Nonparametric Foetal Ultrasound Scene Understanding using Markov Random Fields and Texture Information

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Aims: The long term aim of this project is to produce a computer system to visualise ultrasound images in place of the human eye. The first step in this process is to develop software that can identify fetus from non-fetus. We have used a computer process called segmentation.

Methods: We defined four textural classifications: Texture 1 = highly homogenous and anechoic (eg: fluid). Texture 2 = high homogeneity and low echogenicity (e.g. cloudy amniotic fluid). Texture 3 = high homogeneity and medium echogenicity (e.g. soft tissue). Texture 4= high homogeneity and high echogenicity (e.g. bone). We modified a process called the Markov Random Fields theory to suit our purposes for segmentation. We used neural networks to train the system and then tested conventional segmentation algorithms such as Grow Cut (GC) and Smoothness Grow Cut (SGC). We compared this to a state of the art algorithm called Simple Linear Iterative Clustering (SLIC) and to the Markov Random Fields algorithm (MRF)

Results:

SLIC and MRF algorithms were qualitatively and quantitatively superior to GC and SGC. To compare SLIC and MRF algorithms we plotted recall value vs. distance between seeds on the grid and precision value vs. distance between seeds on the grid. For edge recall, MRF performed moderately better than SLC (Y intercept = 0.89 and 0.84 respectively; slope = -0.43 and -0.23 respectively). For edge precision, MRF was clearly superior to SLC (Y intercept = 0.18 and 0.14 respectively; slope = 0.33 and 0.35 respectively.

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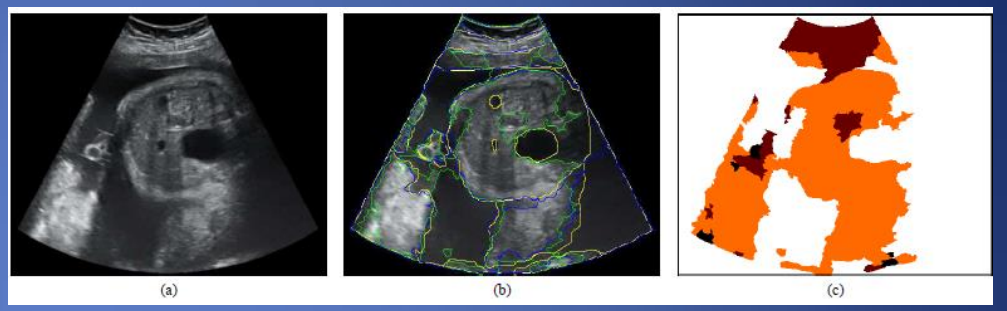
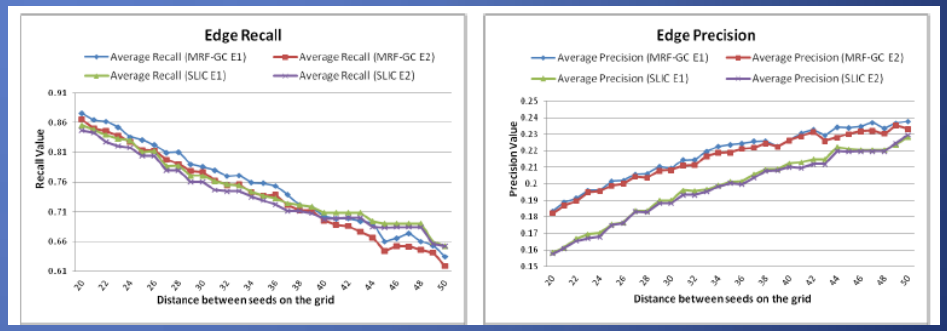


Experimental results: original ultrasound frames, detected boundaries and colour coded labels assigned by classifying superpixels based on their texture.



Edge statistics - MRF-GC vs SLIC

Interpretation:

The Markov Random Fields algorithm is superior to standard algorithms and the state of the art algorithm (SLIC) in the segmentation process of ultrasound images. These results lend weight to the concept that it is possible to replace the human eye (at least in part) in the interpretation of ultrasound images.