Liver tissue characterization and multitemporal parameter selection in triphasic CT

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The aim of the paper is to find the bases for a quantitative study dealing with liver characterization by triphasic CT. This technique allows the acquisition of three abdominal volumes: arterial phase (25 seconds after the contrast injection), venous phase (after 60-90 s), and delayed phase (after 3-5 minutes) [1].

Even though the availability of multitemporal digital volumes represents a significant help to experts for the diagnosis, there is a lack of comprehensive studies devoted to quantitative model characterization and parameter selection which can fully exploit the data information content. The statistical analysis of liver and other tissues is considered an important step in the context of diagnosis and classification [2], but detailed studies on multitemporal parameters are only partially proposed.

In this work, by referring to several regions of liver parenchyma, a statistical study is applied to various slices in each phase of the training patients cases. Densitometry and texture parameters are extracted and the following features are computed [3] from about 1400 regions:

1. First-order statistical parameters from Hounsfield Unit (HU) histogram: mean, median, standard deviation (Sdv), mode, skewness (Sk), kurtosis (Kur);
2. Spatial second-order parameters from gray level co-occurrence matrix (GLCM): entropy (Ent), contrast (Con), energy (En), and homogeneity (Hg).

Outliers are found by means of the following formula:

$$x \leq Q_1\text{-}1.5(Q_3\text{-}Q_1) \quad (1)$$

$$x \geq Q_3\text{+}1.5(Q_3\text{-}Q_1) \quad (2)$$

where x is the parameter value, Q_1 is the first quartile, and Q_3 the third quartile. Equation (1) finds the inferior outliers, while equation (2) the superior ones. After deleting the outliers, the average value is computed for each parameter.

As shown in Tab.1, some parameters change from one phase to the others, while some parameters, such as kurtosis, entropy, energy and homogeneity, have similar values in all phases.

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Taking into account the values of skewness (≅0.03) and kurtosis (≅3) it is possible to assume that the histogram of each parameter has a Normal distribution.

Table 1: Parameters average values for each phase.

LIVER	Mean	Sdv	Sk	Kur	Ent	Con	En	Hg
Arterial phase	73,737	18,686	0,029	2,865	5,105	182,930	0,007	0,179
Venous phase	102,678	15,534	0,034	2,862	4,948	121,053	0,007	0,203
Delayed phase	83,497	14,891	0,026	2,849	4,890	106,961	0,007	0,210

The two parameters "mean" and "contrast" show a significant variation between the different phases. The GLCM contrast has a globally decreasing trend from arterial phase to delayed phase. However, by analyzing each patient, one can notice that this feature is very dispersed, as shown in Fig.1; therefore it is not statistically significant.

The mean in venous phase is larger as compared to arterial phase, while the mean of delayed phase is lower than venous phase. This trend is confirmed also for each patient and, as shown in Fig.2, this parameter is less dispersed, too. As a consequence, the mean parameter turns to be the most significant feature in multitemporal CT analysis, as compared with traditional non-dynamic CT.

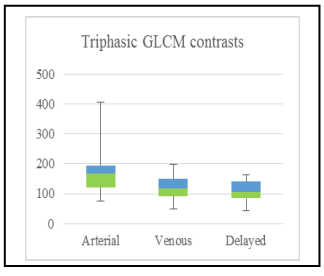

Figure 1: Box-Plot of GLCM contrast in the three phases.

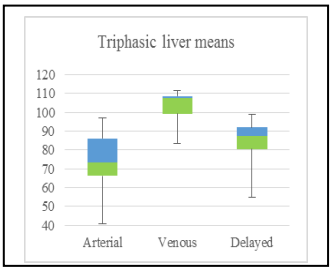

Figure 2: Box-Plot of mean in the three phases.

REFERENCES

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