

SIFT TEXTURE DESCRIPTION FOR UNDERSTANDING BREAST ULTRASOUND IMAGES

Joan Massich, Fabrice Meriaudeau, Melcior Sentís, Sergi Ganau, Elsa Pérez, Domenec Puig, Robert Martí, Arnau Oliver and Joan Martí

Abstract

Texture is a powerful cue for describing structures that show a high degree of similarity in their image intensity patterns. This paper describes the use of Self-Invariant Feature Transform (SIFT), both as low-level and high-level descriptors, applied to differentiate the tissues present in breast US images. For such a task, a subset of 16 images has been randomly selected from a larger dataset of 700 Ultra-Sound (US) images acquired at the *UDIAT Diagnostic Centre of Parc Taulí* in Sabadell (Catalunya), between 2010 and 2012. This subset has been complemented with multi-label Ground Truth (GT), as illustrated in figure 1.

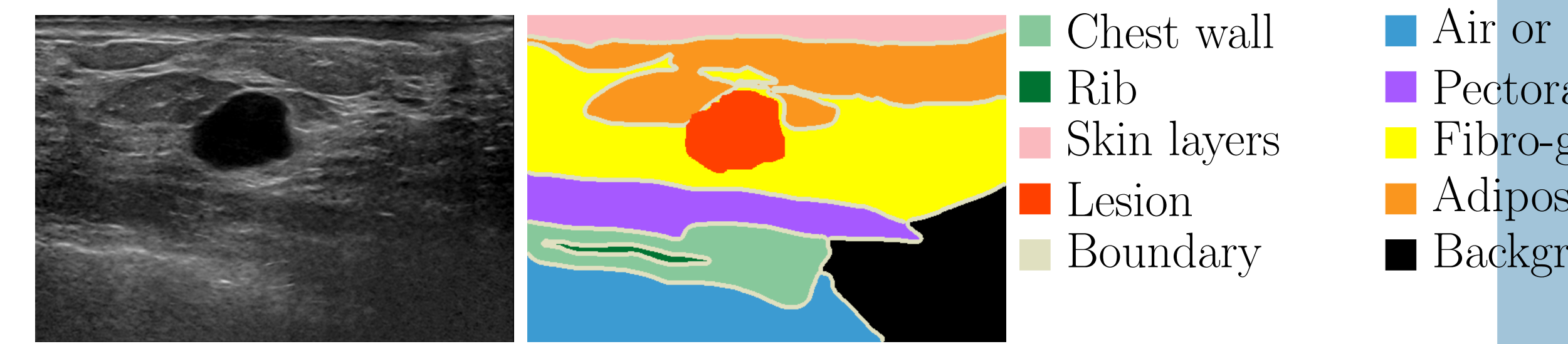


Fig. 1: Dataset sample. From left to right: image sample, accompanying multi-label GT, tissue label GT color-coding.

SIFT as a low-level descriptor, tested using Maximum A Posteriori (MAP)

- Goal: Analyze how separable are the tissue classes present in breast US images
 - Bayesian framework for tissue discrimination (see eq. 1).
 - low-level descriptors based on SIFT
- Feature Description.
 - Extract SIFT descriptors at all pixel positions.
 - Project the 128D SIFT to 2D using Principal Component Analysis (PCA).
- Qualitative analysis can be found in fig. 2-4.
- Quantitative analysis can be found in fig. 5, where a comparison with intensity feature can be found. The overall sensitivity for the intensity case is $16.6 \pm 27.5\%$, whereas for the SIFT case is $18.8 \pm 17.2\%$ which show that both feature spaces produce similar results.

$$P(\omega|\bar{x}) = \frac{P(\bar{x}|\omega) \cdot P(\omega)}{P(\bar{x})} \quad (1)$$

