Texture descriptor approaches to segmentation in medical images

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Introduction

Medical image analysis has become an important tool for improving medical diagnosis and planning treatments. It may help towards the construction of reliable computer-aided diagnosis systems. Specifically, deformable models such as Active Shape Models (ASM) and Level Set methods have emerged as a general framework for image segmentation; such methods are mainly based on gradient information and provide satisfactory results.

We study the influence of texture on deformable models segmentation and propose the use of Hermite features that are incorporated into ASMs and level set model. The proposals are also compared against other texture descriptors such as different local binary patterns, Image derivatives, and Hounsfield low attenuation values.

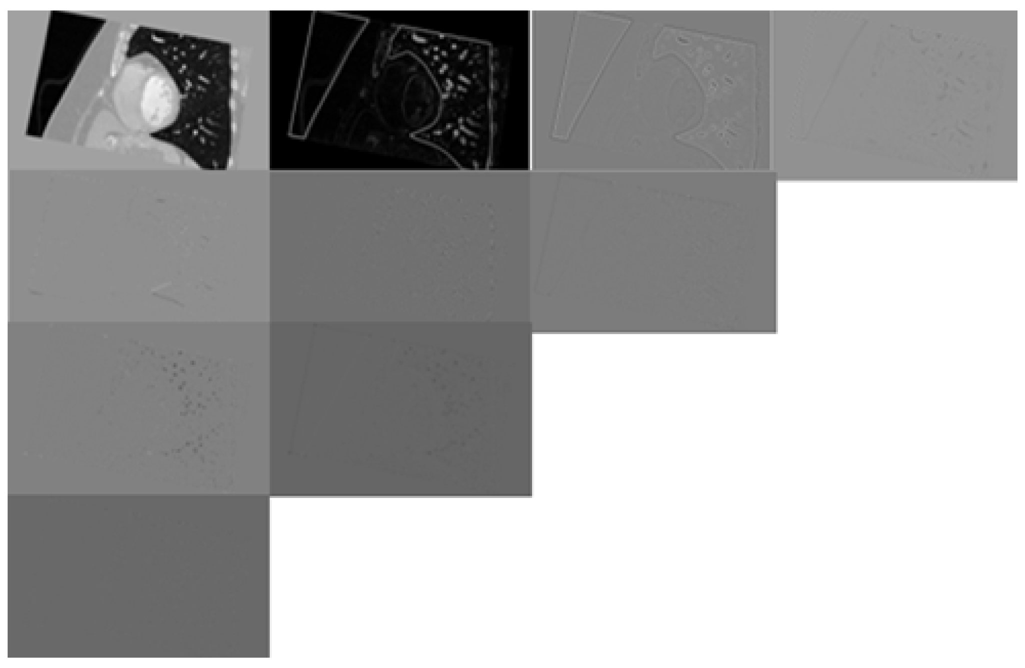
Texture Descriptors

Hermite Filters:

$$L_{m,n-m}(x_0,y_0)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}L(x,y)D_{m,n-m}(x_0-x,y_0-y)dxdy \quad (1)$$

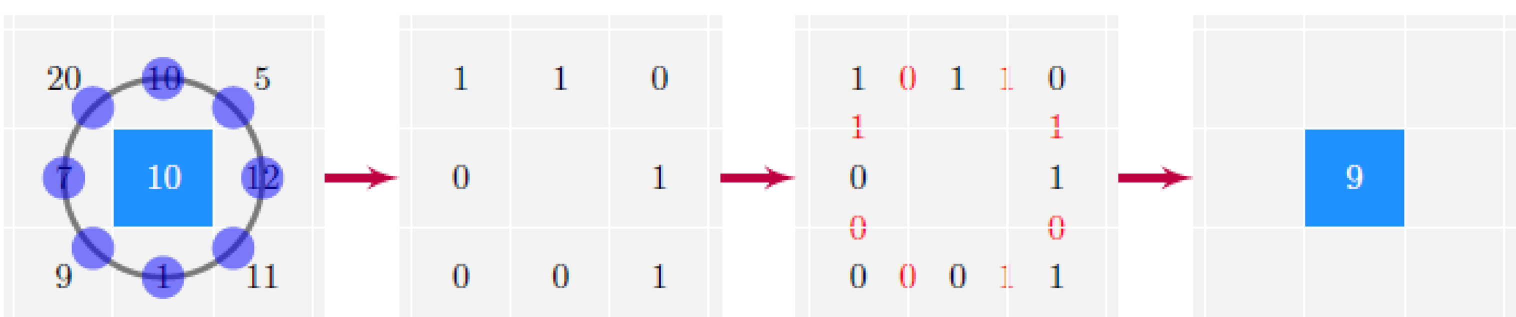
where m and $(n-m)$ denote the analysis order in X and Y respectively with $n=0,\ldots,\infty$ and $m=0,\ldots,n$. The steered Hermite coefficients:

