Questions and Answers

Chapter 2

Questions

(Q1) *What is tissue characterization in IVUS images?*

(Q2) *Why is automatic tissue characterization an important issue?*

(Q3) *Why do we use texture-based descriptors?*

(Q4) *Why do we use supervised classification?*

(Q5) *What is the feature space?*

(Q6) *Why is dimensionality reduction needed in the classification process?*

(Q7) *What is the main idea under the boosting classification?*

(Q8) *What is the segmentation of the plaque for?*

(Q9) *Discuss the methodology for the tissue characterization framework.*

(Q10) *Which are the most reliable frameworks for real-time classification?*

Answers

(A1) Tissue characterization is the name given by the physicians to designate the process of labelling the different areas between intima and adventitia, usually called *plaque*. It is a fundamental tool for studying and diagnosing

the pathologies and lesions associated to the vascular tree, since it provides a histological estimation of the composition of the plaque.

(A2) Tissue characterization is an arduous task that, usually, requires from specialists manual identification of the tissues. It is a high time consuming process and it is prone to subjectivity of the classification depending on the specialist. Automatic tissue characterization solves both drawbacks.

(A3) The unreliability of gray-level only methods to achieve good discrimination among the different kind of tissues forces us to use more complex measures. Texture-based features are some of the most popular techniques for tissue characterization in medical imaging, since they provide structure, statistical, scale and orientation related measures.

(A4) In order to take advantage of the *a priori* knowledge of what the tissues we want to identify are, we can provide samples of the different tissues to a learning process. The fact of providing these different kind of tissues guiding the learning process to separate among the samples of each class is called supervised classification.

(A5) The feature space is the result of the transformation of the original space (IVUS image) into a set of features that try to describe different properties of the IVUS image. This set of features usually differs in dimensionality with the original space.

(A6) Since the feature space has an arbitrarily high dimensionality, a process to identify which the most discriminative features are, can be used. This feature space dimensionality reduction is usually necessary because high dimensional problems are ill-posed, since they need a great amount of sample data points for the classification process to be reliable.

(A7) Boosting classification is a technique for creating a high performance classifier (low error rate) given a low performance classifier (above random decision learning process). The method relies on weighing the samples in the feature space according to their discriminability. Therefore, each weak learning process added to the ensemble focuses on the data samples that were wrongly classified the previous step, thus, increasing the overall classification rate.

(A8) Plaque segmentation is the previous step to tissue characterization. It is extremely important since it identifies the working region for the plaque identification process. The methodology for plaque segmentation differs from author to author, however, an approach that takes advantage of the texture-based feature extraction consists of a snake-based border location of the intima and the adventitia. The intima is segmented using a texture-based feature space that describes tissue and blood. Adventitia is segmented taking into account the intima segmentation and using a Sobel-like operator that provides the main edges under the intima.

(A9) Tissue characterization relies on two processes: plaque segmentation and tissue characterization properly said. Plaque segmentation is concerned with the identification of the intima and adventitia borders. This information is of great importance since what we call tissue characterization is, in fact, the identification of the different tissues in that region. The process described in the chapter consists of: The first step is the coordinate transformation of the original IVUS image into a cartesian representation of the same. This is done because we want the feature extraction processes to be invariable to rotation. The second step is the texture-based feature extraction process. After the extraction, the feature samples are sent to a classification process that labels each pixel of the original IVUS image as soft plaque or hard plaque. The next step is the identification of the calcium regions. At the end, the resulting image is smoothed for visualization purposes and casted to its original polar domain.

(A10) The most reliable and faster frameworks are: the combination of Local Binary Patterns feature extraction process with maximum likelihood classification; and, an Adaptative Boosting scheme using a feature vector provided by Accumulation Local Moments.