Hierarchical Clustering-based Segmentation (HCS) Aided Interpretation of Multi-parametric MR Images of the Prostate

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Hierarchical Clustering-based Segmentation (HCS)

Hierarchical Clustering-based Segmentation implements the traditional bottom-up approach of agglomerative clustering, where the regions of an initial partition are iteratively merged. Thus HCS automatically generates a hierarchy of segmented images.

A unique operation of the HCS process is the border pixel reclassification. Border pixel reclassification aids in overriding local inhomogeneity while clustering similar regions (Figure 1). The algorithmic diagram below, illustrates the overall operation of the HCS process (2).

**REFERENCES**


**Aim of the Study - HCS PROCESS AS AN AID TO DIAGNOSIS IN mpMRI OF PROSTATE**

To evaluate HCS process as semi-quantitative analytical tool, to complement radiologist’s interpretation of mpMR images of prostate.

**METHOD**

In prostate cancer, the leaky characteristics of the tumour angiogenesis, is demonstrated in DCE-MRI by the early rapid high enhancement just after the administration of contrast medium followed immediately by a relatively rapid decline. In comparison there will be a lower and continuously increasing enhancement for normal tissues.

The above characteristics can be demonstrated by the quantitative measurement of signal enhancement in DCE-MRI with time i.e. Time Intensity Curve (TIC). The characteristic shape of the TIC (Figure 2) may be used for supporting diagnosis.

**DISCUSSION**

In discriminating malignant lesions from normal and benign regions, T2-weighted MR images has a diagnostic performance such that it complements the DCE T1-weighted based diagnosis.

So to confirm whether the signal loss in the T2-weighted image is due to tumour, the DCE-MRI TIC based classification is made use of.

In the case shown in Fig. 3B, the corresponding region, where there is signal loss in the T2-weighted image, is classified as Type-3 carcinoma (Blue). Thus HCS aids diagnosis of mpMRI.

In prostate cancer, the leaky characteristics of the tumour angiogenesis, is demonstrated in DCE-MRI by the early rapid high enhancement just after the administration of contrast medium followed immediately by a relatively rapid decline. In comparison there will be a lower and continuously increasing enhancement for normal tissues. How the above characteristics can be demonstrated by the quantitative measurement of signal enhancement in DCE-MRI with time i.e. Time Intensity Curve (TIC). The characteristic shape of the TIC (Figure 2) may be used for supporting diagnosis.

Within the user defined ROI, the HCS process is applied to the DCE-MRI temporal frame of a slice of interest identified by the user.

For **qualitative** analysis, for dissimilar regions, HCS process provides following (Fig. 3A, B)

(a) Heat map, boundaries of HCS regions and HCS regions coloured based on their TIC types (Fig. 2) for 35 HCS regions (Row 2) and 12 HCS regions (Row 3).

(b) The suspicious region’s Parametric TIC.

(c) Classification of the HCS process’ regions based on the 6 types of TIC enhancement patterns (Fig. 2).

Apart from the usual patterns, Type 6 (Red) and Type 7 (White) are added to denote ambiguous cases.

**RESULTS**

Table below lists the correlation of the radiologist’s finding and the HCS process based TIC classification with that of the pathologist’s findings.

<table>
<thead>
<tr>
<th>Radiologist’s finding</th>
<th>HCS based TIC classification</th>
<th>Pathology finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive</td>
<td>Type-2 (Green)</td>
<td>Benign</td>
</tr>
<tr>
<td>True Negative</td>
<td>Type-1 (Gray)</td>
<td>Benign</td>
</tr>
<tr>
<td>False Positive</td>
<td>Type-3 (Blue)</td>
<td>Clear</td>
</tr>
<tr>
<td>False Negative</td>
<td>Type-5 (Yellow)</td>
<td>Benign</td>
</tr>
<tr>
<td></td>
<td>Type-4 (Magenta)</td>
<td>Carcinoma</td>
</tr>
<tr>
<td></td>
<td>Type-6 (Red)</td>
<td>Ambiguous</td>
</tr>
</tbody>
</table>

**IMAGE GUIDED THERAPY**

Prostate cancer diagnosis is confirmed using a needle biopsy in the UK. A Trans-rectal Ultrasound (TRUS) biopsy involves taking 10 to 12 cores in a systematic manner. There are no significant risks and complications arising from TRUS procedure. To minimise such complications HCS process aided targeted biopsy may be taken.