Texture-Based Classification of Hepatic Primary Tumors in Multiphase CT*

Dorota Duda[1,2], Marek Krętowski[2], and Johanne Bézy-Wendling[1]

[1] LTSI-INSERM, Université de Rennes 1, France
[2] Faculty of Computer Science, Białystok Technical University, Poland

Abstract. A new approach to the hepatic primary tumor recognition from dynamic CT images is proposed. In the first step of the proposed method, texture features are extracted from manually traced ROI-s to objectively characterize lesions. The second step consists in applying decision tree classifier. For the first time, the parameters obtained in subsequent acquisition moments are analyzed simultaneously.

Introduction. Computed Tomography (CT) is now widely applied for diagnosis of hepatic tumors. Typical visual inspection of scans enables radiologists to localize pathological regions and to recognize, to a certain extent, the type of lesion. Nevertheless, the definitive diagnosis usually requires invasive procedures like needle biopsy. More accurate computer-aided image analysis allows obtaining reliable predictions and avoiding these undesirable interventions [2].

In the paper texture-based classification of hepatic lesions from CT images is investigated. So far, the proposed diagnostic systems, which combine texture analysis with classification methods (e.g. [3,4]) were applied to non-enhanced CT scans of the liver. In our previous contribution [5] it was shown that considering the acquisition moments could improve classification accuracy in case of hepatic metastasis. In this paper, for the first time, the texture characteristics obtained in subsequent acquisition moments are analyzed simultaneously.

Method. In clinical practice, when dynamic CT of the liver is performed, three scan series are usually acquired: non-enhanced images and after contrast product injection, in arterial and portal phases. Radiologists commonly exploit an evolution of the tissue region appearance in different acquisition moments as a discriminating factor in the tumor diagnosis. An analogous idea is adopted in the proposed approach. Not only the texture characteristics of the considered region are analyzed, but also their changes in the three acquisition moments.

The first step in applying any classification tool is preparation of a learning set, which is used to generate the classifier. In our approach, the learning set is composed of texture feature vectors, each describing the same region of interest (ROI) in the three corresponding images. The regions are visually detected and manually drawn. As the classifier, Dipolar Decision Tree [1] is applied. When the classifier is created it can be used in prediction of suspected ROI-s.

* This work was supported by the grant W/WI/1/02 from Białystok Technical University

C. Barillot, D.R. Haynor, and P. Hellier (Eds.): MICCAI 2004, LNCS 3217, pp. 1050–1051, 2004.
© Springer-Verlag Berlin Heidelberg 2004

Results. The proposed approach was applied to recognizing the normal liver and its two main primary malignant lesions: hepato-carcinoma and cholangiocarcinoma. The database of 495 images from 22 patients was gathered in Eugene Marquis Center in Rennes, France. Acquisitions were performed with a GE HiSpeed CT device and the standardized acquisition protocol was applied: helical scanning, slice thickness 7 mm, 100 ml of contrast material injected at 4 m/s. For each phase and each tissue class 150 non-overlapped ROIs (diameters from 30 to 70 pixels) were traced. In our experiments the following texture features were extracted: (*i*) 4 first order parameters, (*ii*) entropy of image after filtering it with 24 zero-sum 5x5 Laws' filters, (*iii*) 8 Run-Length Matrix features and (*iv*) 11 Co-occurrence Matrix parameters. For the two last methods, features computed in 4 standard directions (0°, 45°, 90°, 135°) and for 5 distances (from 1 to 5) were averaged. The 5-times repeated 10-fold cross-validation procedure was applied to estimate the classification accuracy (Table 1).

It could be observed that regardless of texture analysis method, the classification quality is significantly increased, when feature vectors are composed of parameters from subsequent acquisition moments.

Table 1. Classification accuracy obtained for different groups of texture features

Method	No contrast (N)	Arterial (A)	Portal (P)	N + A + P
First order	90.16 ± 1.31	85.82 ± 1.48	90.40 ± 1.69	98.76 ± 0.73
Laws' filters	94.16 ± 0.87	95.56 ± 1.23	94.53 ± 1.37	97.33 ± 1.50
Run length	95.53 ± 1.02	93.89 ± 1.28	95.45 ± 1.59	99.73 ± 0.42
Co-occurrence	96.36 ± 0.88	94.29 ± 1.79	94.87 ± 0.83	99.67 ± 0.37

Conclusion. In the paper, texture characteristics derived from images corresponding to three typical acquisition moments in dynamic CT of the liver are analyzed simultaneously. The experimental validation shows that the proposed approach improves the capability of hepatic primary tumor recognition.

References

1. Bobrowski, L., Krętowski, M.: Induction of multivariate decision trees by using dipolar criteria. Lecture Notes in Computer Science, **1910** (2000) 331–336
2. Bruno, A., Collorec, R., Bézy-Wendling, J., Reuzé, P., Rolland, Y.: Texture analysis in medical imaging. In: Roux, C., Coatrieux, J.L. (eds.): Contemporary Perspectives in Three-dimensional Biomedical Imaging. IOS Press (1997) 133–164
3. Chen, E.L., Chung, P.C., Chen, C.L., Tsai, H.M., Chang, C.I.: An automatic diagnostic system for CT liver image classification. IEEE T-BE, **45(6)** (1998) 783–794
4. Gletsos, M., Mougiakakou, S.G., Matsopoulos, G.K., Nikita, K.S., Nikita, A.S., Kelekis, D.: Classification of hepatic lesions from CT images using texture features and neural networks. Proc. of 23^{rd} Int Conf of the IEEE EMBS (2001) 2748–2751
5. Krętowski, M., Bézy-Wendling, J., Duda, D.: Classification of hepatic metastasis in enhanced CT images by dipolar decision tree. Proc. of GRETSI (2003) 327–330