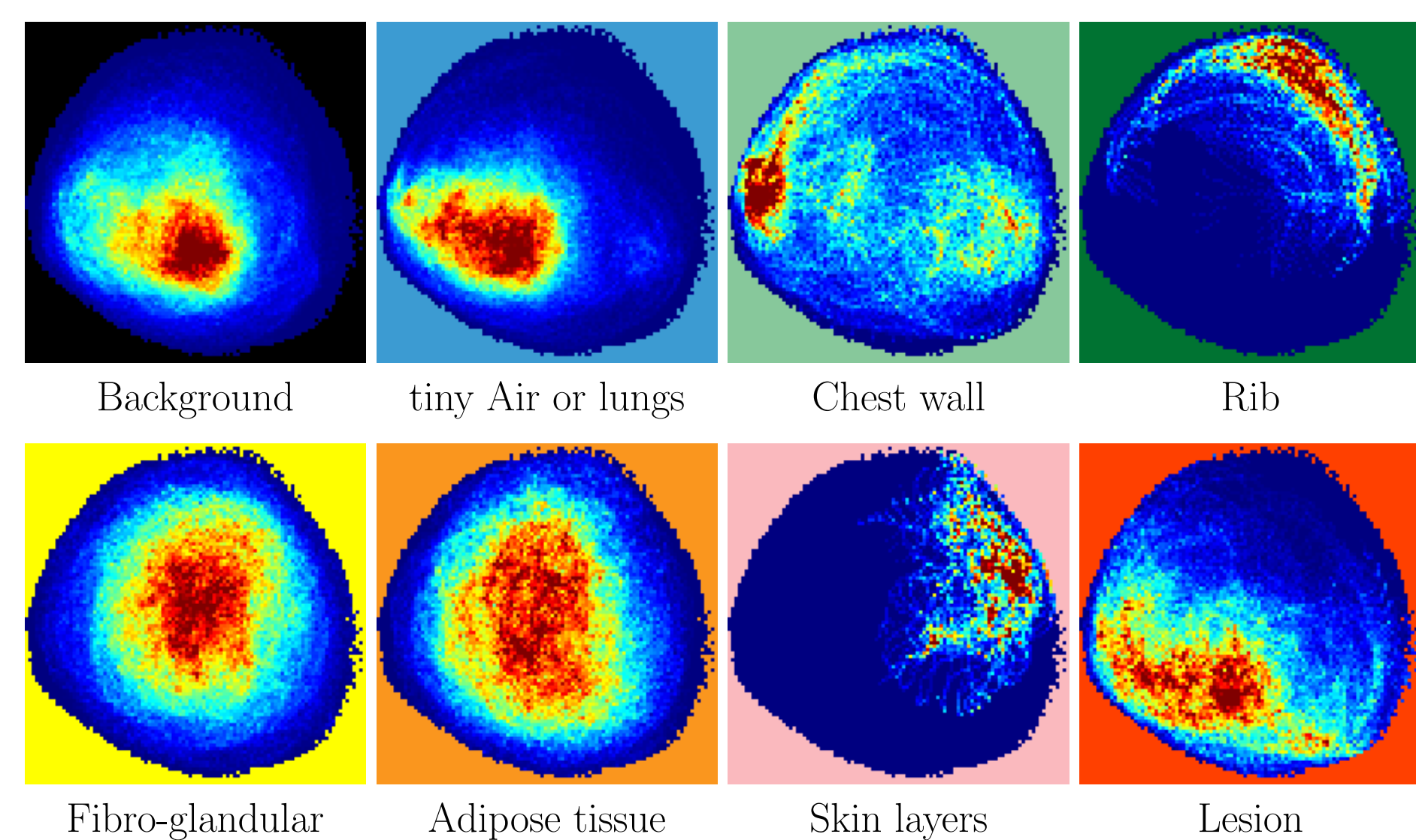


Fig. 2: Distribution of the SIFT descriptors for some classes in the GT.

