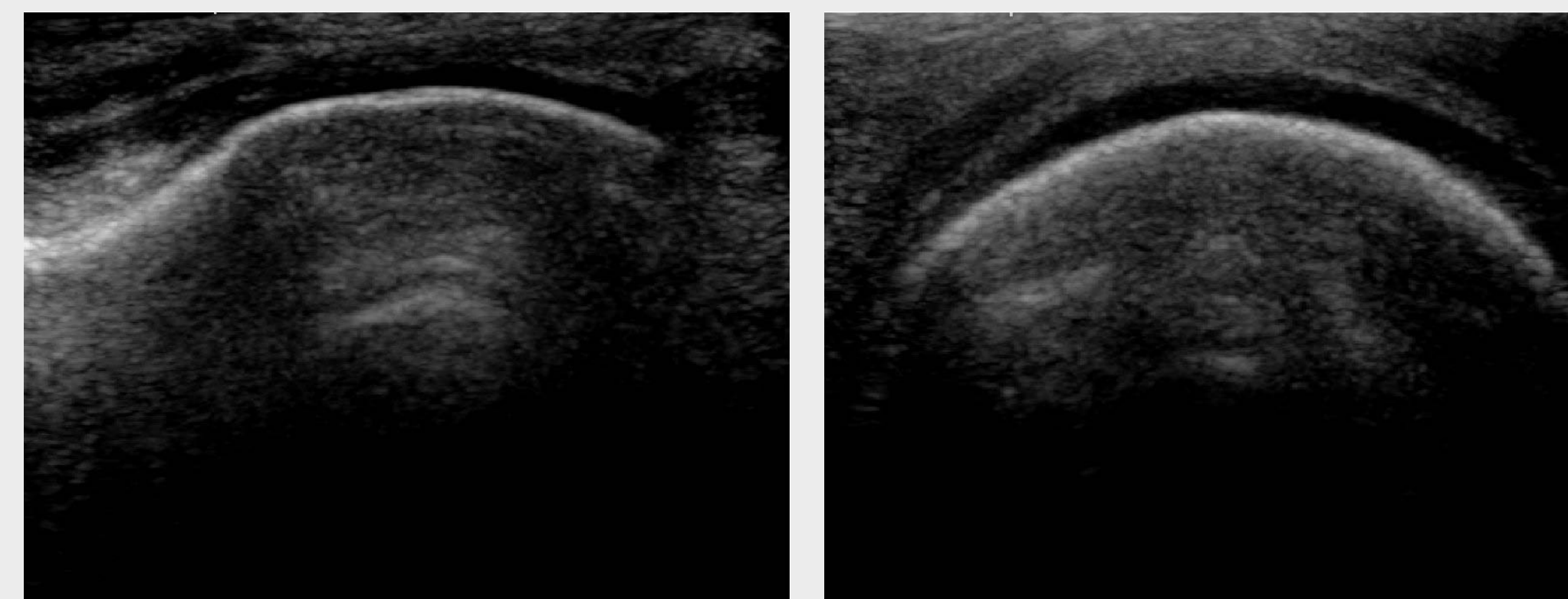


Abstract

This paper presents a simple, reliable, and conceptually different segmentation technique to locate and extract bone contours from ultrasound images. Our technique proposes to fuse several segmentation maps associated with simpler segmentation models in order to get a final reliable and accurate segmentation result. More precisely, our segmentation model aims at fusing several K-means clustering results, each one exploiting, as simple cues, a set of complementary textural features, either spatial or frequential. Eligible models include the gray-level co-occurrence matrix, the re-quantized histogram, the Gabor filter bank, and local DCT coefficients. The experiments reported in this paper demonstrate the efficiency and illustrate all the potential of this segmentation approach.

