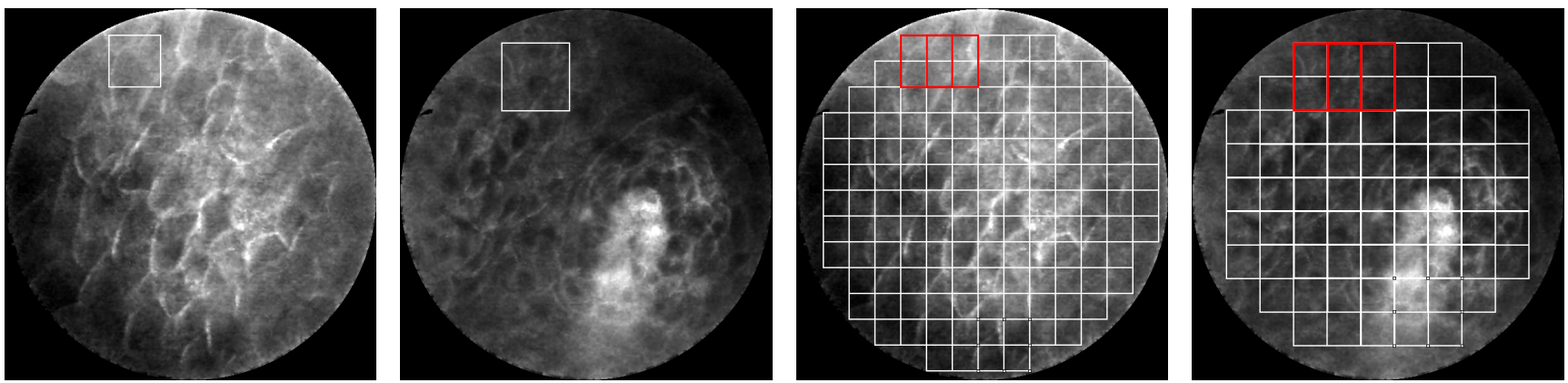

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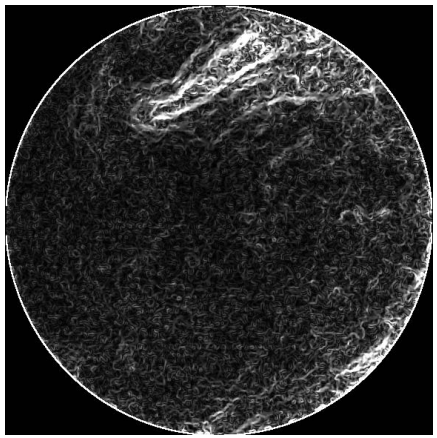
Methods – Extracted Features

Histogram features

- frequency of gray level occurrences
- no information of structure
- computation of statistics

Homogeneity features

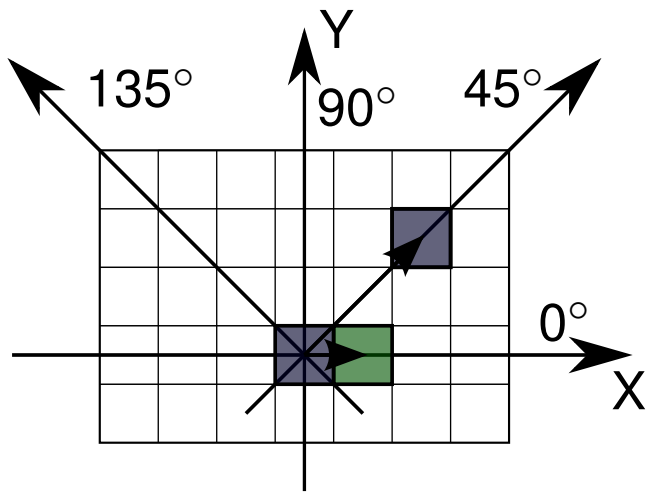
- evaluates gray values
- evaluates edge images
- simple features