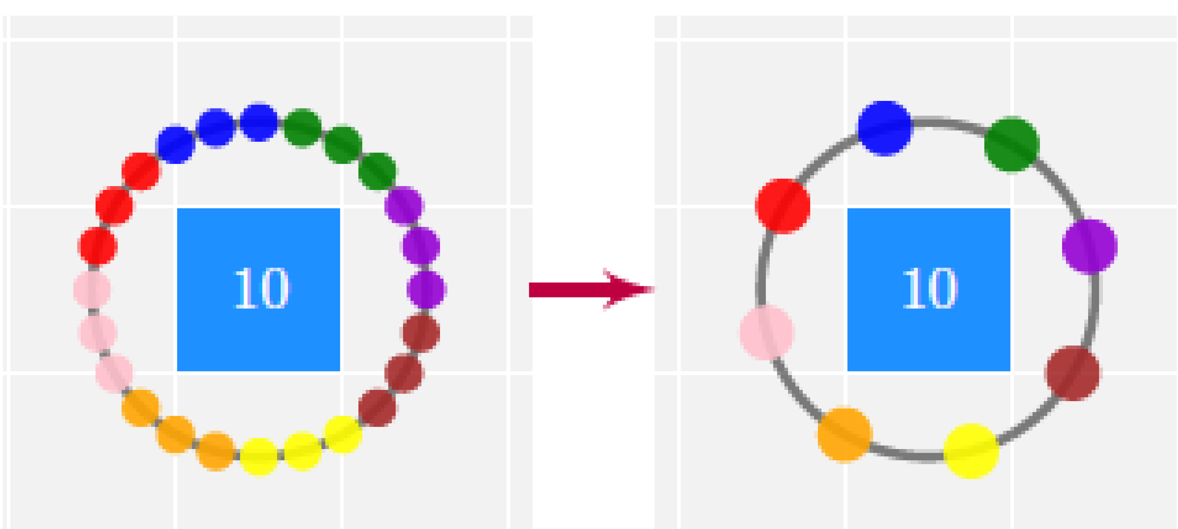
$$l_{m,n-m,\theta}(x_0,y_0)=\sum_{k=0}^{n}L_{k,n-k}(x_0,y_0)g_{k,n-k}(\theta) \quad (2)$$



- *Hounsfield information.*
- *Different types of Local Binary Patterns* (LBPU) (OJALA2002). LBP Uniform can be obtained as:

$$LBPU_{P,R}(g_c)=\begin{cases}\sum_{p=0}^{P-1}s(g_p-g_c) & \text{if } U(g_c)\le 2\\ P+1 & \text{otherwise}\end{cases} \quad (3)$$





