

# RV features for DENSEanalysis

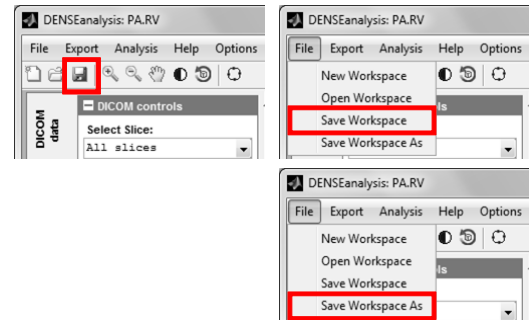
2013.06 | Andrew D. Gilliam, Ph.D.

## Introduction

Welcome to the enhanced DENSEanalysis software package, now with right ventricular (RV) analysis! The DENSE analysis workflow remains the same: open the software, load a workspace, add images, delineate anatomy, and analyze tissue motion. This document outlines the latest software enhancements geared toward RV analysis. This is a supplement to the original manual; new users should refer to the original manual for general software guidance.

## Workspace “Save” vs. “Save As”

- **Save Workspace** will save the changes to the currently open workspace.
- **Save Workspace As** allows the user to save the current workspace to a new file.

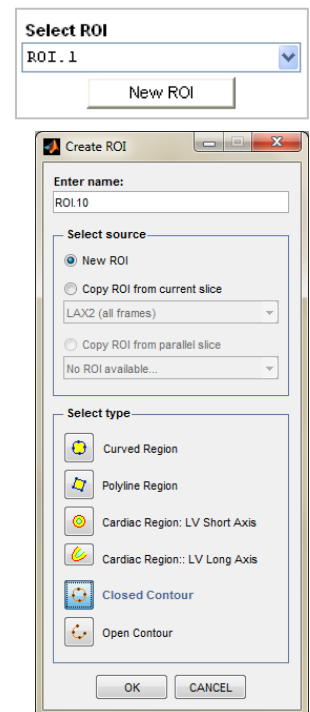


## Contour delineation

Users now have access to *contours* for RV analysis (in addition to the *regions* for LV and other anatomical analysis).

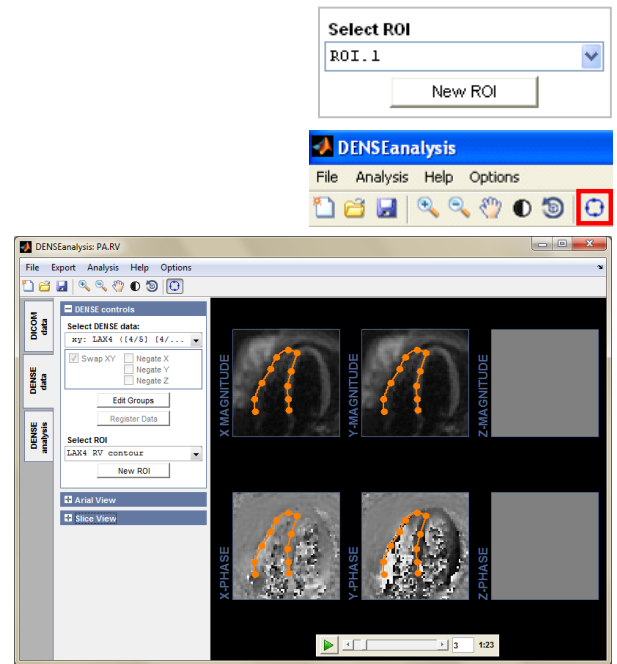
### Creating an empty contour

- Select the **New ROI** from the DICOM or DENSE controls. This will access the **Create ROI** tool.
- Provide the region with a descriptive **Name**
- Select **New ROI**
- Select the type of ROI you wish to define from the available options. New options are **Closed Contour** and **Open Contour**. Note this type cannot be changed at a later time
- Select **OK**



