

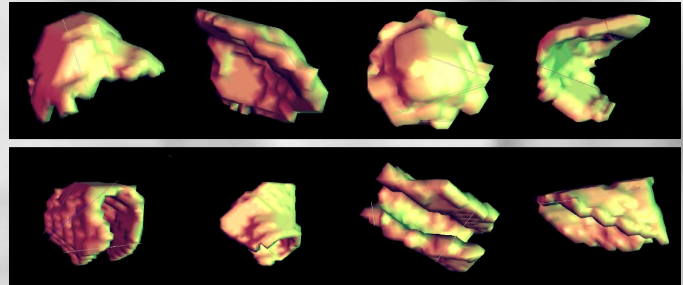
Shape Classification of Colorectal Polyps at CT Colonography using Support Vector Machines

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Introduction

- Computer Aided Diagnosis (CAD) at Computed Tomography Colonography (CTC) help detect colorectal polyps before they become fatal.
- Aim of CAD-CTC: Classification of highly complex colorectal shapes with high sensitivity and low False Positives (FP) rate.



Typical Colorectal Polyps (Top Row) & Non-polyps (Row Below)

Features for Shape Classification

- Features obtained from *Shape Distribution Function*^[1] (SDF) and *Gaussian Distribution of Surface Voxels*^[2] of the candidate surfaces.
- Feature set per candidate surface = $\{d_G, f_{dB}\}$
- d_G = sum of weighted Gaussian distances of all surface voxels normalized by the surface number
- f_{dB} = -9dB attenuation frequency of the power spectral density of the SDF

Feature-space & SVM Classifier

- Feature-space $\{d_G, f_{dB}\}$ is sparse with training set $\mathcal{X} = \mathcal{X}_p$ comprising of Phantom Polyps $\geq 5\text{mm}$
- Introduce artificial populations $\mathcal{X}_1, \mathcal{X}_2,$ and \mathcal{X}_3
- There exists no linear classification boundary between polyps and non-polyps in feature-space
- SVM classifier with polynomial kernel of degree k introduces non-linear decision boundaries

Results

		<i>SVM1</i>	<i>SVM2</i>	<i>SVM3</i>	<i>SVM4</i>
k		3	3	5	5
\mathcal{X}		\mathcal{X}_p	$\mathcal{X}_{SVM2} = \mathcal{X}_p + \mathcal{X}_1$	$\mathcal{X}_{SVM3} = \mathcal{X}_{SVM2} + \mathcal{X}_2$	$\mathcal{X}_{SVM4} = \mathcal{X}_{SVM3} + \mathcal{X}_3$
<i>Sensitivity</i> (%)	≥ 10 mm	90	90	90	90
	[5,10) mm	72	78	75	81
	< 5mm	60	63	62	60
Total Sensitivity ≥ 5 mm (%)		76	81	79	83
FP per dataset		2.54	5.78	4.42	6.45

Conclusions

- SVM-based colorectal shape classification achieves very high sensitivity for polyps > 5mm.
- Expansion of feature-set envisaged for further work for increasing sensitivity of flat and small polyps, and masses.

References

- Chowdhury, T. A., Ghita O., Whelan, P. F., Miranda, A. A., "A Note on Feature Selection for Polyp Detection in CT Colonography", *ICPR* (2006)
- Miranda, A. A., Chowdhury, T. A., Ghita, O., Whelan P.F., "Shape Filtering for False Positive Reduction at Computed Tomography Colonography", *MICCAI* (2006)