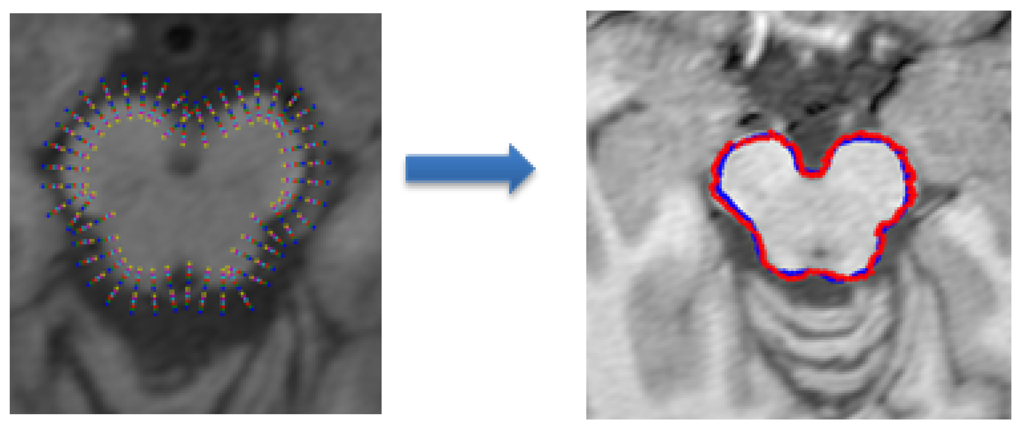
Methods and Results

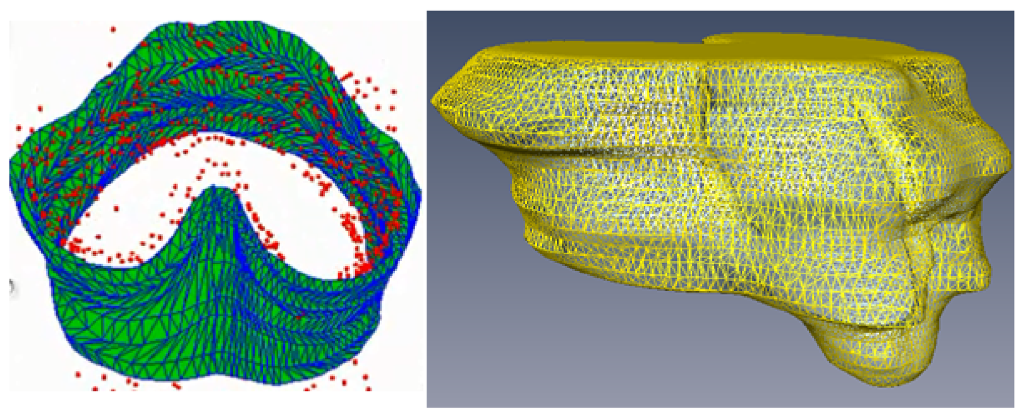
Active Shape Models:

Active Shape Models (COOTES1995) can deform to some extent within a certain variability so that they resemble the real organ. ASMs need a training set of aligned shapes of an object using pose transformations (rotation, translation, and scaling). The shapes can be modeled as follows:

$$\hat{X}=\bar{X}+P\boldsymbol{b} \quad (4)$$

where $\bar{X}=\frac{1}{s}\sum_{i=0}^{s-1}x_i$ is the mean shape, P is the matrix of the t first principal components, b is a vector of weights and $\hat{X}$ is the estimated shape. It is possible to generate new shapes by modifying b to obtain similar shapes of the object to be recognized.

