Real-Time Tracking Of Polyps For Computer-Assisted Colonoscopy

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Colorectal Cancer

**Developed countries**

- Incidence
- Mortality

**World incidence**

- Colorectum: 10%
- Lung: 14%
- Breast: 12%
- Prostate: 8%
- Stomach: 8%
- Bladder: 3%
- Kidney: 2%
- Melanoma of skin: 2%
- Non-Hodgkin lymphoma: 3%
- Other and unspecified: 38%
Gold standard examination

- Video endoscopy (colonoscopy)
Origins of Colorectal Cancer

The colorectal cancer is produced, in majority of cases, from degeneration of a polyp.
The colorectal cancer is produced, in majority of cases, from degeneration of a polyp.
Pit Pattern classification
Dr. ETO

Approach based on pattern recognition during the exam by the pratician
Gold standard examination

- Video endoscopy (colonoscopy)

**Advantages**
- Total physician control
- Real time detection
- Possibility of biopsys

**Drawbacks**
- Anaesthesia
- Hospitalisation
- Risks for the patient
- Random result of the exam
Problem

- Depends on the pratician
- Depends on the time of the exam
- Depends on the quality of colon preparation
- Up to 26% of polyps are missed during the exam (Ramsoekh et al., 2014)

Need to develop computer aided diagnosis system
Smart Video Colonoscopy

Colorectal Cancer Diagnosis

Detection

Software

Hardware

Caracterisation

Fluorescence

Multispectral Imaging
Smart Video Colonoscopy

Colorectal Cancer Diagnosis

Detection
  - Software
  - Hardware

Caracterisation
  - Fluorescence
  - Multispectral Imaging
### State of the art

<table>
<thead>
<tr>
<th>Authors</th>
<th>Main principle</th>
<th>Database</th>
<th>Classification performance</th>
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<tbody>
<tr>
<td>Bernal et al., 2012</td>
<td>Geometry</td>
<td>300 videocolonoscopy images containing a polyp <em>(freely available)</em></td>
<td>Sensitivity : 89% Specificity : 98%</td>
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Proposed method

Gray-level Image → Edge detection → Hough Transform → ROI extraction → Feature extraction (Texture)

Learning by boosting Training examples → Classifiers → Candidate Polyps

Database: 300 Positive examples, 1200 Negative ones
Data used

- 300 images with 15 different kinds of polyps (Bernal et al, 2012)
- 1200 images without polyps
ROI extraction

<table>
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<th>Method</th>
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<th>Specificity</th>
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<tr>
<td>Hough transform (Angermann et al, 2015)</td>
<td>94%</td>
<td>15%</td>
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<tr>
<td>Log-Gabor (Karagyris et al, 2009)</td>
<td>42%</td>
<td>89%</td>
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Texture Analysis

- Use of co-occurrence matrix
- Based only on grayscale images (ROI)

- Allow to extract parameters of the ROI

\[
\text{Contrast} = \sum_{k=0}^{N_g-1} k^2 \left\{ \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j) \right\} \text{ with } |i - j| = k
\]

1. Autocorrelation
2. Contrast
3. Correlation
4. Cluster Prominence
5. Cluster Shade

\ldots

23. Mean
24. Variance
25. Kurtosis
26. Skewness
Learning

- Classification with boosting
  - Adaboost
  - Chained Adaboost
Learning Results

Classification comparison

- Classification with LVQ
- Classification from PCA
- Adaboost
- Chained Adaboost
Learning Results

Classification comparison

- Classification with LVQ
- Classification from PCA
- Adaboost
- Chained Adaboost

80% of images used for learning
20% of images used for testing
Proposed method

Gray-level Image → Edge detection → Hough Transform → Texture Analysis

ROI extraction

Training examples → Classifiers

Learning

Candidates Polyps
Results

![Images of medical images]

A bar graph showing sensitivity and specificity for different approaches:

- Sensitivity: Bernal 88%, Our Approach 91%
- Specificity: Bernal 99%, Our Approach 95%
- FPR: Bernal 1%, Our Approach 5%
Results

- Towards real time processing

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<th>Programming method</th>
<th>Average computational time</th>
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<td>Matlab</td>
<td>2.5 seconds</td>
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<tr>
<td>OpenCV</td>
<td>37.5 milliseconds</td>
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- Allow to perform real-time tracking
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Conclusion

- Combination of 2 techniques (texture and geometry)
- Better results obtained and better detection of polyps
- Able to perform real time detection and tracking during the exam

- Need to reach medical performance (like 95% of sensitivity)
- Improve global and real time performance using hardware acceleration
Prospect

- HD imaging

- Caracterisation
  - Fluorescence
  - Multispectral
Towards Embedded CAD

A Smart Videocapsule

2D feature based detection+Boosting -Based Learning
Thank you for your attention

Join us at MICCAI polyp detection challenge
October, 9th in Munich
Website: http://polyp.grand-challenge.org/
Training data already available
Testing data: July, 24th