Fetal Left Atrium Segmentation using Kohonen Maps to Measure the *Septum Primum* Redundancy Index

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Abstract

Echocardiographic images are used by physicians in early detection of congenital heart diseases. Such diseases affect a significant percentage of newborns every year, and only preventions can reduce the risk of a fatal heart condition. Ultrasounds imaging has been the basis of non-invasive methods for early detection of fetal heart diseases. However, echocardiographic images are contaminated by speckle noise, and other imaging disturbances, making it difficult to visualize important heart structures.

Usually the diagnosis are obtained by measures in the echocardiographic images. Among several measures used, we can highlight the redundancy index of the septum primum that is associate with premature atrial contractions and the thickness of septum interventricular that can indicate the presence of miocardic hipertrofy in the fetus. The redundancy index of septum primum was obteined by ratio ledger between the maximum excursion of the septum primum (SP) to inside of left atrium and the measure of maximum diameter of left atrium, both during the diastole.

For images of fetal echocardiography exams, we use the self-organizing maps (SOM) of Kohonen to segment and afterwards obtain measures that can help the physicians in the analysis of several congenital cardiopaties.

The SOM organizes unknown data into groups of similar patterns, according to a similarity criterion (e.g. Euclidean distance). An importante feature of this neural network is its ability to process noisy data. For this reason, the SOM approach has been recommended to process echocardiographic images.

In this work it was used random samples of gray tones means of the images to train the map.

Table 1. Comparison between both physicians and prototype measures

Measure	physician	prototype
Maximum extention of SP (mm)	10,1	10,25
Diameter of left atrium (mm)	15,1	15,39
Redundancy index of SP	0,6688	0,6660

During training, the neuron weights are updated as follows. At each step, one pattern is extracted from the sample set, and the winner neuron is found (i.e. the neuron nearest to the sample in feature space). Its weights, as well as the weights of the neighboring neurons, are updated, so they converge to the presented pattern. At the end of process, neurons agglomerate into regions of higher probability. Therefore, we post-process the SOM after the training, by considering neurons as patterns, and grouping them into two clusters using the k-means technique. With this procedure, are detected the representative regions in an image, and the clusters of neurons that are associated to them. During image segmentation, a window (5 x 5) is moved throughout the image. The window center pixel is used as a reference, and at the image location (x,y) the local mean is measured. These feature value is then passed to the trained SOM, and the pixel at (x,y) receives the label of the winner neuron.

Starting from the segmented image we obtained the measure of redundancy index of the septum primum. The results was good comparing with the same obteined by the physicians. This is shown in the table 1.

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