Real-Time Tracking Of Polyps For Computer-Assisted Colonoscopy

Q. ANGERMANN, A. HISTACE, O. ROMAIN, X. DRAY 24/06/2015

> HÔPITAUX DE PARIS





Gold standard examination

Video endoscopy (colonoscopy)





Origins of Colorectal Cancer

The colorectal cancer is produced, in majority of cases, from degeneration of a polyp.



e)

d)

Origins of Colorectal Cancer

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e)

Hyperplastic Preneoplastic Adenomatous

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Pit Pattern classification Dr. ETO

Approach based on pattern recognition during the exam by the pratician



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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





State of the art

Authors	Main principle	Database	Classification performance
Bernal et al., 2012	Geometry	300 videocolonoscopy images containing a polyp (freely available)	Sensitivity:89% Specificity:98%
Figueiredo et al, 2011	Geometry	17 wireless capsule endoscopy (WCE) videos of 100 images each, containing examples of polypes, flat lesions, diverticula, bubbles and trash liquids	No indicated performance
Karkargyris et al., 2009	Geometry	50 WCE images (10 polyps and 40 non-polyps)	Sensitivity : 100% Specificity : 67.5%
Kodogiannis et al, 2007	Texture	140 WCE images (70 polyps and 70 non-polyps)	Sensitivity : 97% Specificity : 94%

Proposed method



Data used

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











e)



f)

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ROI extraction



Method	Sensitivity	Specificity
Hough transform (Angermann et al, 2015)	9 4%	15%
Log-Gabor (Karagyris et al, 2009)	42%	89 %
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Texture Analysis



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



Allow to extract parameters of the ROI

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

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

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

Learning



Classification with boosting

- Adaboost
- Chained Adaboost



Learning Results



Classification comparison

- Chained Adaboost

Learning Results



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

Classification comparison



Proposed method

Results













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Results

Towards real time processing

Programming method	Average computational time
Matlab	2.5 seconds
OpenCV	37.5 milliseconds

Allow to perform real-time tracking



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Angermann et al, 2015	Geometry and texture	300 videocolonoscopy images containing a polyp	Sensitivity : 91% Specificity : 95%

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



SD Image (30% of original size)



HD Image (30% of original size)



- Fluorescence
- Multispectral



Towards Embedded CAD

A Smart Videocapsule





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

