

MULTI-SEQUENCE MRI-BASED HIERARCHICAL MODEL FOR BREAST CANCER MOLECULAR SUBTYPING

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Abstract

Breast cancer is a clinically and biologically heterogeneous disease in which molecular subtype commonly operationalized using hormone receptor (HR) status, HER2 expression, and proliferation indices strongly influences prognosis and treatment planning. In routine practice, subtype assessment relies on tissue sampling and immunohistochemistry (IHC), which can be limited by spatial heterogeneity, sampling error, procedural invasiveness, reporting delay, and variability across laboratories. Multi-sequence breast magnetic resonance imaging (MRI), comprising dynamic contrast-enhanced (DCE) MRI, T2-weighted imaging, and diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) maps, provides complementary information on vascular kinetics, morphology, edema, and cellularity. This project proposes a Multi-sequence MRI-Based Hierarchical Expert Diagnostic Method to predict breast cancer molecular subtype using imaging-derived features and clinical metadata. The method is designed as a clinically aligned decision hierarchy: (i) a lesion-level malignancy gate, (ii) an HR-grouping gate separating HR-positive from HR-negative phenotypes, and (iii) specialized subtype experts to discriminate Luminal A vs Luminal B in the HR-positive branch and HER2-enriched vs triple-negative in the HR-negative branch. This decomposition aims to improve interpretability, reduce class confusion, and reflect real diagnostic workflows. The study outlines a complete pipeline including data preparation, feature extraction (radiomics or learned representations), multi-sequence fusion, model calibration, and evaluation using cross-validation, confusion matrices, and clinically relevant metrics. The expected outcome is a transparent, modular, and extensible framework that supports non-invasive, image-guided stratification of breast cancer subtypes as a decision support tool, with potential to assist radiologists and oncologists in prioritization, personalized planning, and longitudinal monitoring.