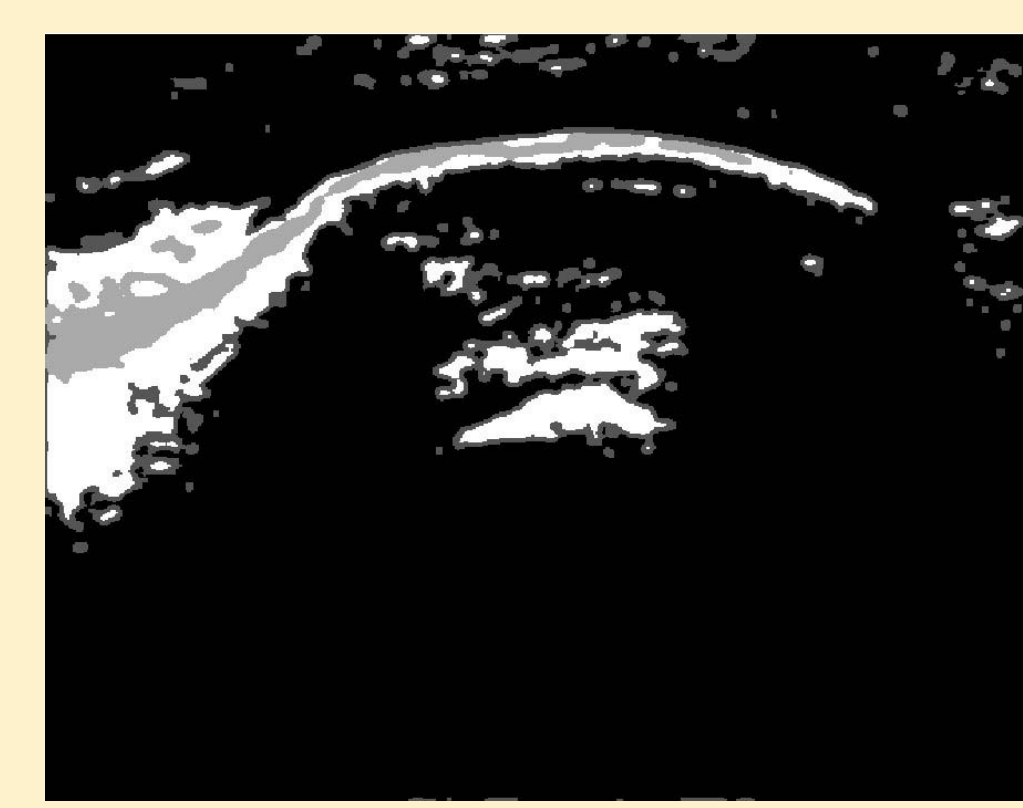
Motivation

Ultrasound imaging is considered to be a safe, non-invasive, portable, and non-expensive visualization medical tool compared to other medical imaging techniques. Automatic ultrasonic detection and segmentation of anatomical structures would allow various clinical applications but is a real challenge due to speckle noise and image artifacts. More precisely, the poor image quality (i.e. low signal-to-noise ratio, low resolution and contrast), and artifacts caused by blood and muscles make contours of anatomical structures, such as bone contours, sometimes imperceptible in certain zones.

