

**Automated MRI-Based Framework for Quantification of Vertebral
Bone Quality Using Neural Network Segmentation, Gaussian
Mixture Modeling, and Entropy Analysis**

Kristian Stojšić

This investigation explores the use of T1-weighted magnetic resonance imaging (MRI) for automated assessment of vertebral bone quality as a non-invasive alternative to conventional densitometric methods. The study focuses on developing a fully automated computational framework that combines neural network-based image segmentation, Gaussian mixture modeling, and entropy-based texture analysis to extract quantitative descriptors of vertebral bone structure and marrow composition. Vertebral bodies and the spinal canal are segmented automatically from lumbar spine MRI data, after which cerebrospinal fluid is isolated for signal normalization and vertebral marrow heterogeneity is characterized using statistical texture metrics. The objective is to evaluate whether MRI-derived signal intensity and heterogeneity can provide meaningful surrogate markers of bone quality beyond traditional bone mineral density measurements. By integrating medical image physics with machine learning and quantitative image analysis, this work investigates the potential of MRI to capture structural and compositional properties of vertebral bone that are not fully represented by conventional imaging metrics, highlighting vertebral bone quality as a complex, multifactorial physical property.