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Letter to the Editor Regarding Paper "Automatic Computation of Left Ventricular Volume Changes over a Cardiac Cycle from Echocardiography Images by Nonlinear Dimensionality Reduction"

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Dear Editor,
I have read the paper "Automatic Computation of Left Ventricular Volume Changes over a Cardiac Cycle from Echocardiography Images by Nonlinear Dimensionality Reduction" [1] with great interest. I congratulate the authors on their comprehensive and very balanced overview of recent studies of the curve of left ventricular volume changes and its application to ischemic heart diseases and analysis. However, there are several new aspects that in my opinion needs clarification. I draw a general flowchart of their method that is based on NLDR software Fig. 1. I intend to discuss each box in the mentioned flowchart step by step.

1- Echocardiography Images:

Images were acquired from end of diastole to end of systole at different phases (7 phases) within a cardiac cycle by a Vivid 3 GE Health echocardiography machine. Obtaining worthy images at denoted phases will depend on the operator (for the best clinical examination). Ofcourse, having assumed images not only were acquired from A4C and A2C but also from short-axis views. Short-axis views have not been used in their paper, so radial, circumferential, and rotatory data are missed.

2- Observed data y_i's:

Echocardiography images play the role of observed data and they are symbolized by y_i's, and there is a sequence of observed data y_1, y_2,… y_N, where N is the number of obtained images. In fact, we have made a chain of displacements, rotations, and pure strain or nonrigid transformations (deformations) of these observed data that is started at y_1 and is terminated at y_N. (y_1 —> y_2… …> y_{N-1} —> y_N).

This chain has some conceptual interpretations of the elasticity of the global left ventricular motion/function and the regional LV fiber arrangement/movement.

3- Embed observed data to a high dimensional space.
4- Image processing on y_i's and geodesic distance between y_i's:

Observed data y_1, y_2,… y_N are embedded to a meshed surface sized number of pixels of an image. Translations, rotations, and pure deformations of y_1, y_2,… y_N have been implemented and studied at this surface utilizing the mathematical elasticity theory. A distance metric is defined that computes distances between observed points. Medical interpretations of observed points over the time should be checked/and stated clearly. Images are not usual images but also are images from the left ventricle. Motion (displacement and velocity), deformation (strain and strain rate), and torsion of each myocardial sample have to be extracted during a cardiac cycle in the mentioned surface. These are used on the creation of graph G referred to their paper.

5- An Isomap f:

The main tool in this method is the function "f" which is an isometric map [2, 3]. I will be interested to know the structure/formula or relationship of this isometric function which most probably contains a lot of practical information of the left

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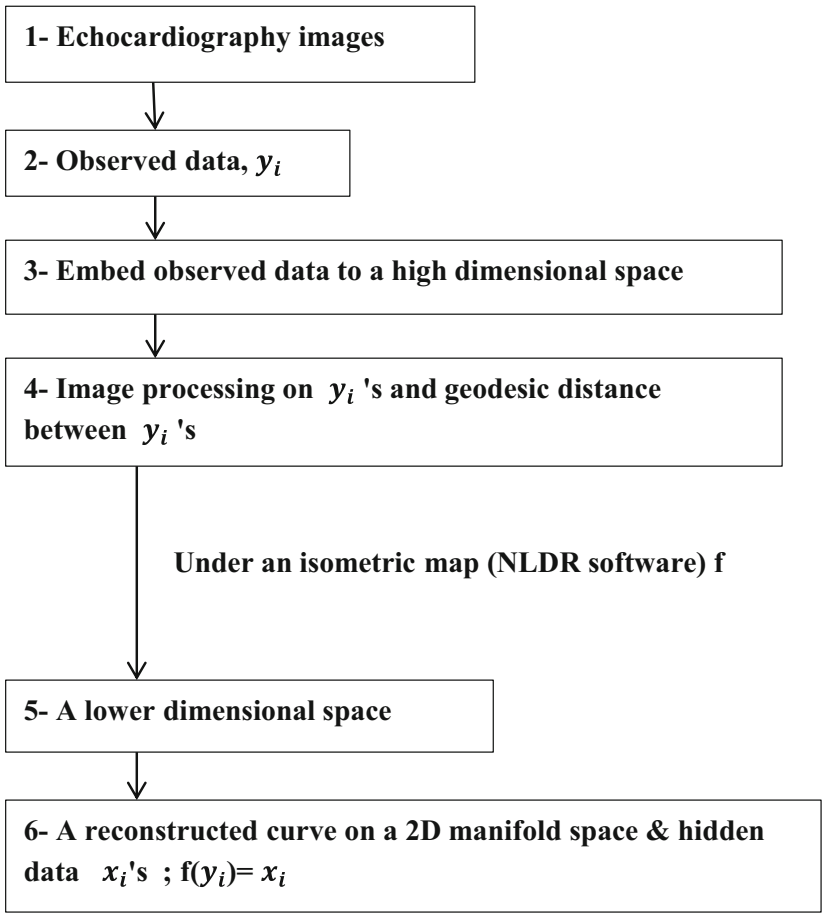

Fig. 1 This figure shows a general outline of the relationship between observed data and hidden data based on NLDR software

ventricular function and structure. I mean, how can we get a good representation of such or the function of "f" for cardiology? Is it this "f" known as an algebraic function? What information has been coded to fibers (f^{-1}) of this isometric function "f"?

6- A reconstructed curve on a 2D manifold space & hidden data x_i's; f(y_i)=x_i

Isometric function results in a reconstructive curve crossing from hidden data ($x_i's$) on a surface. It is natural that some information (maybe clinical information) would be transferred to these hidden points like the curve of LV volume changes and so on. The main question is: what are these new points x_i's exactly from the medical point of view? What other data have come out from these hidden points? I think all of these questions emphasize the importance of gaining a good understanding of isometric function "f".

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