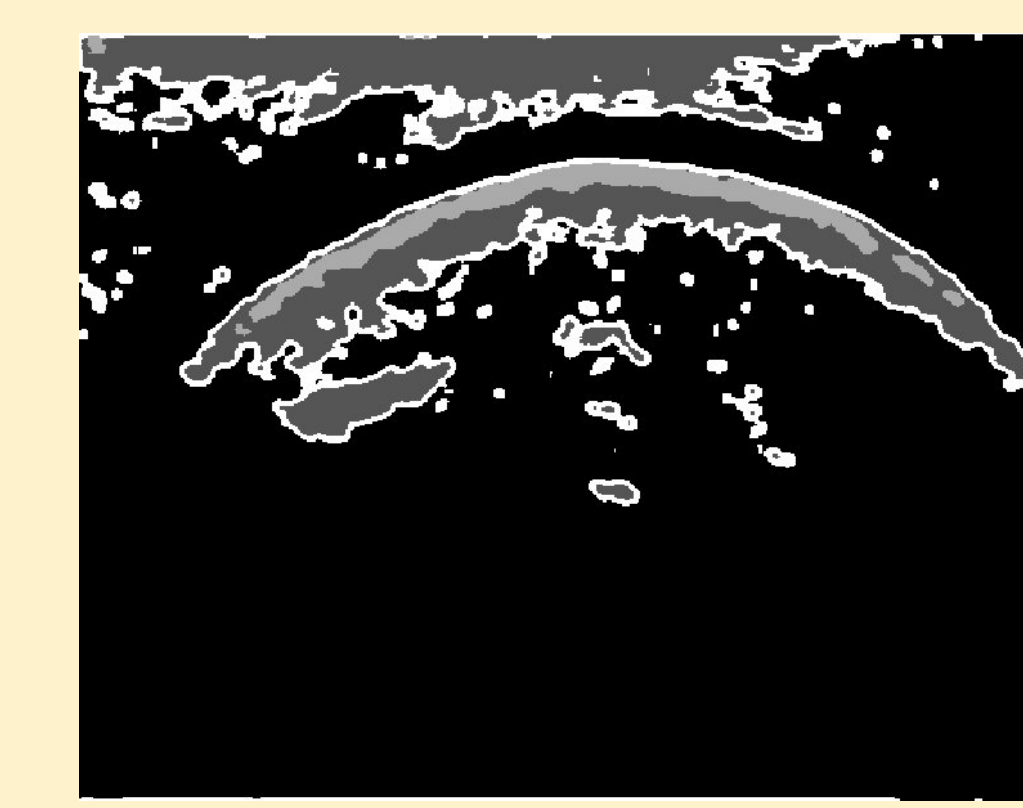


Spatial Textural Features

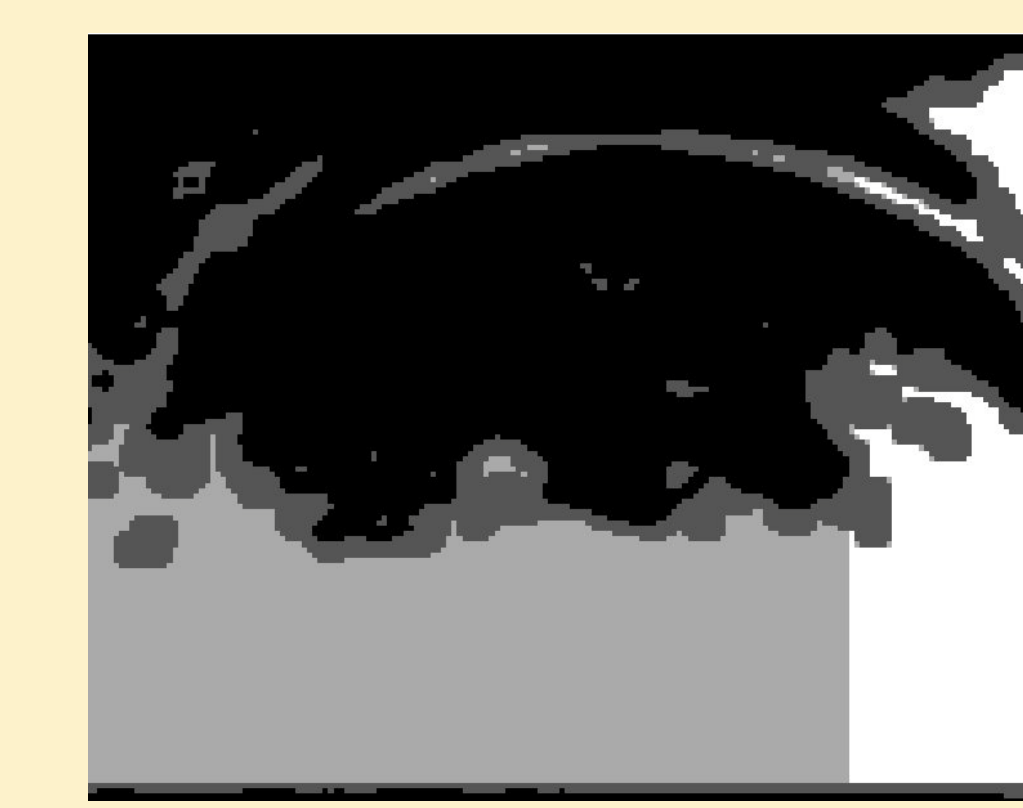