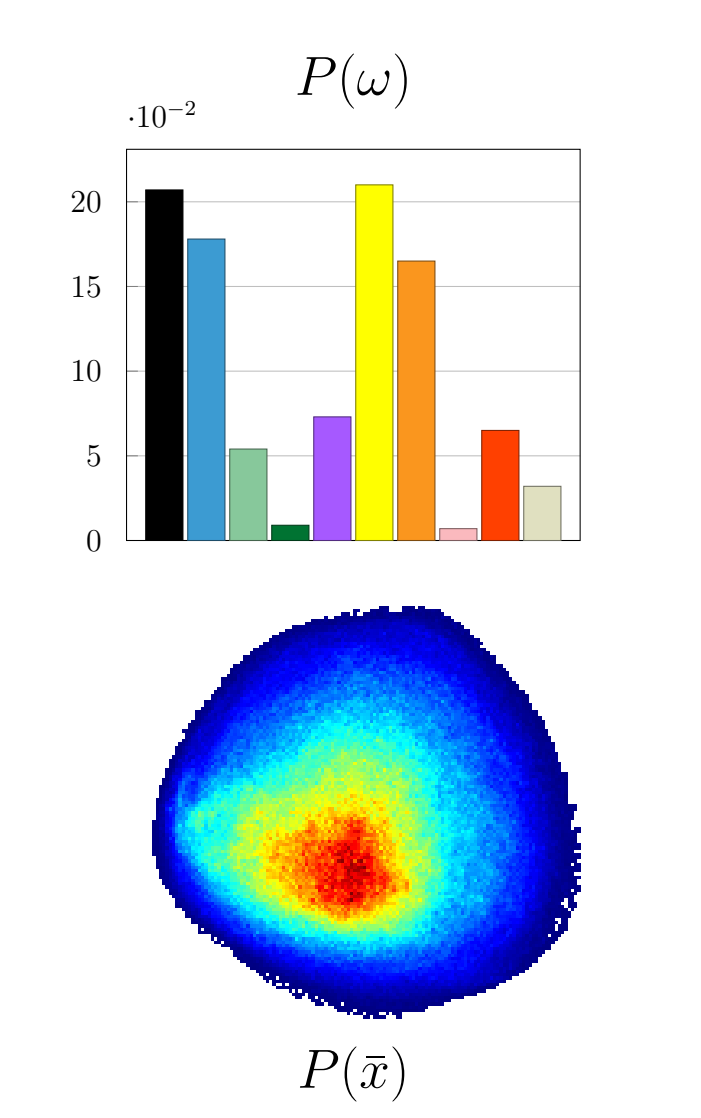


Fig. 3: Data prior knowledge.

