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

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

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BACKGROUND

Tissue abnormality is usually related to a dissimilar part of an otherwise homogeneous image. Choosing the optimal post processing threshold value can be difficult because the image composition may vary depending on the acquisition parameters and the type of tissue. Hierarchical Clustering-based Segmentation (HCS) is an approach to Computer Aided Monitoring (CAM) that enables a user to define a region of interest and the process generates a hierarchy of segmentation results to highlight the varied dissimilarities that might be present.

HCS allows the user to derive the maximum benefit from the computational capability (perception) of the machine while at the same time, enabling them to incorporate their own interpretation in the appropriate place. This achieves a complementary synthesis of both computer and human strengths [1].

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

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].

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. 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)

- heat map, regions coloured as per their TIC types and correlation with T2 regions.
- For quantitative analysis, parametric image of the time intensity curves of the contrast wash-in, wash-out process are plotted for suspicious regions confirmed by user (Fig. 3C).

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.

Except for two false positive classification, for the rest of the cases the HCS based TIC classifier classification corresponds with the pathology finding. Those two false positive cases have been diagnosed correctly as normal by the radiologist.

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. Tumour in T2-weighted MR image will appear as signal loss (dark). But false positives occur in haemorrhage, calcification, inflammation and fibrosis (post-inflammatory, postoperative, haemorrhage, fibrosis).

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.

So to confirm whether the signal loss in the T2-weighted image is due to tumour, the DCE-MRI T1-weighted based diagnosis 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.

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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 number of significant risks and complications arising from TRUS procedure. To minimise such complications HCS process aided targeted biopsy may be taken

REFERENCES


2. Selvan, A. N.; Pettitt, Sam and Wright, C. “Hierarchical Clustering-based Segmentation (HCS) Aided Interpretation of DCE MR Images of Prostate” In Medical Image Understanding and Analysis Conference, Lincoln, UK. 2015


IMAGES GUIDED THERAPY

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<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>True Positive</td>
<td>True Positive</td>
</tr>
<tr>
<td>False Negative</td>
<td>False Positive</td>
<td>False Negative</td>
</tr>
<tr>
<td>False Positive</td>
<td>False Positive</td>
<td>False Positive</td>
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</tbody>
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Table: - Radiologist’s interpretation, HCS process based TIC classification and Pathology finding (TP: True Positive, TN: True Negative, FP: False Positive, FN: False Negative)