Sparse registration for three-dimensional stress echocardiography


Abstract
Three-dimensional (3-D) stress echocardiography is a novel technique for diagnosing cardiac dysfunction. It involves evaluating wall motion of the left ventricle, by visually analyzing ultrasound images obtained in rest and in different stages of stress. Since the acquisitions are performed minutes apart, variabilities may exist in the visualized cross-sections. To improve anatomical correspondence between rest and stress, aligning the images is essential. We developed a new intensity-based, sparse registration method to retrieve standard anatomical views from 3-D stress images that were equivalent to the manually selected views in the rest images. Using sparse image planes, the influence of common image artifacts could be reduced. We investigated different similarity measures and different levels of sparsity. The registration was tested using data of 20 patients and quantitatively evaluated based on manually defined anatomical landmarks. Alignment was best using sparse registration with two long-axis and two short-axis views; registration errors were reduced significantly, to the range of interobserver variabilities. In 91% of the cases, the registration result was qualitatively assessed as better than or equal to the manual alignment. In conclusion, sparse registration improves the alignment of rest and stress images, with a performance similar to manual alignment. This is an important step towards objective quantification in 3-D stress echocardiography.