SDMVIS Manual

Max Hermann[*]

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SDMVIS is a visual analysis software to explore statistical deformation models (SDM) of volumetric organisms. Interactive exploration is facilitated by integrating two kinds of expert knowledge: taxonomical or other classifications of the datasets as well as knowledge about relevant structures and parts of the shape. Given a classification into two groups the corresponding dominant shape differences between the groups (a so-called trait) can be computed and visualized in a dynamic fashion. Based on a selected region of interest (ROI) a new weighted SDM can be derived whose principal modes of shape variability are again accessible in a dynamic visualization.

Contents
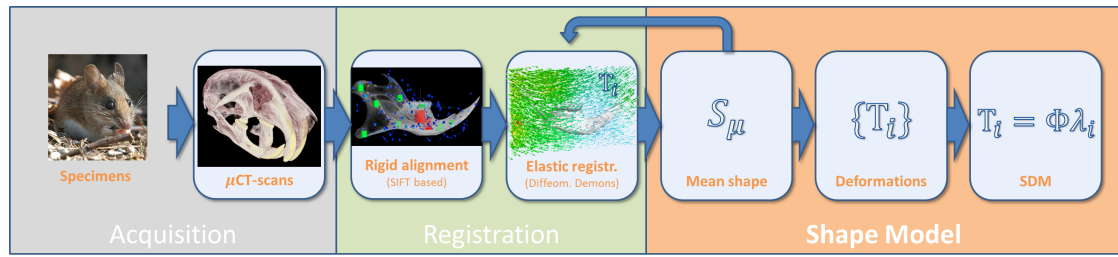
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[*]`hermann@cs.uni-bonn.de`

Figure 1: Processing pipeline from acquisition to shape model. SDMVIS is a tool to explore a given shape model and derive new (sub-)models from it. It also provides visualizations to assess registration quality.
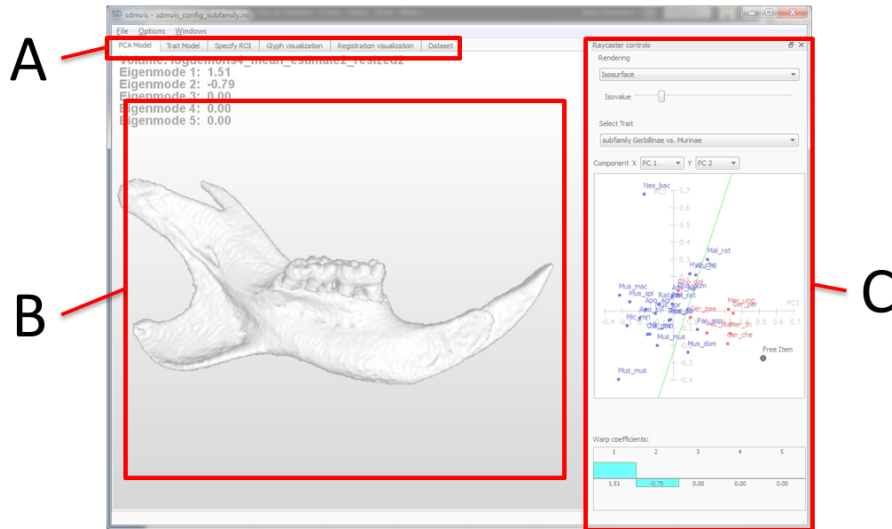

Figure 2: SDMVIS user inteface overview: **(A)** Tab bar with available visual analysis tasks which can be activated by clicking on the corresponding tab entry. **(B)** Visualization of the active task. **(C)** Control widget with options and controls for the active task.

1 Overview

SDMVIS assumes as input an already registered subset of your data, see Figure 1. For now an initial shape model has also to be provided (which will hopefully soon be obsolete). The user interface is designed task-oriented with respect to the following visual analysis tasks:

- Investigate PCA model [PCA Model]

- Investigate and/or compute trait model [Trait Model]

- Spefiy a region of interest and compute a new PCA model [Specify ROI]

- Assess shape variability of an eigenwarp or trait in a static visualization [Glyph visualization]

- Assess registration quality visually [Registration visualization]

- Prepare results in a table e.g. for exporting to Excel [Dataset]

In braces the shorthand term for the specific task respectively mode in SDMVIS is given. Only one mode can be active at a given time. The user interface provides a tab-bar to switch between the different modes. Each mode has its own controls and visualization as indicated in Figure 1.

Item	Description	Storage
list of names	names of the analysed datasets	in configuration file
mean estimate	estimate of a mean shape or a reference dataset	.MHD volume
warpfields	warpfields describe the deformation of the mean to a specific dataset	single huge .MAT matrix
eigenwarps	high-dimensional PCA eigenvectors	single huge .MAT matrix
PCA model	low-dimensional scatter matrix, eigenvectors, eigenvalues	in configuration file
traits and traitwarps	a single trait is described in an custom configuration file	custom .TWF file
(optional)	low-dimensional trait vector	small .MAT vector
	high-dimensional traitwarp	.MHD volume
ROI *(optional)*	user selected region of interest (new specific analysis)	in configuration file

Table 1: Items of a specific analysis

2 Data Management

The data management concept is not finished yet. We currently rely on configuration files which represent a specific analysis session in SDMVIS, see also Table 2. To discern different analyses an identifying keyword has to be specified by the user for each analysis.