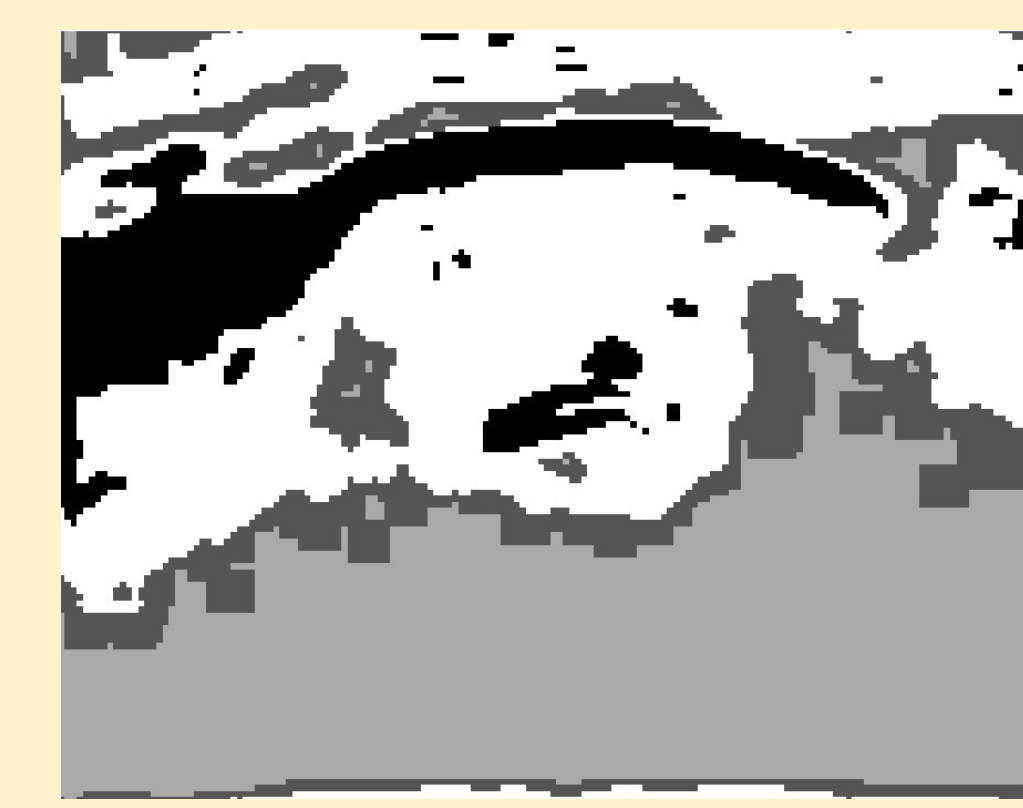
K-means-based Segmentation maps achieved on original images by the following texture model



