12th Summer School on SCIENTIFIC VISUALIZATION

Tutorial: matplotlib

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Introduction

Dynamic phase-contrast (PC) MRI is being used for quantitation of pulsatile motion and flow in many clinical applications.

In order to achieve accurate and consistent flow measurements, a reliable automated method for segmentation of the lumen region is needed.

The difference in temporal information from pixels located in the lumen and in the surrounding tissue is used as a segmentation Criterion. (Alperin and Lee 2004)

Algorithm description

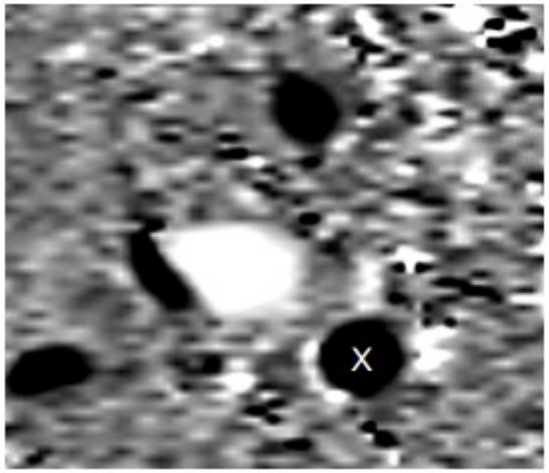
The automated procedure includes four steps:

1) selecting a reference velocity waveform
2) generating CC map
3) computing optimal CC threshold
4) tracking the edge of the segmented region

Algorithm description

1) selecting a reference velocity waveform

Phase contrast image with location of the reference waveform



2) generating CC map

The CC coefficient is used to quantify similarity between the reference waveform and waveforms obtained from other pixels in the image

$$P_{XY} = \frac{\sum_{K=0}^{N}(R_K - \bar{R})(V_{XYK} - \bar{V}_{XY})}{\sqrt{\sum_{K=1}^{N}(R_K - \bar{R})^2 \sum_{K=1}^{N}(V_{XYK} - \bar{V}_{XY})^2}}$$

Algorithm description

3) computing optimal CC threshold

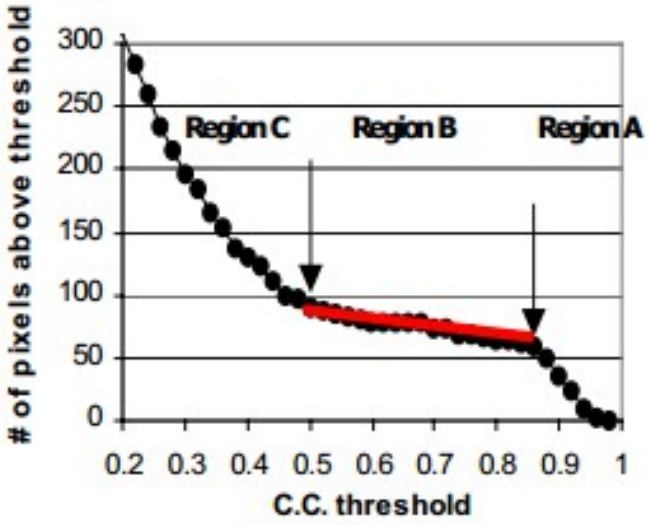
A histogram of number of pixels with CC value

above the threshold for different threshold values is

generated.

The optimal threshold CC value is selected at the point

of transition from region C to region B

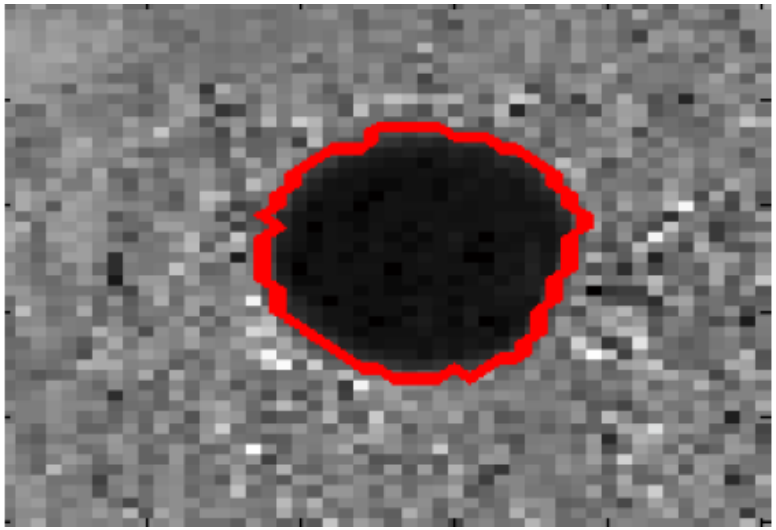


Algorithm description

- 4) tracking the edge of the segmented region

Region-growing algorithm is applied in order to obtain a segmentated image based on similarity threshold value criterion.

if C(xy)>threshold OK



Implementation

- Use IPython for interactive processing analysis
- Load data file into numpy array (`loadtxt` function)
- Visualize temporal data (`imshow` function) and choose time reference image.
- Apply a rectangular selection to select a sub-region of interest. (`RectangleSelector`)
- Choose a pixel inside the lumen area (`picker event`)
- Plot the waveform of selected pixel and of the surrounding ones (using `subplot`)
- Compute CC matrix and plot CC histogram (`bar`)
- Track the edge of the segmented region and show it (`imshow`)
- Plot the 3d-surface and animate it through time (`plot_surface` and `animation`)
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