



Right Ventricle Segmentation Challenge Information about images and contours



MR Image acquisition and manual segmentation methodology

Patients

The institutional review board approved the study¹ and all patients gave written informed consent. From June 2008 to August 2008, all patients referred to our centre (Rouen University Hospital) with a clinical indication of cardiac MR were invited to participate in the study¹. Exclusion criteria were as follows: age <18 years; contra indication to MR; arrhythmias during MR examination; CHD; and patients referred for an examination that did not include ventricular function analysis (i.e. MR angiography of pulmonary veins or thoracic aorta). Mean patients' age was 53.5 ± 17.5 years and 42 (70%) were males. Clinical indications were represented by a panel of the currently most frequent cardiac MRI indications in patients with AHD: myocarditis, ischaemic cardiomyopathy, suspicion of arrhythmogenic right ventricular dysplasia, dilated cardiomyopathy, hypertrophic cardiomyopathy, aortic stenosis.

Cardiac MR protocol

Cardiac MR examinations were performed at 1.5T (Symphony Tim[®], Siemens Medical Systems, Erlangen, Germany). A dedicated eight-element phased-array cardiac coil was used. Retrospectively synchronized balanced steady-state free precession sequences were performed for cine analysis, with repeated breath-holds of 10-15 s. All conventional planes (2-, 3- and 4-chamber views) were acquired and a total of 8-12 contiguous cine short axis slices were performed from the base to the apex of the ventricles. Sequence parameters were as follows: TR = 50 ms; TE = 1.7 ms; flip angle = 55°; slice thickness = 7 mm; matrix size = 256 x 216; Field of view = 360-420 mm; 20 images per cardiac cycle. Cardiac images have been zoomed and cropped to a 256x216 (or 216x256) pixel ROI, leaving the LV visible for joint ventricle segmentation, if necessary.

Manual RV segmentation methodology

End-diastole (ED) and end-systole (ES) definitions: ED was defined as the first temporal image of each stack (first cine phase of the R-wave triggered acquisition) whereas ES was defined on a mid short axis slice as the image with the smallest ventricular cavity area.

Definition of basal slices: The basal slice of the RV at ED and ES was inferred from the position of the tricuspid annulus as defined on the 4-chamber view at ED/ES.

Definition of apical slices: Apical slice was defined as the last slice with a detectable ventricular cavity.

Endocardial and epicardial delineation: The expert manually delineated endocardial and epicardial borders of the RV on short axis slices at ED and ES. Trabeculae and papillary muscles were included in the ventricular cavity. The interventricular septum was not included in the RV mass. Processing time per patient was around 15 minutes.

¹J. Caudron, J. Fares, V. Lefebvre, P.-H. Vivier, C. Petitjean, and J.-N. Dacher. Diagnostic accuracy and variability of three semi-quantitative methods for assessing right ventricular systolic function from cardiac MRI in patients with acquired heart disease, *European Radiology*, 21(10), 2111-20, 2011

Data organization - File naming convention

Each patient examination typically includes between 200 and 280 images, with 20 images per cardiac cycle. Manual delineation is performed on ED and ES images, yielding around 15 manually segmented images per patient.

Data is organized as follows. There is one directory per patient that includes:

- One directory that includes all DICOM files, ex: P01dicom
- One directory that includes all contour files, ex: P01contours-manual
- One text file indicating the images that have manual contours, ex: P01list.txt

Images are named in this format²:

P[TWO DIGIT NB]-[FOUR DIGIT NUMBER].dcm

- TWO DIGIT NB: patient number
- FOUR DIGIT NUMBER: it signifies the position of the image within the series. For example, P01-0000 would be the first (ED) phase of the slice closest to the base. Taking into account that there are twenty phases per slice, you can then determine that an image with the number 0121 would represent the second phase of the sixth slice from the bottom.
ED images are P01-0000.dcm, P01-0020.dcm, P01-0040.dcm, etc.
ES images may be for example, depending on the ES definition, P01-0008.dcm, P01-0028.dcm, P01-0048.dcm, etc.

Contours are named in this format:

P[TWO DIGIT NB]-[FOUR DIGIT NUMBER]-[i/o]contour-[manual/auto].txt

With:

- TWO DIGIT NB: patient number
- FOUR DIGIT NUMBER: position of the image within the series (please see image naming)
- i/o: it signifies the area that the contour represents. I contours are inner contours, or contours that segment the endocardium. O contours are outer contours, contours that segment the epicardium.
- manual/auto: it signifies the process through which the contours were obtained. All of the expert contours will be denoted manual as they were drawn by humans, and all of the contours that were algorithmically generated should be labelled auto (for automatic).

Contour File Format

Each contour file is a text file in the following format:

X1 Y1

X2 Y2

...

With each (Xi,Yi) pair representing the coordinates of the ith pixel in the contour in pixel units. The conversion factor between pixel and millimeter units can be found by reading the PixelSpacing parameter of a DICOM file. (0, 0) is taken to be the top left hand corner, so (256, 216) would represent a distance of 256 pixels from the left hand side of the DICOM image and 216 pixels from the top of the DICOM image.

Contour listing file

P[TWO DIGIT NB]list.txt

With:

- TWO DIGIT NB: patient number

The file P01list.txt is the listing for patient P01: it indicates the images that have manual contours.

The first line of that file is:

.\patient01\P01contours\P01-0080-icontour-manual.txt

indicating that DICOM image P01-0080.dcm has an "i" (inner or endocardial) contour.

² The file naming convention is similar to the one used for MICCAI'09 LV segmentation challenge:

http://smial.sri.utoronto.ca/LV_Challenge/Home.html

Radau P., Lu Y., Connelly K., Paul G., Dick A.J., Wright G.A Evaluation Framework for Algorithms Segmenting Short Axis Cardiac MRI, MIDAS Journal, 2009. <http://www.insight-journal.org/browse/publication/658>