Quantified histogram

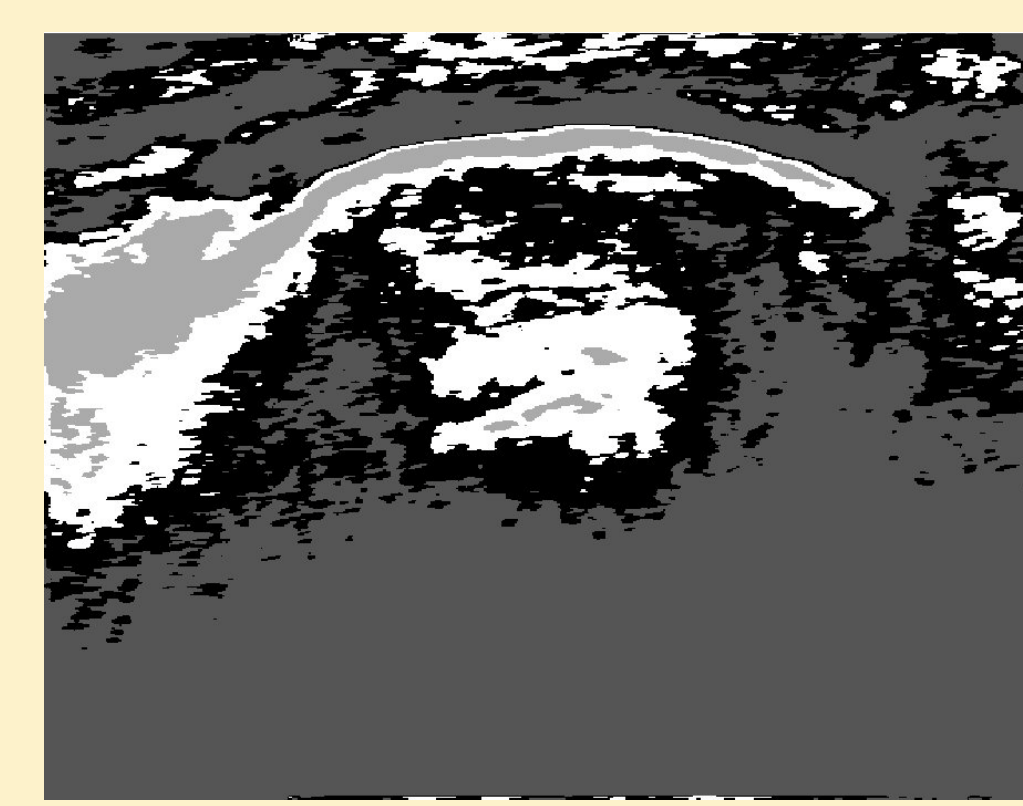


Co-occurrence matrix

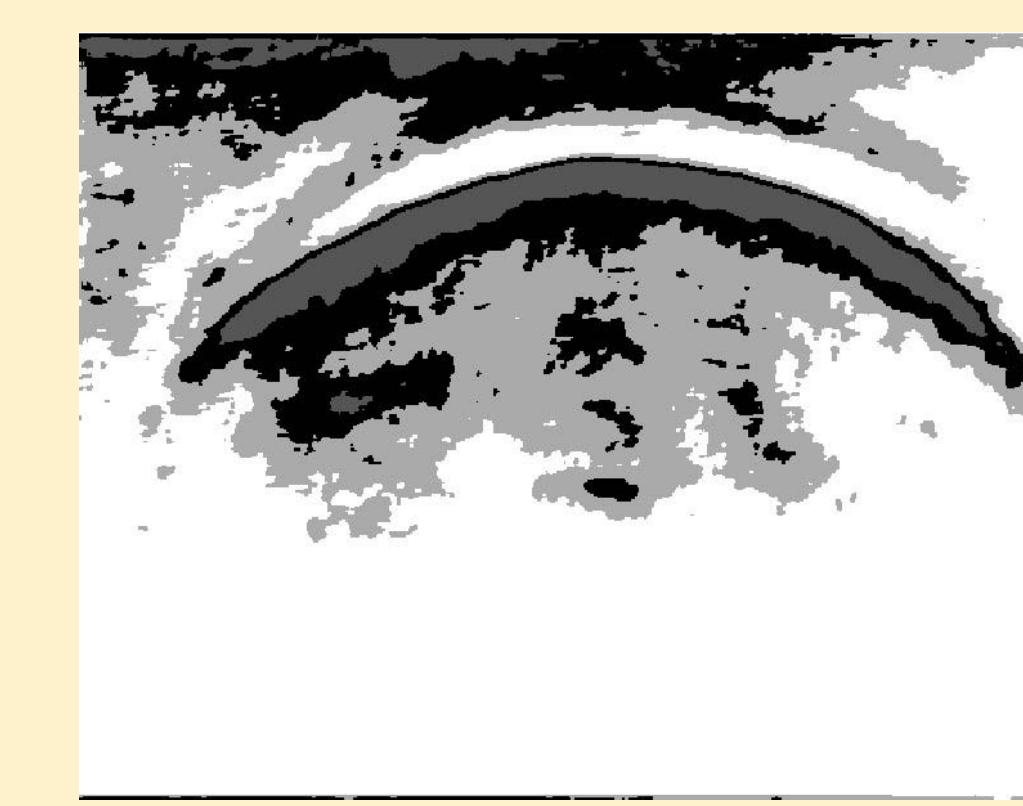


Frequential Textural Features