The current data management approach can be summarized as follows:

- Data files follow a specific naming convention.

- Relevant files of a *specific analysis* are stored in a single directory.

- A single *configuration file* holds the needed filenames and additional parameters of a specific analysis (see Table 2).

- SDMVIS *automatically* creates configuration files and the needed directory structure for trait and/or ROI analyses.

- For now, each analysis is identified by a user specified line of text or a *keyword*.

By performing a ROI selection a new SDM is derived for which a new analysis with SDMVIS has to be performed. Thus SDMVIS automatically creates a new configuration file which is loaded immediately after creation. All relevant data files are stored in a sub-directory of the original analysis configuration file. The new sub-directory is named according to the new keyword specified for the ROI analysis.

Computing a new trait does not change the current SDM and the current configuration file is simply updated. The newly created trait files are stored in a sub-directory named according to the keyword of the current analysis.

The datasets and mean estimate as well as all eigen- and traitwarps are stored as Metaimage MHD files. These can be loaded and displayed by most Visualization Software Packages like for example ParaView.

3 Visualizations

3.1 PCA Scatterplots and Diagrams
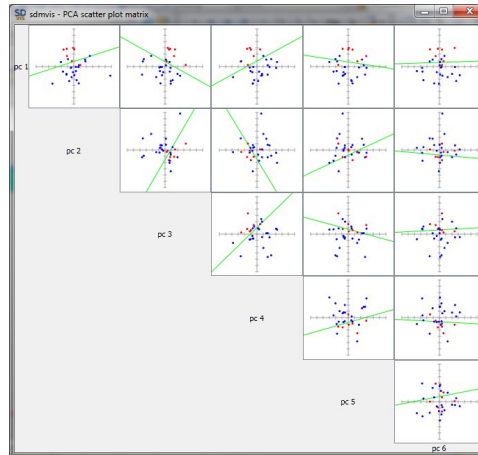
- groups are colored blue and red (if classification is available)
- trait separating hyperplane is shown in green (if available)
- in [Trait Model] view:
    - single items may be selected by clicking on them
    - right click in diagram area opens context menu with further options
    - "Free Item" mode provides dynamic visualization

## 3.2 Dynamic Visualization of Deformation Fields

[PCA Model] [Trait Model]
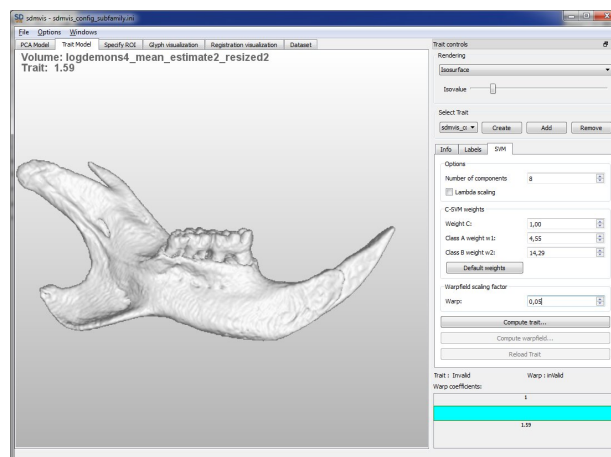
- warp coefficient(s) can be adjusted by manipulating the bar plot to the lower right of the control widget
- in [PCA Model] one can alternatively use the "Free Item" mode of the PCA plot (right click on the PCA diagram to activate the context menu from which the Free Item mode can be set)
- in [Trait Model] the warp scaling parameter has to be adjusted manually

## 3.3 Static Glyph Visualization of Deformation Fields

[Glyph visualization]
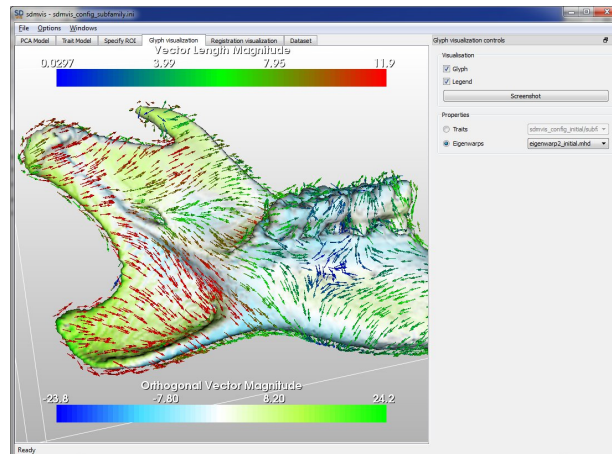
- first, select in the control widget which trait or eigenwarp you want to be visualized
- color coding of the surface indicates growth/shrinking of the shape
- glyph vectors represent tangential shift on the shape

