Quantitative Ultrasound via the Lempel-Ziv complexity

Tomasz Steifer¹, Marcin Lewandowski¹, Institute of Fundamental Technological Research PAS, Poland

Background, Motivation and Objective

Automatic breast lesion classification is one of the most important goals for the quantitative ultrasound. Various methods and parameters were proposed to facilitate computer-assisted diagnosis of breast lesions. These raise hopes for improved diagnosis and lowering the number of unnecessary biopsies.

Statement of Contribution/Methods

A novel quantitative ultrasound parameter is presented. The method is based on the Lempel-Ziv complexity – an important concept from the coding theory. A full signal processing flow from raw radio-frequency data to the resulting QUS parameter is given. Batches of two-dimensional signals are firstly linearized and then discretized to allow calculation of the Lempel-Ziv complexities. Then the method gives a measure of ultrasound image complexity in the region of interest. This method is utilized to create a binary classifier for the malignancy of breast lesions. Total number of 192 images from OASBUD – an open-access breast lesions image database – were used. These signals were registered at the Department of Radiology at the Maria Sklodowska-Curie Memorial Institute of Oncology in Warsaw, Poland, using Ultrasonix SonixTouch Research scanner with an L14-5/38 linear array transducer.

Results/Discussion

The new method slightly outperforms the state-of-art classifier based on the pixel entropy as estimated via receiver operating curve (ROC AUC = 0.87 for the novel method as compared to 0.84 for the referential one). The difference is even more significant for small lesions which are generally difficult diagnostically. The method performance is also studied as a function of algorithm parameters the size of the dictionary used to discretize the input data.