## Editing contours

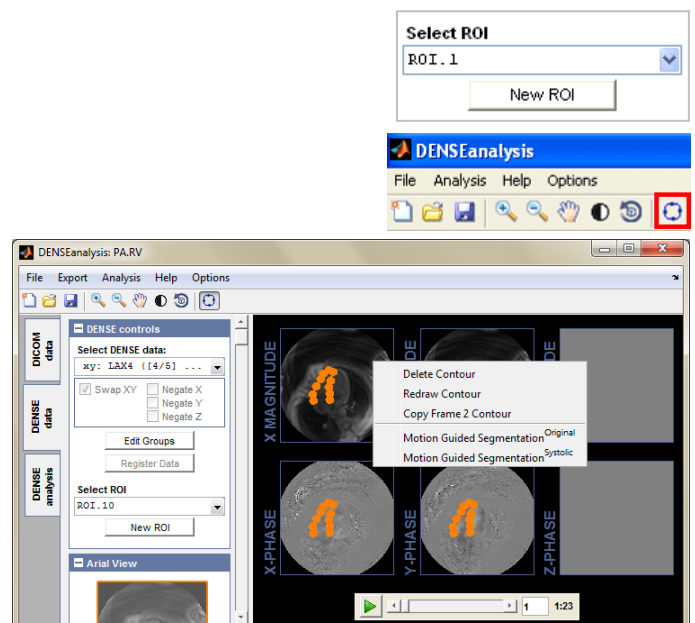
- Select the contour you wish to edit from the **Select ROI** dropdown box
- Select the Edit ROI tool
- The contour on any frame may be manipulated a number of different ways:
  - Drag any control point to a new location  
left click and hold any control point
  - Drag the entire contour to a new location  
left click and hold any segment
  - Add a point  
right click any segment and select **Add Point**
  - Delete a point  
right click any control point and select **Delete Point**
  - Smooth/Corner point  
right click any control point and select **Smooth Point** or **Corner Point**
  - Curved/Straight segment  
right click any segment and select **Curved Segment** or **Straight Segment**

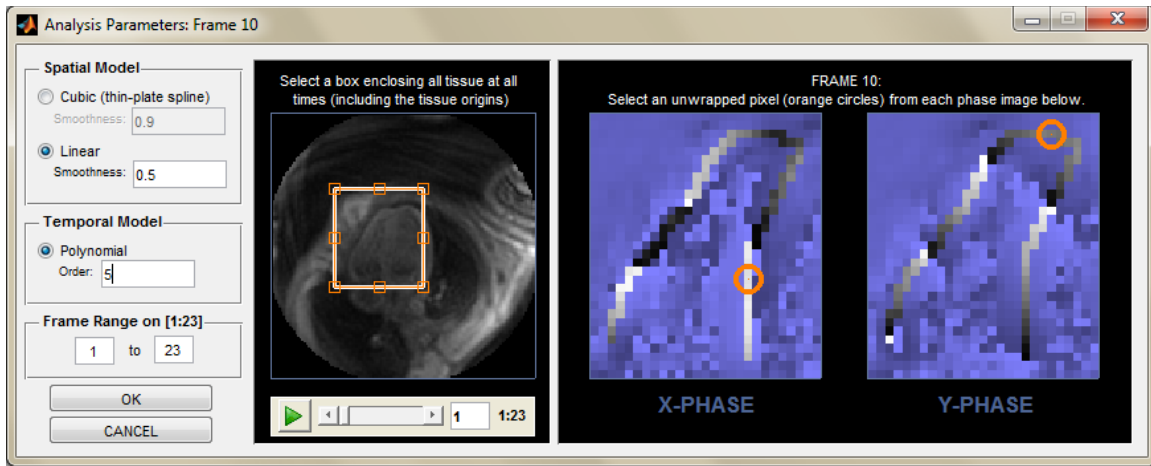


## Motion guided segmentation

Rather than manually define the region of interest on every frame of a sequence, you can attempt Motion Guided Segmentation (MGS). The enhanced DENSEanalysis software features MGS from the systolic frame, more appropriate (and more successful) for contour based anatomy. As always, remember to closely examine MGS contours for errors!

- Select the region you wish to edit from the **Select ROI** dropdown box (DENSE tab only)
- Select the **Edit ROI** tool
- Two MGS options are available (right-click in any DENSE display axes and select):
  - Original: MGS as defined in the original DENSEanalysis software.
  - **NEW** Systolic: Navigate to the systolic frame, define your contour (or region), and select this option