Methods – Extracted Features

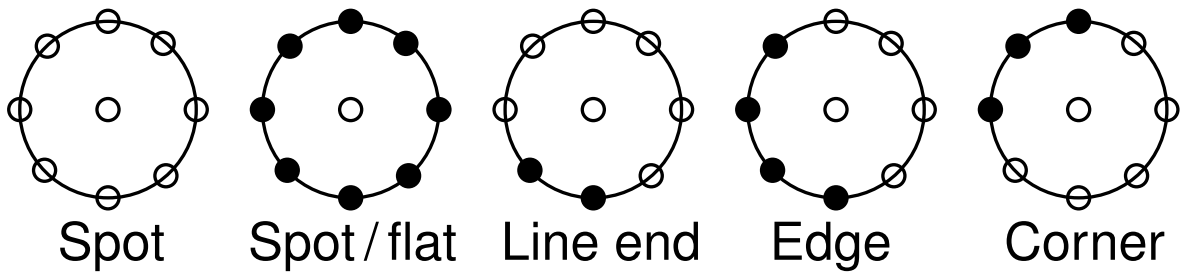
Grey Level Co-Occurrence Matrices

- frequency of gray values
- geometrical arrangement of gray values
- features by Haralick, GLCM (8/16/32)

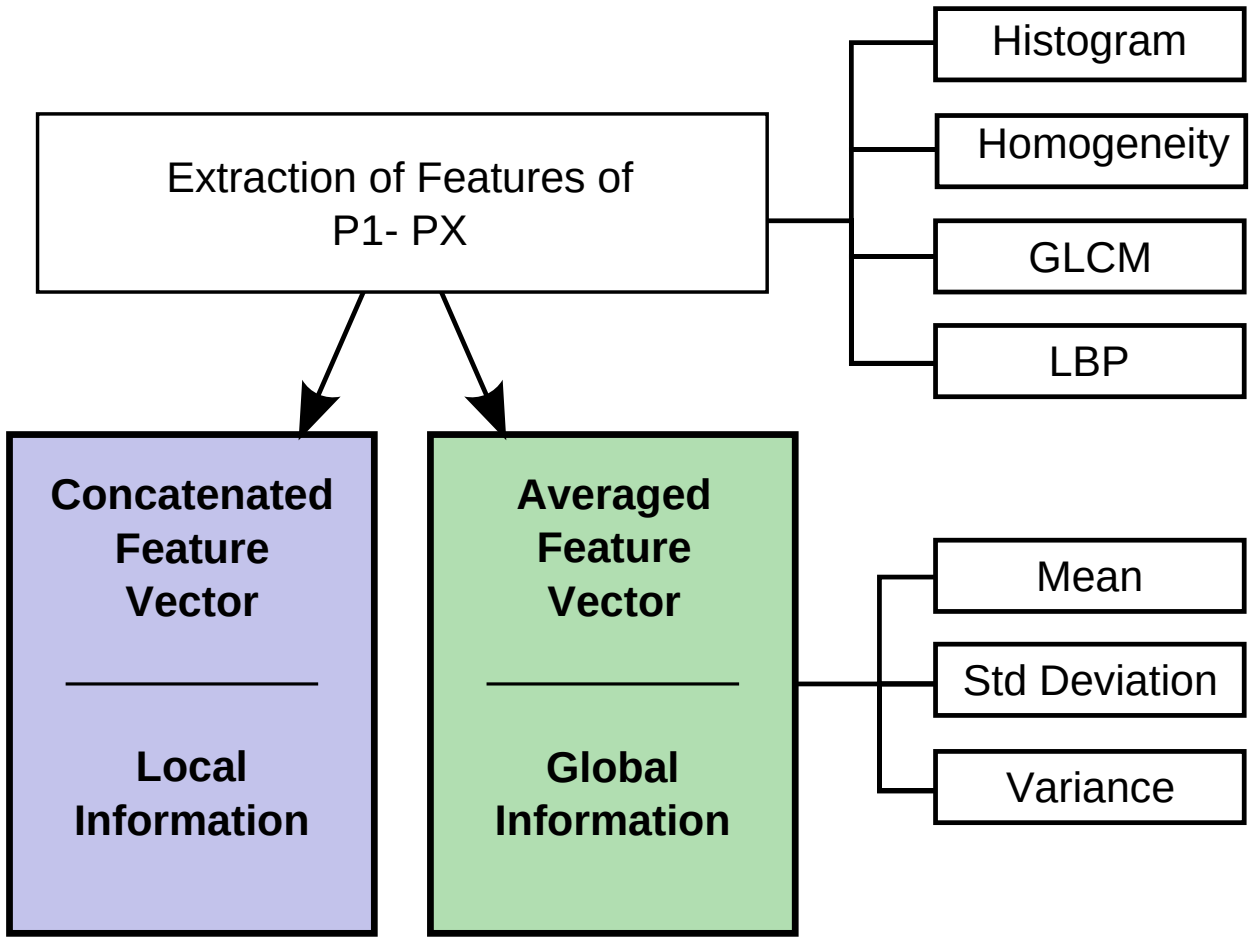


Local Binary Pattern

- pixel described by binary pattern
- binary patterns describe structures



Methods – Feature Vectors



Methods – Classifier & Evaluation

Classification algorithms

- Support Vector Machine (SVM)
- Random Forest (RF)