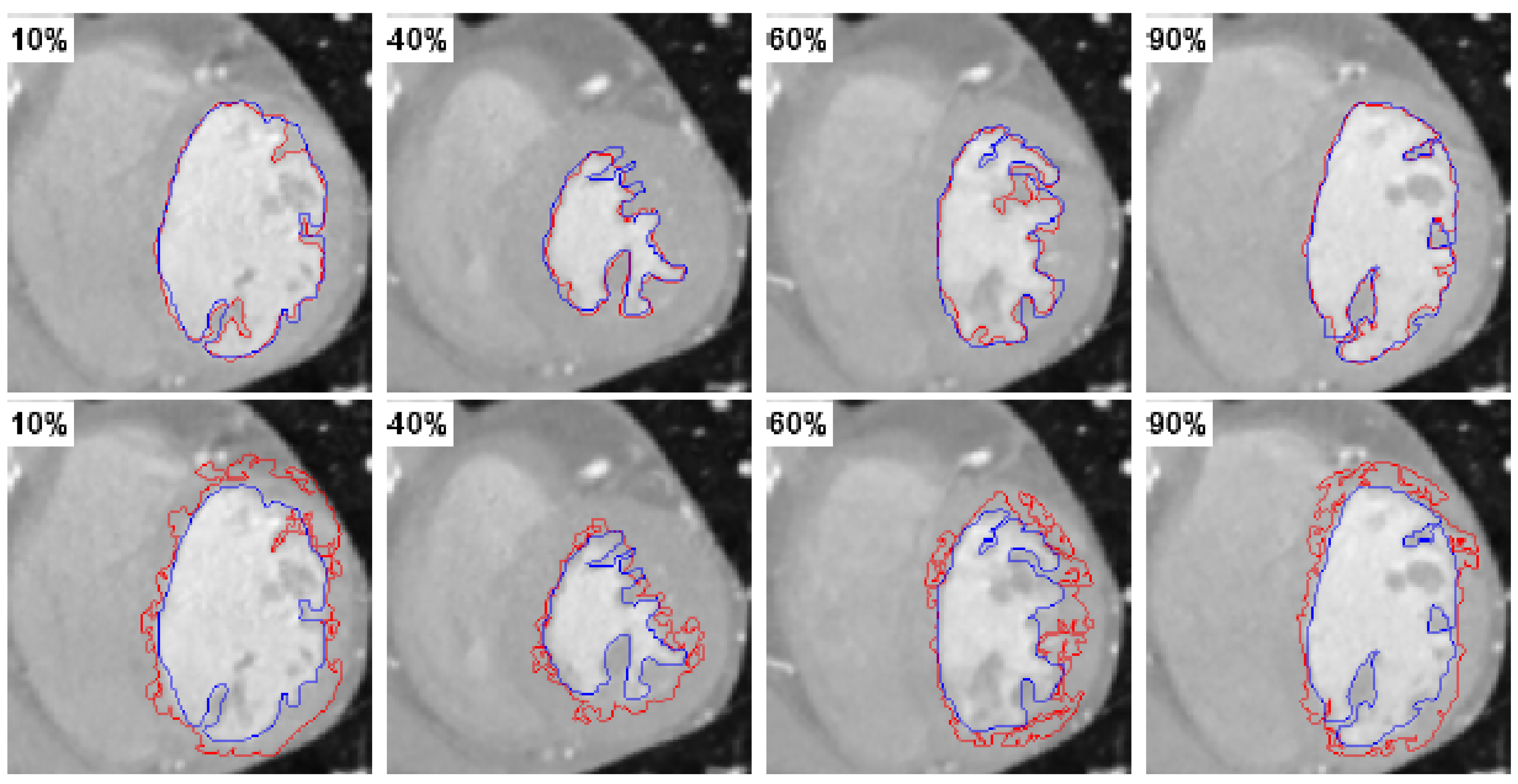




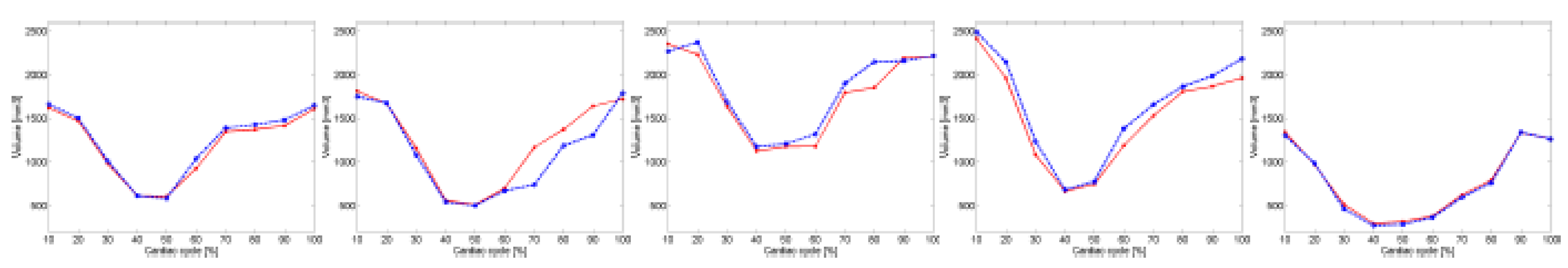
Level Sets - Chan Vesse:

The level set method is an evolving curve $C=(x,y)\in\Omega:\phi(x,y)=0$, assuming that ϕ has opposite signs on each side of C. The vector value Chan-Vese (CHANVESE2000) algorithm can be achieved using complementary information of the same image, such as gradients or texture. The definition :

$$F\left(\vec{c^+},\vec{c^-},\phi\right)=\mu\int_\Omega\delta(\phi(x,y))\left|\nabla\phi(x,y)\right|dxdy+\frac{1}{N}\int_\Omega\sum_{i=1}^{N}\lambda_i^+\left|u_{0,i}(x,y)-c_i^+\right|^2 \ldots$$
$$+\frac{1}{N}\int_\Omega\sum_{i=1}^{N}\lambda_i^-\left|u_{0,i}(x,y)-c_i^-\right|^2\left[1-H(\phi(x,y))\right]dxdy \quad (5)$$



Hermite9 + GRAY (**first row**), and LBPU + GRAY (**second row**). The numbers on the images indicate the percentage of the cardiac cycle.



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