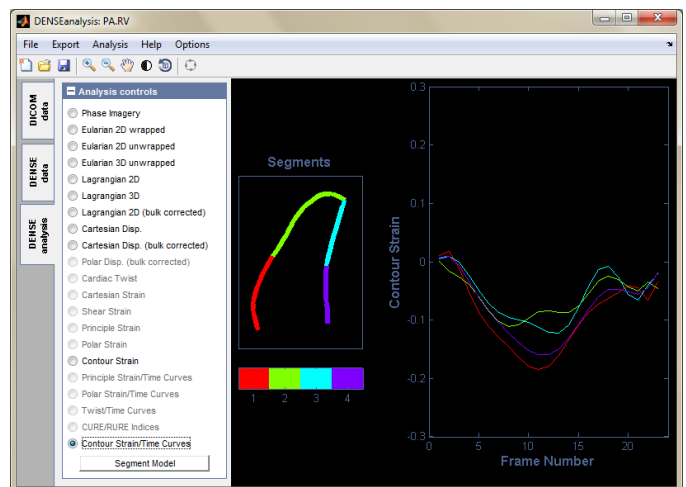
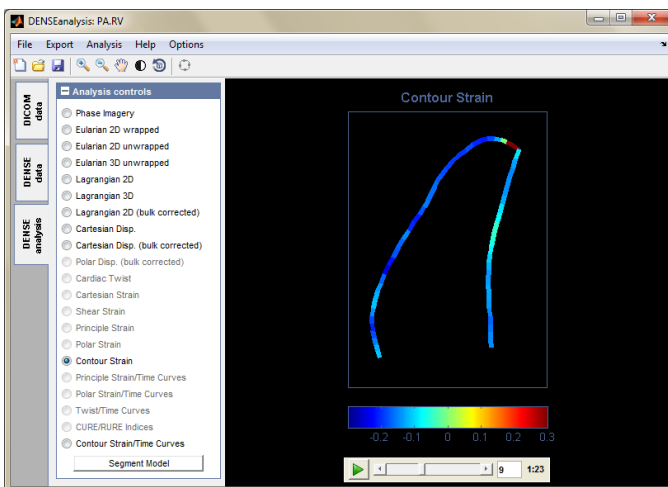




- Define the Spatial Model: we spatially smooth the displacement data using either a cubic (thin-plate spline) or linear model.
  - Select Cubic or Linear
  - Enter a smoothness parameter on the range (0,1], where 1 represents maximal spatial smoothing.
- Define the Temporal Model: we temporally smooth the displacement data using a polynomial of user specified order.
  - Enter an integer order for the temporal model. A lower order will produce a smoother solution.
- Define the tissue extents:
  - Manipulate the box to enclose all tissue of interest at all times.
- Define unwrapped pixels: to correct phase wrapping artifacts, we must identify some unwrapped pixels within each phase image.
  - Drag the Orange circles to identify pixels that are not wrapped.
  - Right click within the axes to add more unwrapping points if necessary
- Select **OK**

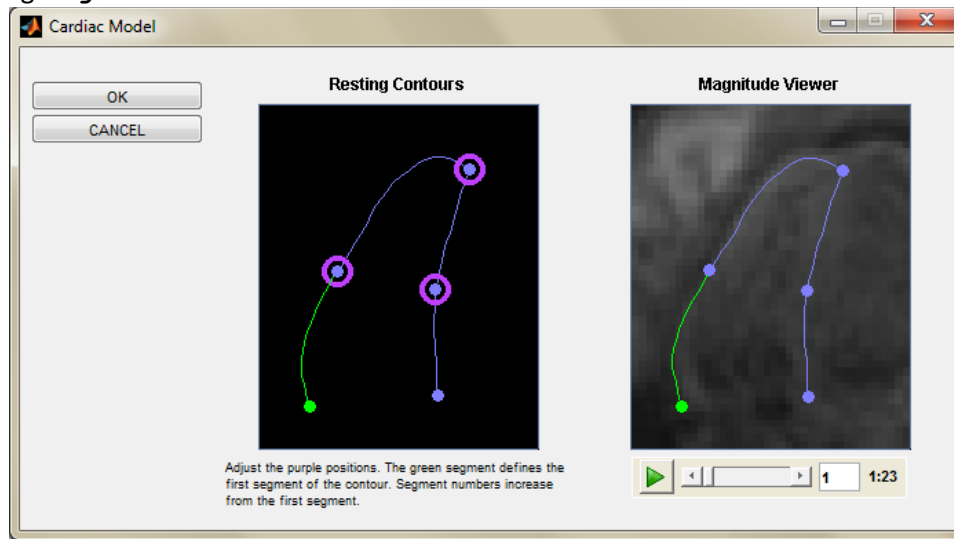
## Analysis

New analyses are available for contours, as a traditional 2D strain tensor cannot be calculated for a 1D anatomical structure. Instead, we calculate contour strain: contours are discretized into multiple short segments, and *contour strain* is calculated via the change in length of each segment.



