Making coronary artery landmark files with *makelmarks*

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1 Purpose

The purpose of *makelmarks* is to generate a set of coronary artery landmarks from a set of points that lie on the surface of the heart. This allows us to create landmarks even if the heart was never digitized directly, or design somewhat schematic coronaries based on a sock mold or generic heart model.

2 Usage

The program reads most of what it needs from files that have to be prepared beforehand. Running *makelmarks* involves telling the program the names of those files, as follows:

```
makelmarks points-filename pnum-filename outfilename
```

where `points-filename` is the name of a standard CVRTI points (.pts) file containing all the points on the surface of the heart[1] and `pnum-filename` is the name of a file that contains lists of points to be used for the coronaries, as described in section 3.3. The value of `outfilename` is the name of the landmarks file (usually using the extension .lmarks) that will contain the coronaries.

2.1 Practical tips

Based on past experience, the best way to proceed is as follows:

1. Select the geometry file for the epicardial surface you wish to use and make sure the order of the points in the display is clear to you; ideally it should match the lead numbers.

2. From a plaster model or a display in *map3d* lay out the coronaries to be included and number them by segments. Remember that a segment is a continuous length of a single artery so that each main branch and each marginal or diagonal branch is its own segment.

3. To make things flow together well, try and use common points to branch off, *i.e.,* select a point that is in the main segment as the first point of a branch segment.

[1] Strictly speaking, it need not contain all points, just those that are used to draw the coronaries, but it is usually best to use a single points file for everything.

4. Try and use *map3d*, and editor (*eg.,* emacs), and the *makelmarks* program all at once in a sort of iterative process to develop the best pnum file, and thus the best coronaries; it is better to spend a fair bit of your time getting the pnum file as good as it can before before trying to edit the landmarks file directly.

3 Input Files

3.1 The program

The program itself is located in macleod/bin/makelmarks (executable) and in macleod/torso/lmarks/makelmarks (source code). Make sure that ROBHOME is defined in your account and then typing `makelmarks` should find the correct files.

3.2 .pts file

The first of the input files is just a .pts file containing the coordinates of points that define the epicardial surface. These are usually created either from a digitization of the heart or perhaps computed somehow, but we assume that such a file exists. This is the file that should be used with *map3d* in order to generate the points that belong in the second input file and to check the results.

3.3 Point number file

This is a special file, developed for this program. Its content direct *makelmarks* as to how to construct the coronaries based on the points in the associated .pts file. This file is in text format and must be created manually beforehand using a text editor. The format of the file is as follows:

Format of .pnum file	
Variables	Contents
ncorsegs	Number of individual segments of coronaries in the whole file.
ncorpts1 radius1	Number of points in segment 1 and the starting radius of the coronary in segment 1
p1.1 [p1.2 p1.3]	numbers of the points from the .pts file that define this node in the coronaries. There can be up to three point numbers specified here and points can be repeated; we compute the mean location of all those supplied, so that repetition serves as weighting.
p2.1 [p2.2 p2.3]	number(s) of the next point(s) to be used to define the coronary segment
...	
...	
ncorpts2 radius2	Same as above but for the second segment of the coronaries
p1.1 [p1.2 p1.3]	Same as above
...	
...	

Note that all the point numbers specified above are relative to the associated .pts file, with the first point in the file assigned the value one, the next two, and so on. So make sure to select a .pts file and stick with that same file throughout the process.

4 Output File

The single output file produced by *makelmarks* is a landmarks file (.lmarks), which is described in the manual for *map3d*.