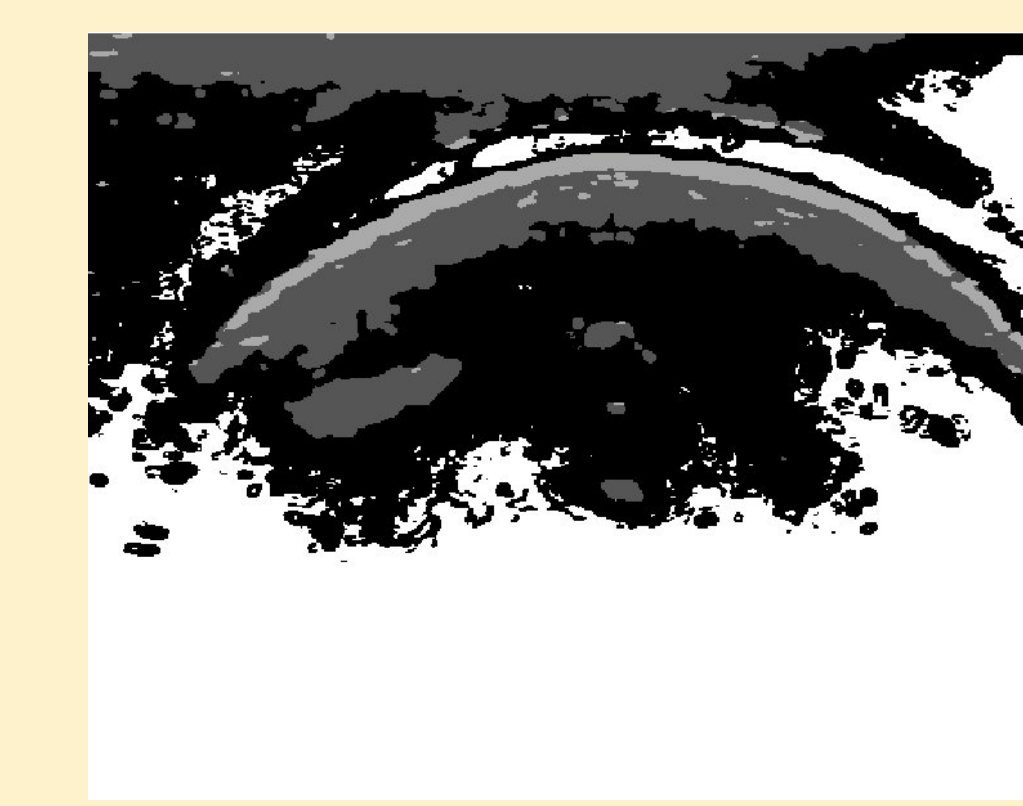
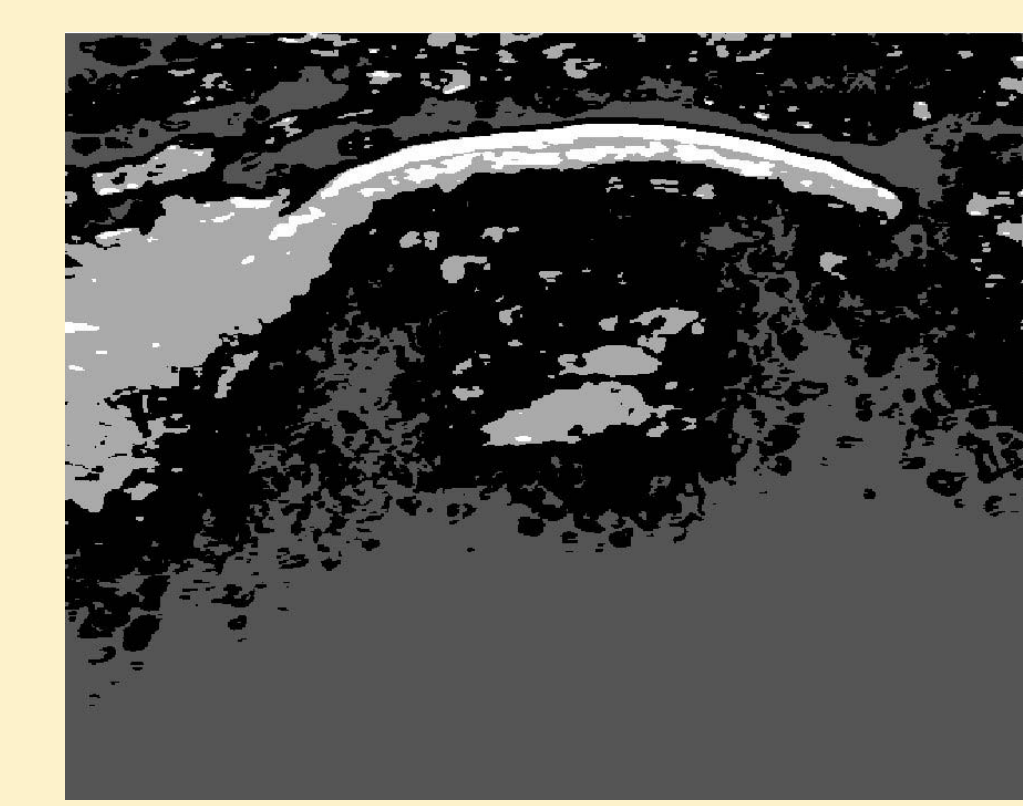
K-means-based Segmentation maps achieved on original images by the following texture model



