# GLCM-based Region Boundary Identification in Shoulder Ultrasound

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## Background & Objectives

Frozen shoulder is a common, with ultrasound frequently used for diagnosis. Previous study relied on manual ROI placement along the deltoid-SSC boundary to calculate the Deltoid-Subscapularis Adhesion Index (DSAI), using motion analysis to assess muscle adhesion [1] (Fig. 1). This study uses GLCM (Grey Level Co-occurrence Matrix) texture analysis to extract tissue characteristics from ultrasound images, laying the groundwork for future deep learning-based segmentation and motion analysis to improve diagnostic accuracy.

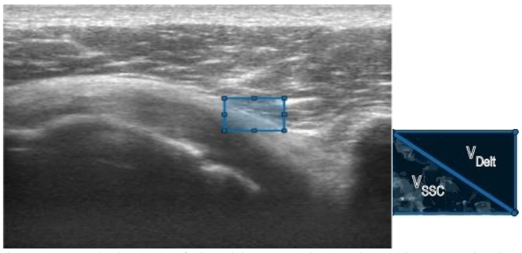


Fig. 1 B-mode image of shoulder muscles and previous methods
Blue rectangle: ROI

## Method

This study uses GLCM to analyze ultrasound images and identify tissue boundaries. Texture features like homogeneity, energy, and mean gray level are extracted to represent properties such as uniformity and intensity variation. These features are visualized as pseudo-color maps, highlighting subtle tissue differences and aiding observation. These maps also serve as essential training samples for machine learning models, enabling the regional segmentation results shown in Fig. 2.1. Combining results from 45° and 135° directions ensures comprehensive texture capture, addressing structural complexity and enhancing tissue differentiation.

Using these methods, the study segments ultrasound images into four regions: skin, deltoid muscle, fascia, and subscapularis & others, providing a strong foundation for automated segmentation research.

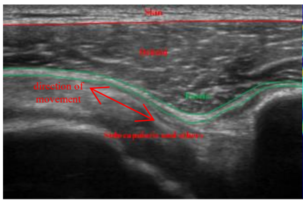

Fig. 1.1 Ideal region segmentation

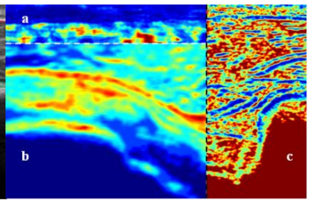


Fig. 2.2 Some feature maps

## Result and discussion

Fig. 2.2 shows a complete image created by combining sections of three feature maps based on Fig. 2.1 and generated with different parameters. All maps use 8 grayscale levels. Section "a" applies "energy" with an offset of 15 and a window size of 20, while sections "b" and "c" use "mean gray level" and "homogeneity" with adjusted settings. Combining these feature maps identifies boundaries, enabling full image segmentation. This method effectively locates the fascial area, separating the muscles and introducing "thickness" as a parameter to enhance diagnostic accuracy.

## Conclusion

This study demonstrates that GLCM texture analysis effectively identifies tissue boundaries, enabling segmentation and introducing "thickness" as a diagnostic parameter. These results will serve as training data for future machine learning models to advance automated analysis.

## Reference

[1] Fujiwara, M, et al. *JSES International* (2024) 8(4), 769-775.