3.4 Comparative Visualization to assess Registration Quality

[Registration visualization]
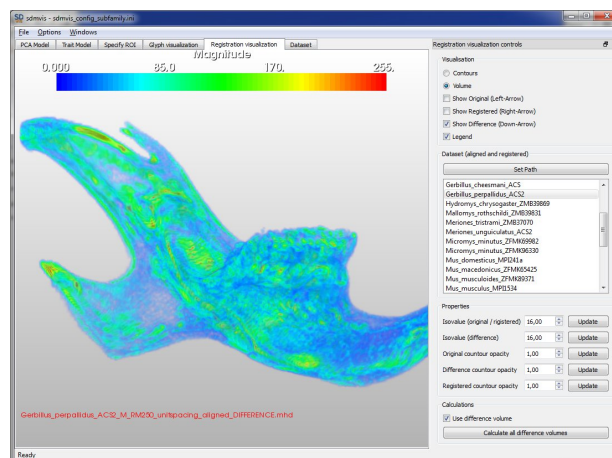
- needs aligned and registered datasets in a specific directory which has to be selected via "Set Path" in the control widget
- can show the aligned original dataset in comparison to the deformed mean estimate (which should match the original as closely as possible for a faithfull investigation)
- supports contour rendering of the surface as well as volume rendering (in rainbow colors)
- can compute and visualize the difference between the aligned and the registered volume (as shown on the screenshot); this maybe a usefull visualization to estimate the registration quality of specific areas

3.5 Statistical Deformation Model Quality (not available yet)
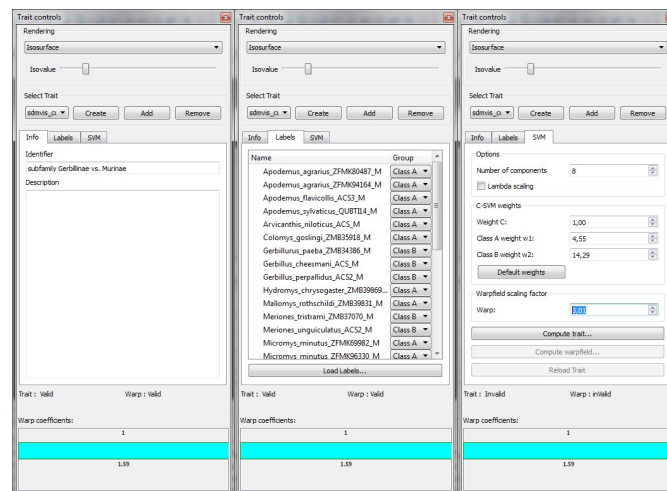
4 Analysis Tasks

4.1 PCA Model

`[PCA Model]`
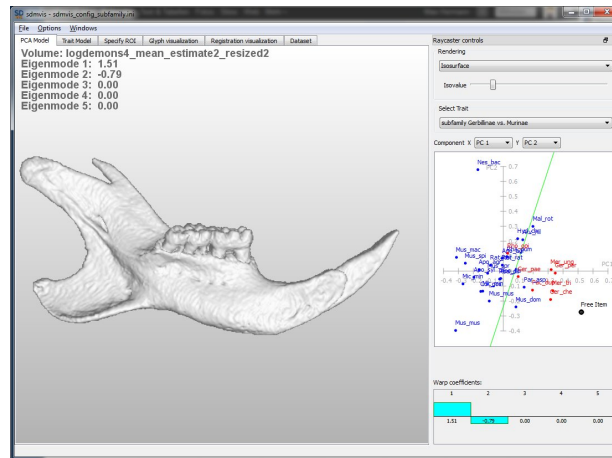

4.2 Classification Trait Vector

`[Trait Model]`

- traits according to a specific grouping (also called labelling or classification) can be loaded, created or deleted
- create a trait:
    - enter a unique identifying text (keep it short)
    - enter a description (optional and changeable later on; e.g. to make some observation notes)
    - go to the second tab and enter the labelling (either manually or via a textfile)
    - go to the third tab and adjust the SVM parameters (details TBD)
    - compute the trait
    - compute the trait warpfield

4.3 Refine shape model according to Region of Interest

`[Specify ROI]`
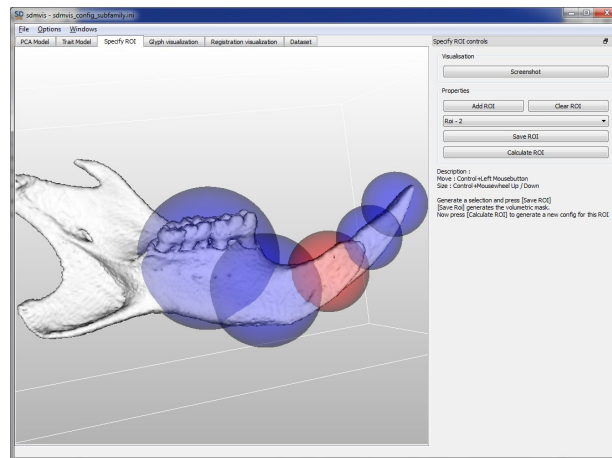
TBD

4.4 Subset Selection (not available yet)

4.5 Trait Quantification (not available yet)