## Contour segments

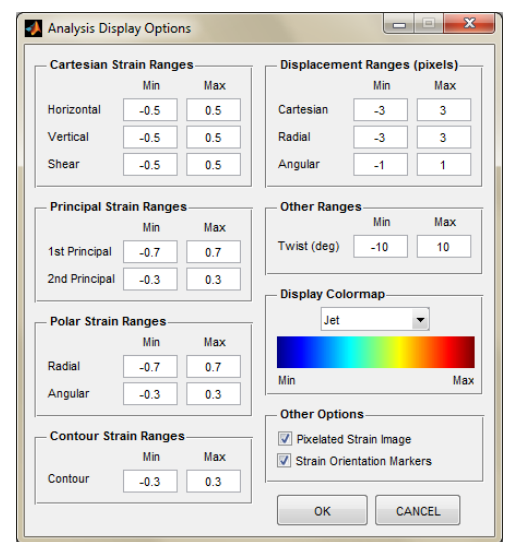
Contour strain/time curves require additional input from the user. Contours may be broken into smaller segments through the segment model. Access the cardiac model tool from the Analysis tab by entering any strain visualization option, or by selecting **Segment Model**.



- Drag the purple circles on the **Resting Contours** to define the first cardiac segment. Use the **Magnitude Viewer** to check your points throughout the image sequence.
  - Points may be deleted  
Right click any purple point and select **Delete Point**
  - Points may be added  
Right click the resting contour and select **Add Point**
  - Segment order may be reversed  
Right click the resting contour and select **Reverse Direction**
- Select **OK**

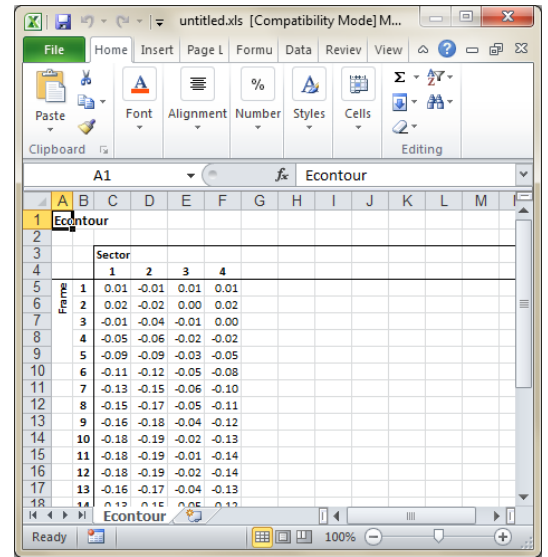
## Contour Strain Range

Users may edit the contour strain range from the **Display Options**, under Contour Strain Ranges.



## Export

All export options are available for contour-based analyses: image, video, mat-file, and excel spreadsheet. Excel export lists contour strain for each user-defined contour segment for each frame of the DENSE sequence.



The screenshot shows an Excel spreadsheet titled "untitled.xls [Compatibility Mode] M...". The spreadsheet is organized into a table with columns for "Frame" and "Sector" (1, 2, 3, 4). The data represents contour strain values for each frame and sector combination.

		Sector			
		1	2	3	4
1	1	0.01	-0.01	0.01	0.01
2	2	0.02	-0.02	0.00	0.02
3	3	-0.01	-0.04	-0.01	0.00
4	4	-0.05	-0.06	-0.02	-0.02
5	5	-0.09	-0.09	-0.03	-0.05
6	6	-0.11	-0.12	-0.05	-0.08
7	7	-0.13	-0.15	-0.06	-0.10
8	8	-0.15	-0.17	-0.05	-0.11
9	9	-0.16	-0.18	-0.04	-0.12
10	10	-0.18	-0.19	-0.02	-0.13
11	11	-0.18	-0.19	-0.01	-0.14
12	12	-0.18	-0.19	-0.02	-0.14
13	13	-0.16	-0.17	-0.04	-0.13
14	14	-0.15	-0.16	-0.05	-0.12
15	15	-0.15	-0.16	-0.05	-0.12
16	16	-0.15	-0.16	-0.05	-0.12
17	17	-0.15	-0.16	-0.05	-0.12
18	18	-0.15	-0.16	-0.05	-0.12