# Advanced texture analysis and classification methods for the automatic diagnosis of the hepatocellular carcinoma

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## Abstract

*Introduction***:** The hepatocellular carcinoma (HCC) is the most frequent malignant liver tumor, appearing in 75% of liver cancer cases. The golden standard for HCC diagnosis is the needle biopsy, but it is invasive, dangerous. We develop non-invasive, computerized methods for the automatic and computer assisted diagnosis of HCC, within ultrasound images. The advanced texture analysis methods, the classification techniques including the deep learning approach, respectively other specific pattern classification and artificial intelligence methods play a major role in our research. Thus, we perform the characterization and supervised recognition of HCC, as well as the unsupervised discovery of the HCC evolution phases. *Materials and methods***:** In order to perform image analysis, both classical and original texture analysis methods were taken into account, including multiresolution features, based on the Wavelet and Gabor transforms [1]. Advanced, original texture analysis methods were developed in the form of the superior order generalized co-occurrence matrices, based on gray levels, edge orientations, respectively complex textural microstructures. These features were provided at the input of some traditional classifiers [1], [2]. Deep learning techniques such as Stacked Denoising Autoencoders (SAE) and Convolutional Neural Networks (CNN) were also experimented [3]. Thus, the imagistic textural model of HCC, respectively of the HCC evolution phases was defined in both supervised [1] and unsupervised manner [4]. The experiments were performed on 300 cases of HCC, and 100 cases of hemangioma, acquired with an older ultrasound machine, respectively on 13 HCC cases acquired with a new generation ultrasound machine. In the case of the supervised classification, we considered the following pairs of classes: HCC/cirrhotic parenchyma; HCC/hemangioma. *Results***:** Our methods led to a satisfying classification accuracy, around 85%. *Conclusion***:** Due to the textural model of HCC, both automatic and computer assisted diagnosis can be performed. We aim to increase the classification performance, in our future research.

## Keywords:

Hepatocellular Carcinoma (HCC); Ultrasound Images; Advanced Texture Analysis; Deep Learning; Automatic and Computer Assisted Diagnosis

## References:

[1] Mitrea D, Mitrea P, Nedevschi S, Badea R, Lupsor M, Socaciu M, et al. Abdominal tumor characterization and recognition using superior-order cooccurrence matrices, based on ultrasound images. Computational and mathematical methods in medicine. 2012;2012:Article ID 348135.

[2] Mitrea D, Nedevschi S, Badea R. Automatic recognition of the hepatocellular carcinoma from ultrasound images using complex textural microstructure co-occurrence matrices (ctmcm). Proceedings of the 7th International Conference on Pattern Recognition Applications and Methods –Volume 1. ICPRAM 2018, pp 178-189.

[3] Deep Learning Tutorial, Release 0.1, LISA lab, University of Montreal, Copyright Theano Development Team, 2015.

[4] Mitrea D, Nedevschi S, Abrudean M, Platon-Lupsor M, Badea R. The Role of the Textural Microstructure Co-occurrence Matrices in the Automatic Detection of the Cirrhosis Severity Grades from Ultrasound Images. Journal of Control Engineering and Applied Informatics, 2016;18(4):96-106.