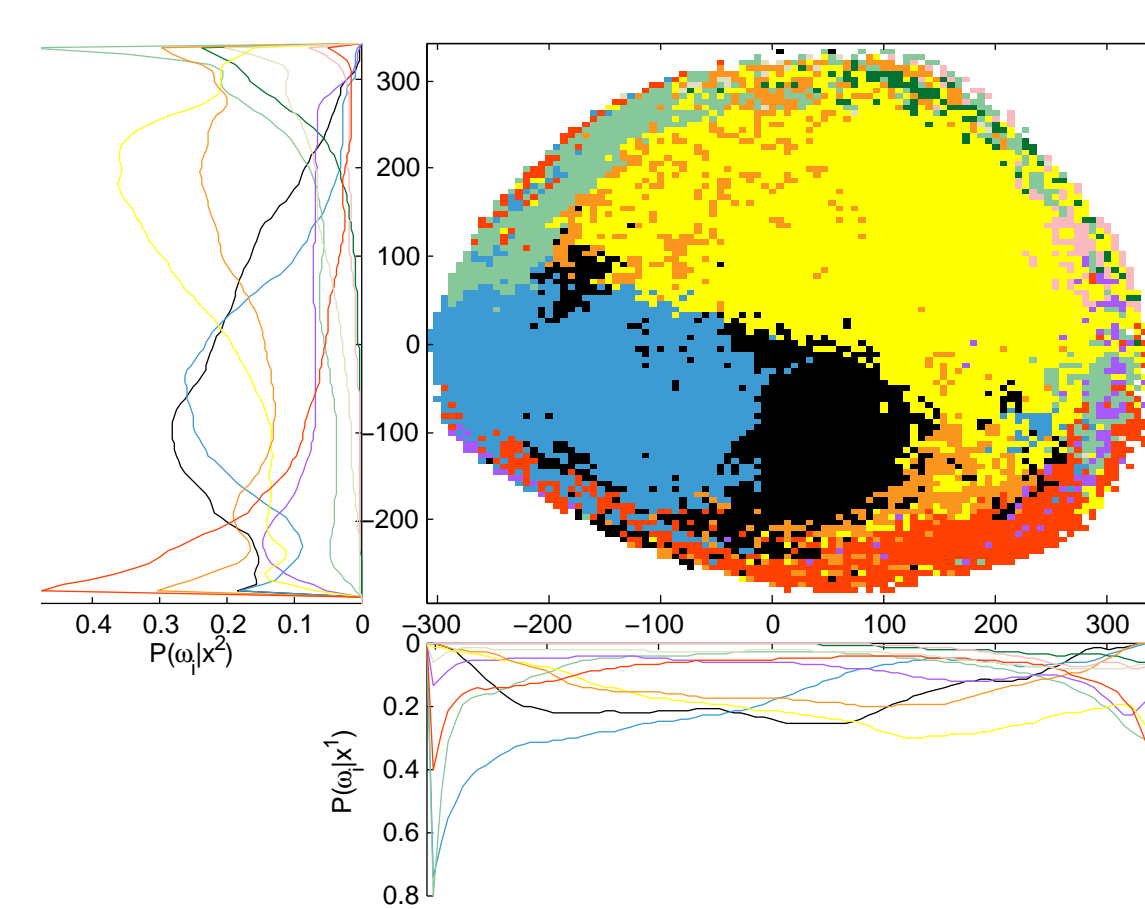


Fig. 4: Qualitative evaluation of the MAP labeling of the feature space.

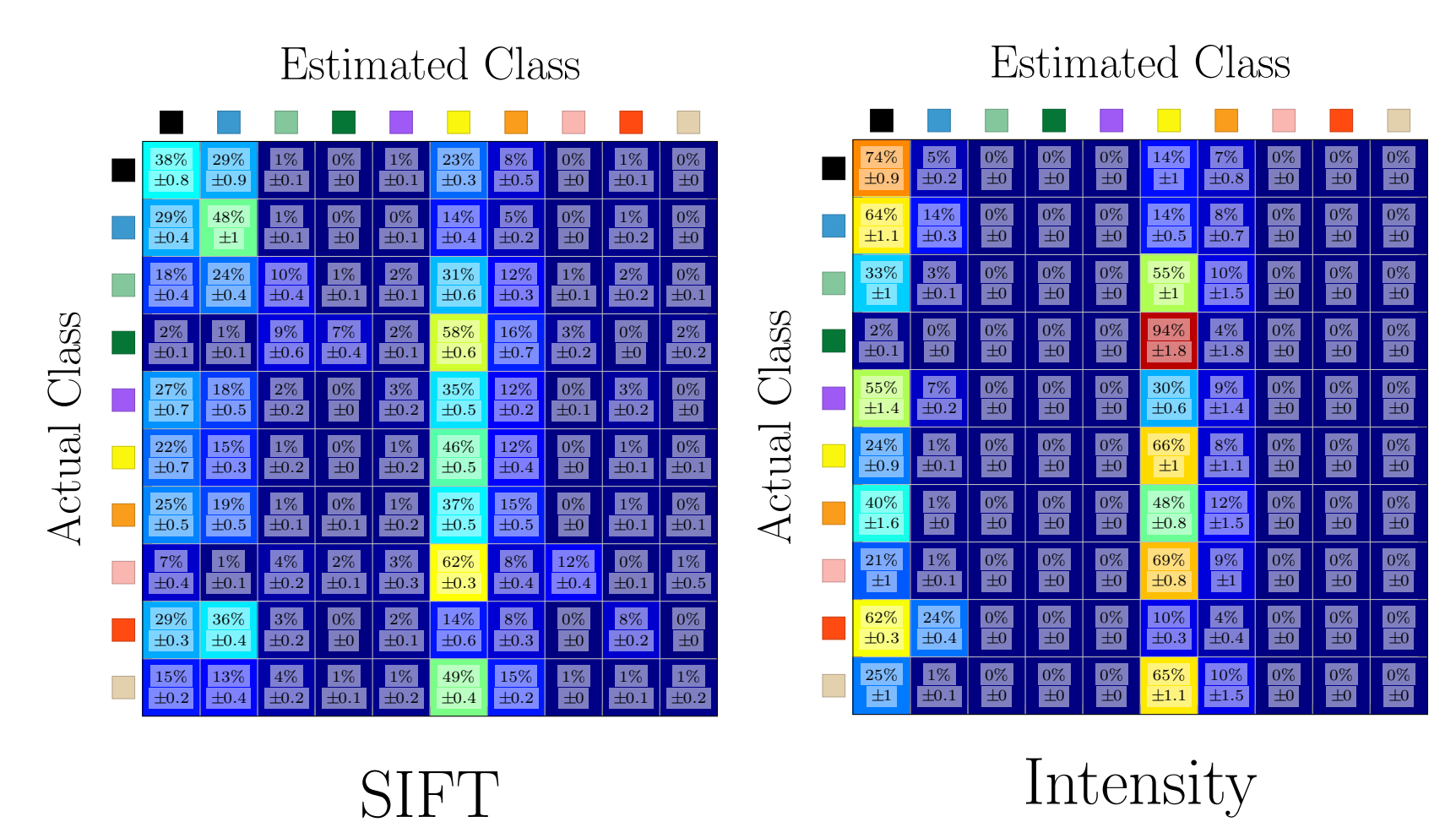


Fig. 5: Confusion matrix showing quantitative results obtained from (10.000 samples \times 10 classes) \times 5 folds cross-validation.

