An Automatic Slice-alignment Method for Both Left and Right Ventricular Analysis in Cardiac Magnetic Resonance Imaging

Shuhei Nitta[1], Taichiro Shiodera[1], Tomoyuki Takeguchi[1], Shigehide Kuhara[2], Kenichi Yokoyama[3], Rieko Ishimura[3], and Toshiaki Nitatori[3]

[1]*Corporate Research & Development Center, Toshiba Corporation, Kawasaki, Kanagawa, Japan,* [2]*MRI Systems Division, Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan,*

[3]*Department of Radiology, Faculty of Medicine, Kyorin University, Mitaka, Tokyo, Japan*

Target audience:

Technologists, radiologists, and image processing researchers involved with cardiovascular magnetic resonance imaging.

Purpose:

Automatic slice alignment is a valuable tool for achieving easier operation, shorter examination times, and higher reproducibility in cardiac MR examinations. Existing methods[1,2] detect only left ventricular planes. However, some cardiac MR examinations require the detection of not only left ventricular planes but also right ventricular planes.[3] The purpose of this study is to develop a new automatic slice-alignment method which detects six left ventricular planes (vertical long-axis, horizontal long-axis, short-axis, 4-chamber, 2-chamber, and 3-chamber views) and four right ventricular planes (short-axis, 4-chamber, 2-chamber, and 3-chamber views) simultaneously.

Methods:

The proposed method detects the positions of the mitral valve, left /right ventricular apex, tricuspid valve, left/right ventricular outflow tract, and left/right anterior wall of the heart in an input image based on a knowledge-based feature recognition technique combined with image processing techniques. The positions and orientations of the left and right ventricular planes are determined from these eight anatomical feature points of the heart. In order to evaluate the results, the angular error of the normal vector of each view between the results and manual annotations was measured.

Results:

ECG-gated 2D steady-state free precession (SSFP) axial multislice cine images covering the entire area of the heart were acquired using a 1.5-T MRI scanner during a single breath-hold. The scanning conditions were TR/TE = 4.2/2.1, matrix = 198 x 256, number of slices = 16-20, and one image per R-R interval. The scanning time was set to less than 20 seconds. The proposed method successfully detected the six left ventricular planes and four right ventricular planes in 55 datasets from 23 healthy volunteers. The processing time was approximately 2.5 seconds on a 3.0-GHz CPU. An example of the detected planes and the average and standard deviation of the angular errors are shown in Fig. 1 and Fig. 2, respectively.

Discussion:

The results show that the proposed method can detect the right ventricular planes with the same accuracy as the left ventricular planes. In addition, the processing speed is very quick compared with previous work even though the proposed method detects both left and right ventricular planes.

Conclusion:

The proposed method can detect six left ventricular planes and four right ventricular planes simultaneously. The experimental results showed that this method is beneficial to both operators and patients.

References:

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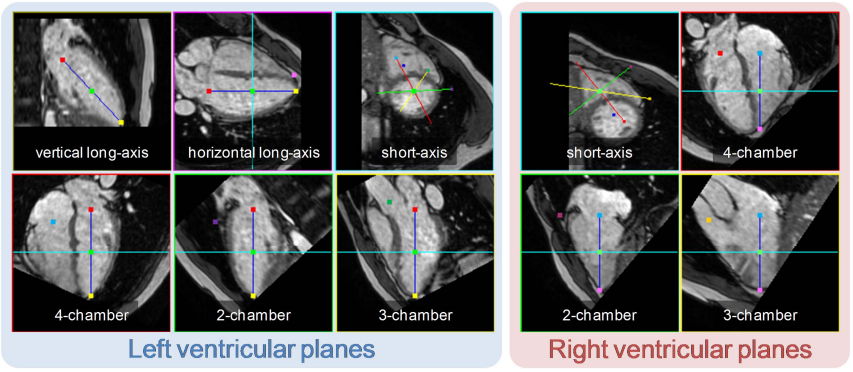

Fig. 1 Example of the detected planes for a healthy volunteer

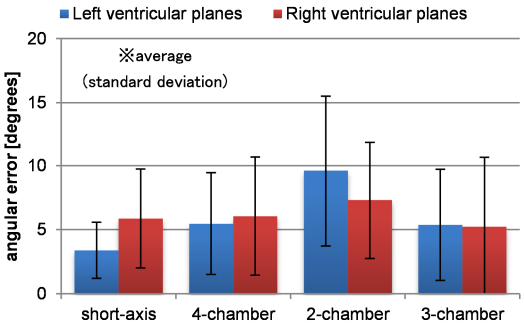

Fig. 2 Average and standard deviation of the angular errors.