Discrete cosine transform

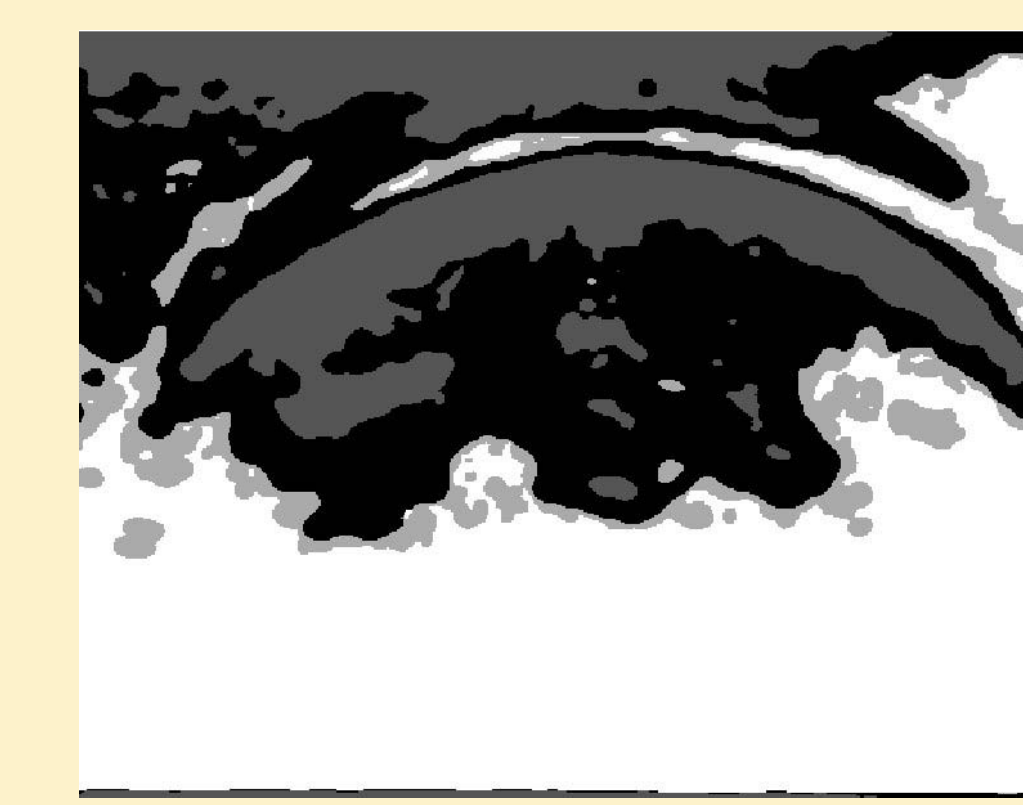
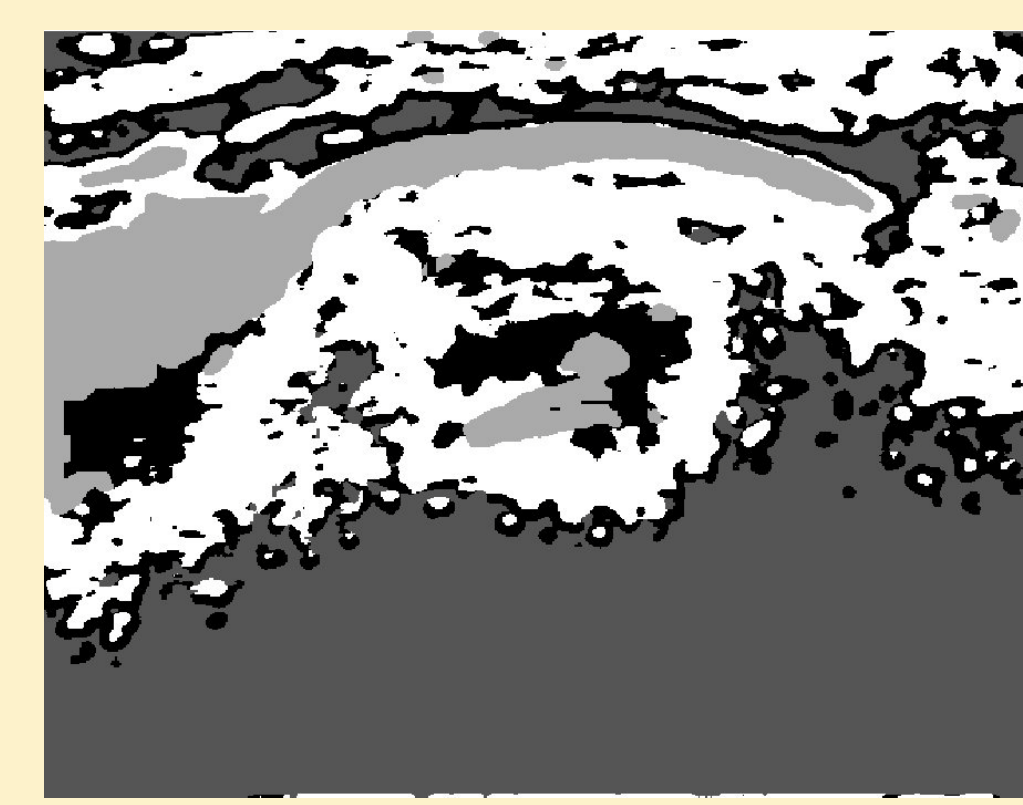