Evaluation methods

- 10-fold crossvalidation
- classification rate (Acc)
- average recall (Rec)

Software

- CONRAD → image analysis & feature extraction
- Weka → classification tasks

Experiments and Results

Experiments – Classification Method

Pathological vs. non-pathological

One patient – same location

- P1 vs. P1 – alveolar ridge
- P1 vs. P1 – buccal
- P2 vs. P2 – lingual

All subjects – all locations

Between subjects – same location

- P1 vs. P2 – alveolar ridge
- P1 vs. P2 & Ctrl – alveolar ridge

$\Rightarrow$ Acc / Rec: 95.8 % / 93.3 %

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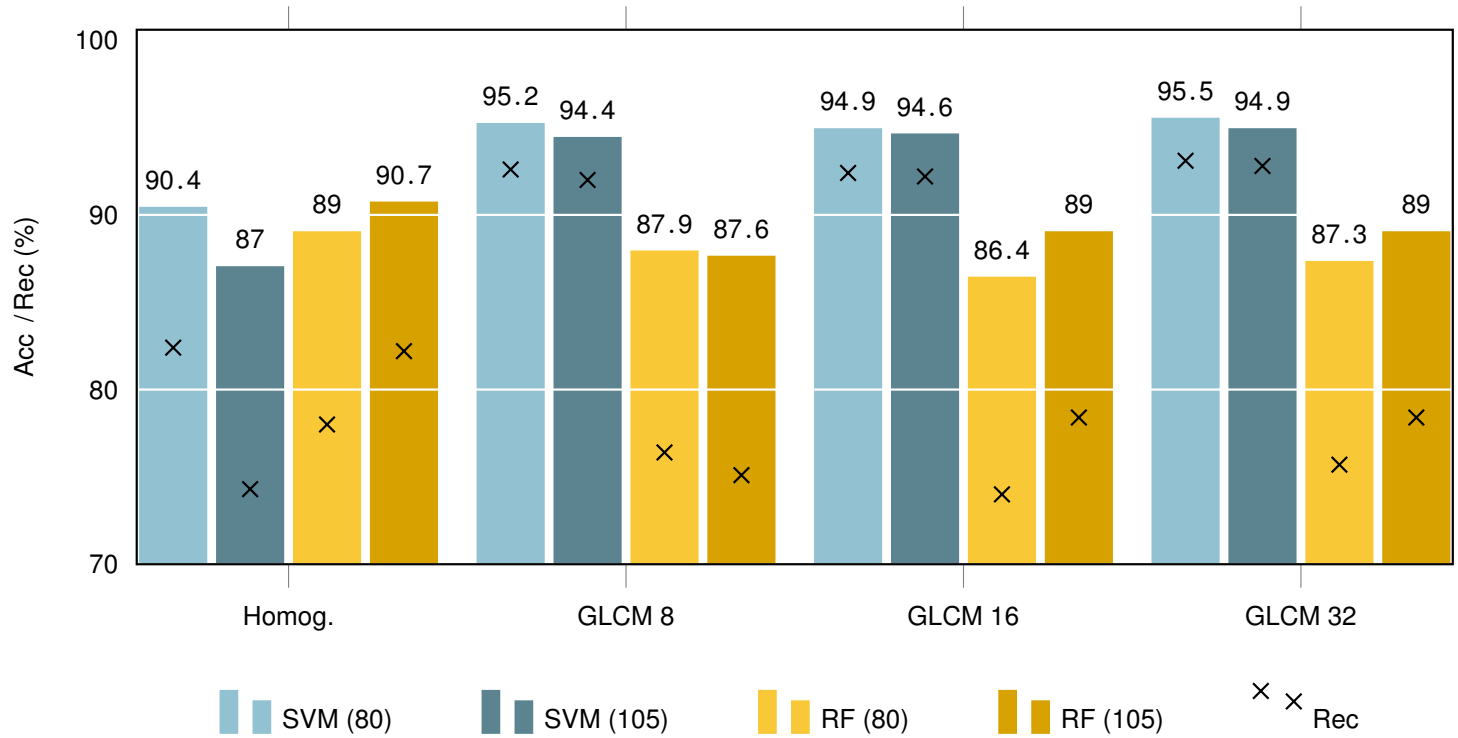
. . . best performing features?
. . . best performing feature vector?