SIFT as a high-level descriptor using Bag-of-Features (BoF), tested using Radial Basis Function (RBF)-Support Vector Machine (SVM) classifier

Texture is an area property related to spatial repetition of structures, statistical similarities, or both.

- Goal: Analyze how separable are the tissue classes present in breast US images
 - Classification framework for tissue discrimination (RBF-SVM).
 - High-level descriptors based on BoF-SIFT.
- Feature Description (see fig. 6).
 - Generate a codebook of the features (k-means, $k = 36$).
 - Extract superpixels (Quick-Shift (QS)).
 - Occurrence study to describe each superpixel.
- Quantitative analysis can be found in fig. 7. The sensitivity achieved is $29 \pm 3.6\%$ for the intenisty and $33.5 \pm 2.3\%$ for SIFT.

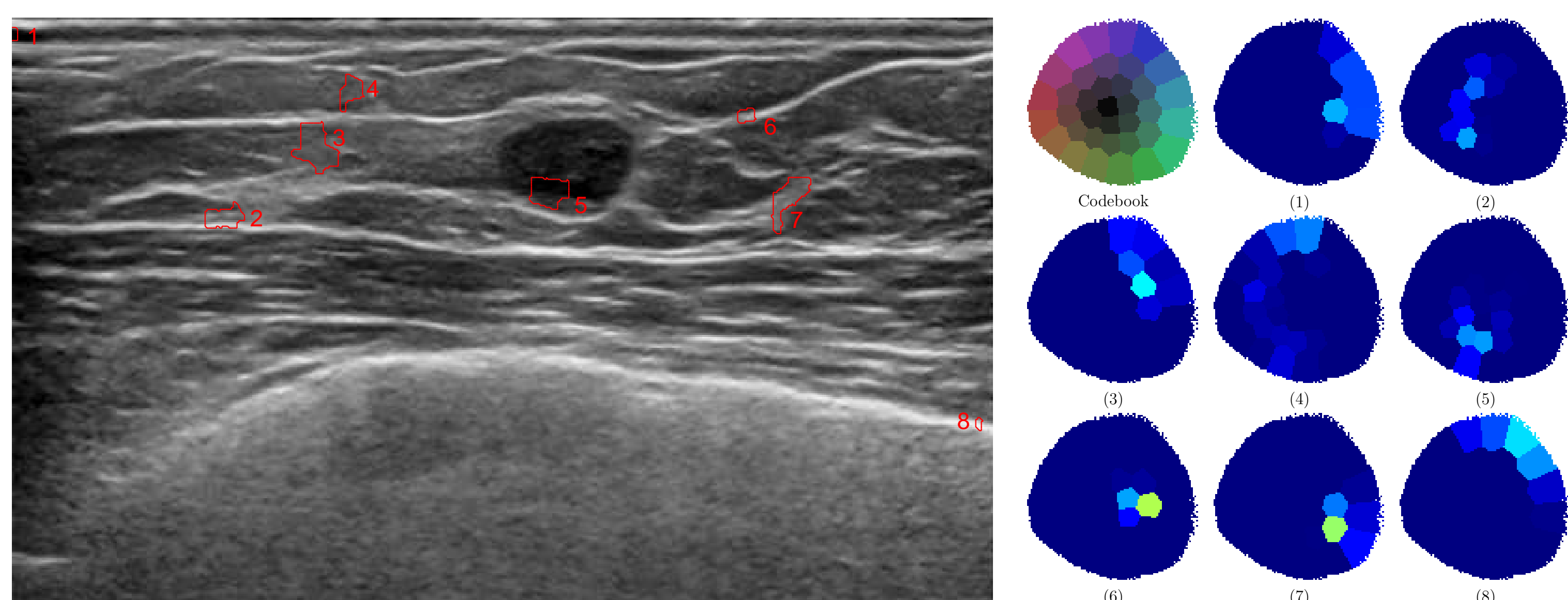


Fig. 6: SIFT-BoF descriptors qualitative analysis. (Left) image example. (Right) Dictionary representation colored using the location of the keypoint location in fig. ??a space. (1-8) Occurrence of the dictionary's key-points associated to each region highlighted in the original image.