Gabor filter



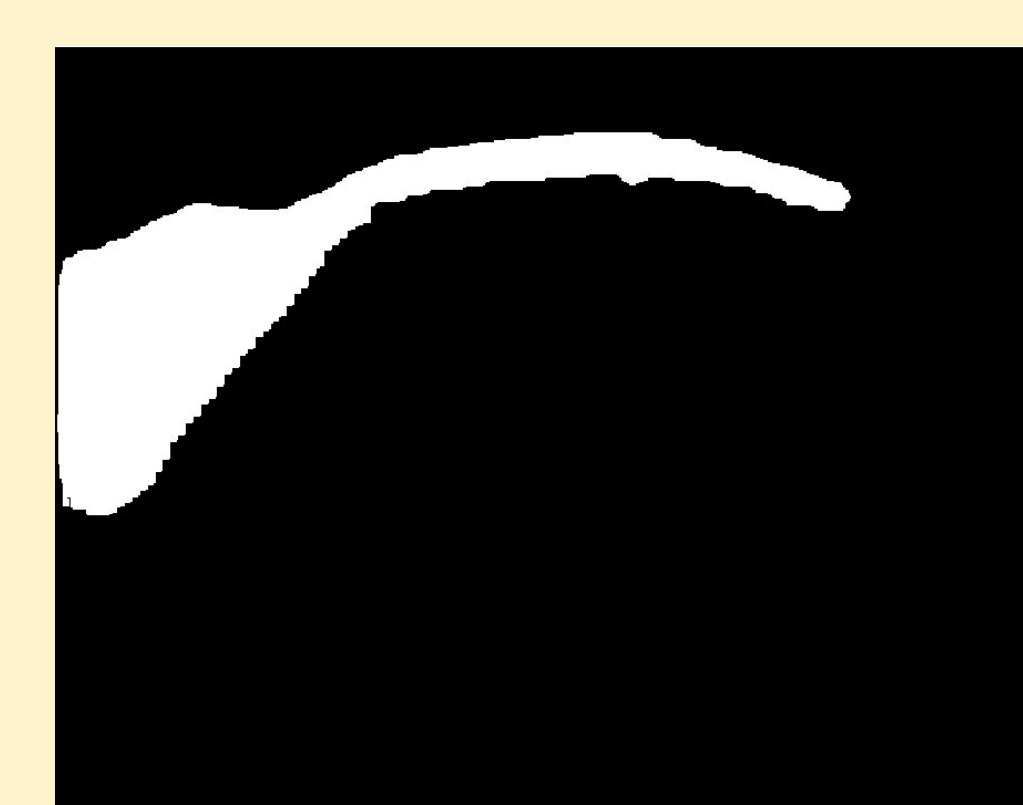
Fusion of Segmentations

Fusion segmentation maps



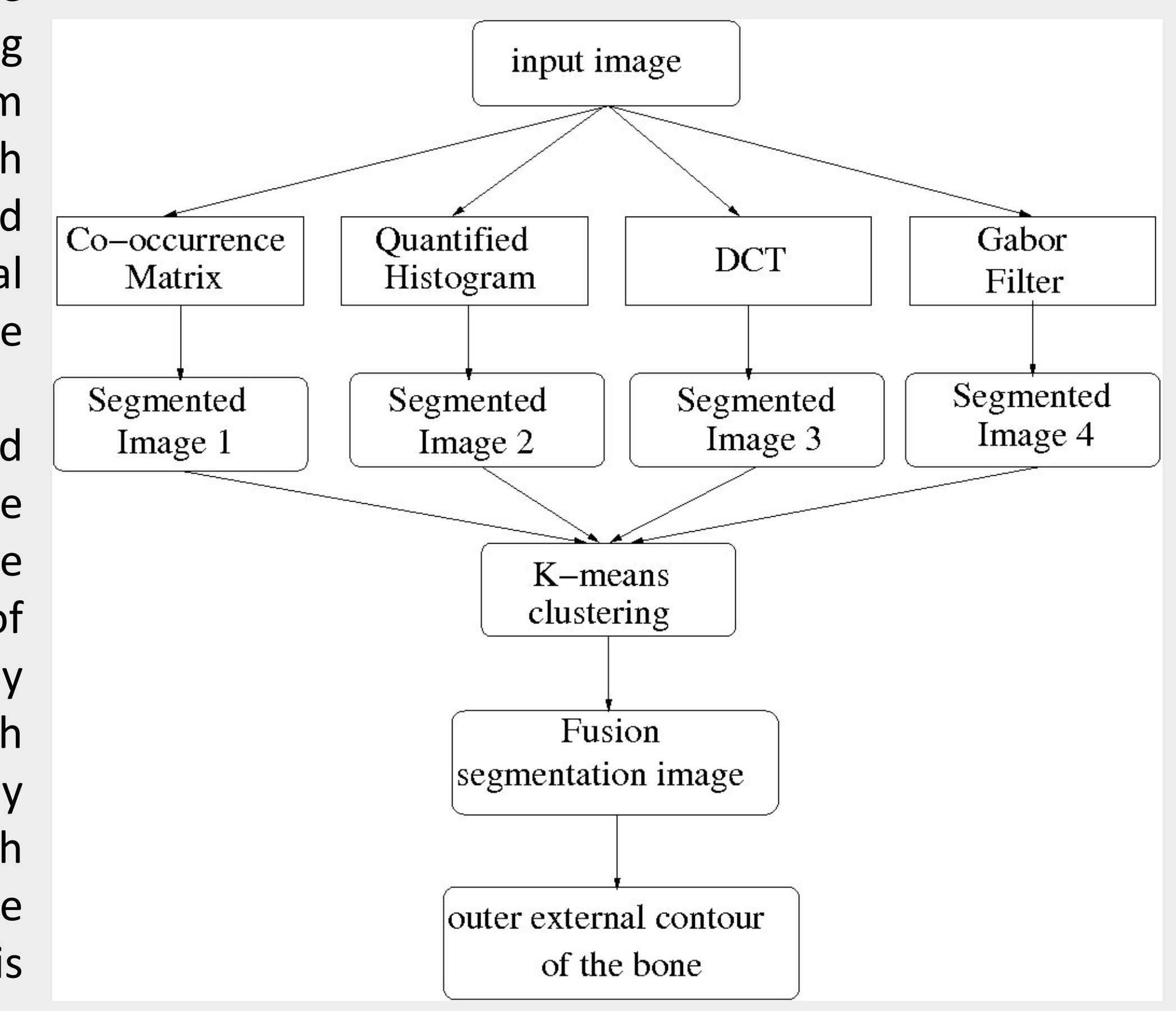
Segmentation Results

Outer region of the bone



Flow diagram of proposed method

Our technique explores the possible alternative of fusing several segmentation results from simpler segmentation models, with each segmentation to be fused using a single set of textural features derived from a single texture model. Our fusion approach allows to find several regions where one corresponds to the outer surface of the bone. The outer contour of the bone is then easily localized by searching the contour which delineates two regions (namely bone and soft tissues) for which the magnitude of the luminance gradient level, computed on this contour, is the highest on average.



Conclusion

In this paper, we have presented a segmentation strategy based on a fusion procedure whose goal is to combine several segmentation maps in order to get a more reliable and accurate segmentation result. We have validated this procedure with ultrasound images acquired with a portable ultrasound machine in the case of unsupervised segmentation of the outer contour of the femur. This fusion method remains simple, fast, easily parallelizable, reliable, and is neither affected by the "curse of dimensionality" problem nor concerned by the feature space normalization problem.

References

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