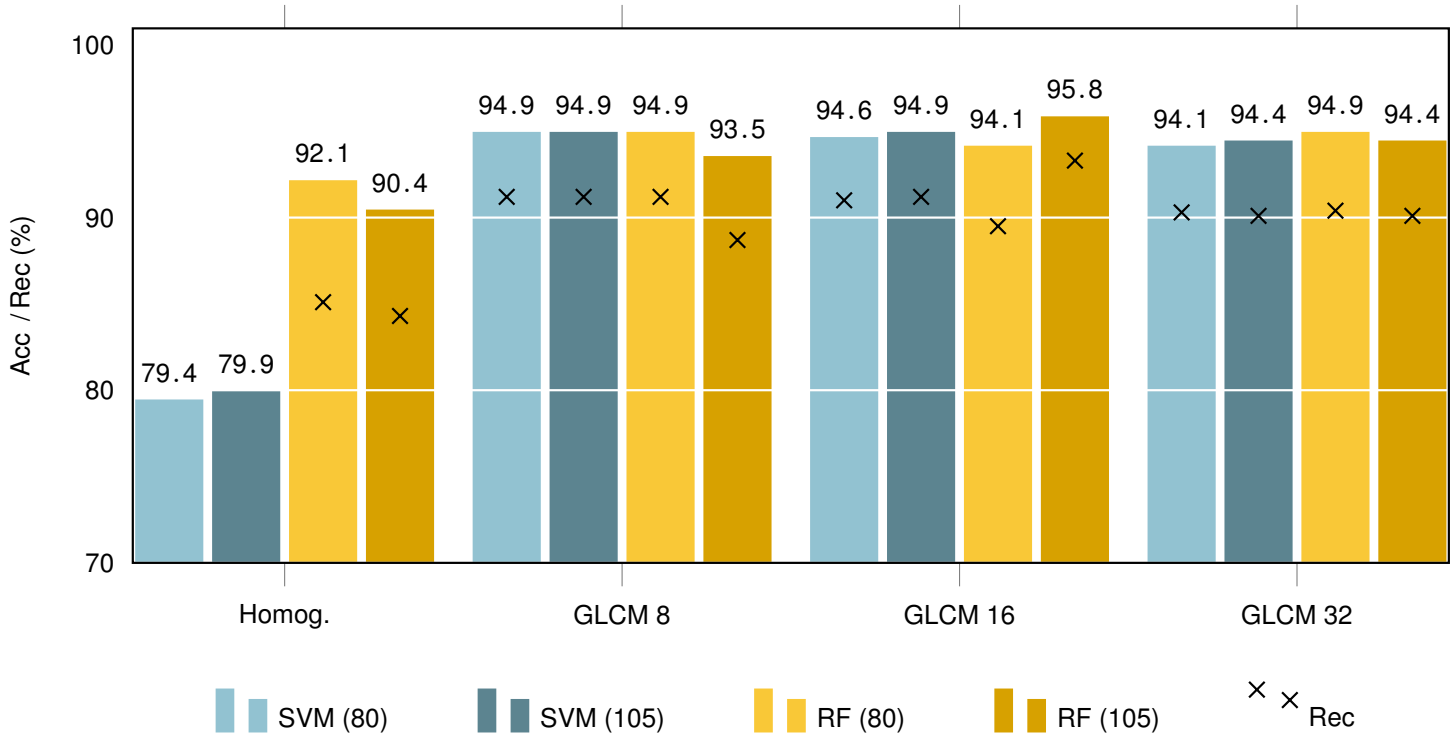
Results – All Subjects all Locations

Comparison of feature vector – concatenated feature vector results



Results – All Subjects all Locations

Comparison of feature vector – average feature vector results



Summary & Conclusion

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Objective: separate patholgical from healthy images

Three problems:

1. creation of image database ✓
2. annotation of images ✓
3. classification of images ✓ **95.8 % / 93.3 %**

Benefits:

- objective method to support the physician
- supports finding of the resection site
- time-saving and less harmful for the patient

$\Rightarrow$ monitor progress of cancer?

Thank you for your attention!

Questions?

Backup – Hardware

Cellvizio Gastro-flex UHD

Imaging rate (frames/s)	12.8
Probe diameter (mm)	2.7
Depth of imaging (µm)	55-65
Lateral resolution (µm)	1
Field of view (µm)	∅ 240
Image resolution (px)	576 × 576

The End