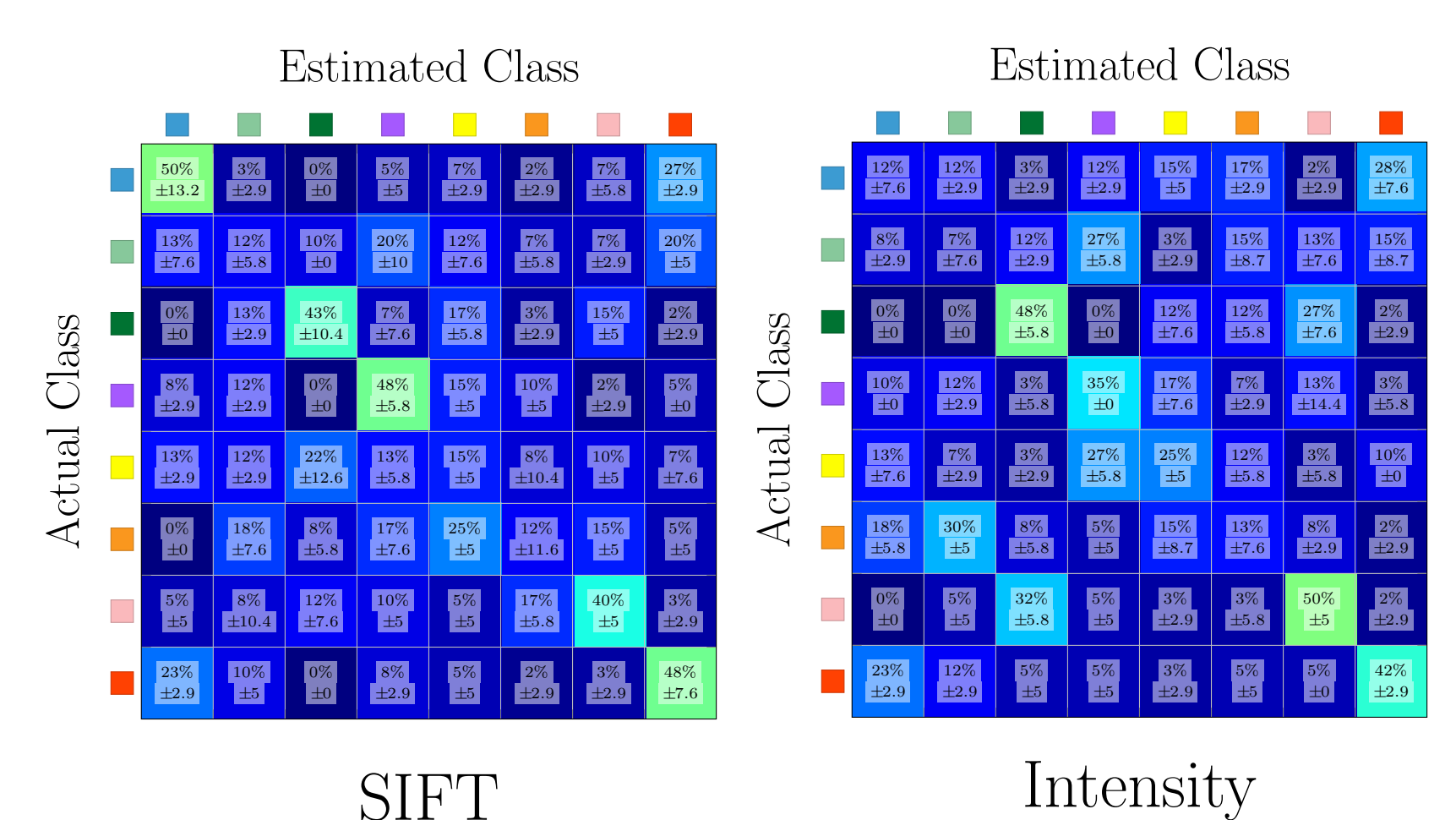


Fig. 7: some caption