Fuzzy algorithms: Application to adipose tissue quantification on MR images

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Abstract

Metabolic syndrome, which is related to abdominal obesity, is a fast growing disease in our western countries. Its presence greatly increases the risk of developing cardiovascular diseases. The accumulation of visceral adipose tissue plays a key role in the development of the metabolic syndrome. The increase of waist circumference is one of the five criteria of the metabolic syndrome diagnosis. But this increase can be due to visceral or subcutaneous adipose tissues. And these adipose tissues do not play the same rule in metabolic syndrome. The purpose of this study was to develop software for automatic and reliable quantification of visceral and subcutaneous adipose tissues, to detect patient with high risk to develop metabolic syndrome and to follow the evolution of adipose tissue repartition after treatment. A gradient echo magnetic resonance (MR) technique is used, with a TE such that fat and water are opposed in phase. The developed process is based on two fuzzy algorithms. First, we fuzzy generalized clustering algorithms allow to merge pixels according to their intensities. Then, fuzzy connectedness algorithm allows to merge pixels according to cost function related to distance, gradient distance and intensities. A validation is performed with a comparison between expert results made by manual drawing and purpose-made software results. Our software provides an automatic and reliable method to segment visceral and subcutaneous adipose tissue and additionally avoids in some case the problem of inhomogeneity of signal intensity.

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