HealthManagement
Promoting Management and Leadership

Advancing Multiorgan Segmentation for Abdominal MRI

Magnetic resonance imaging (MRI) is central to modern diagnostic radiology due to its non-invasive nature and detailed imaging capabilities. Automating the segmentation of multiple abdominal organs and structures in MRI can significantly enhance diagnostic accuracy and reduce the workload for radiologists. Yet, most existing segmentation tools are limited in scope, often targeting a narrow range of organs or lacking robustness across datasets. Addressing this gap, the MRISegmenter model was developed to provide accurate and comprehensive segmentation of 62 abdominal organs and structures using T1-weighted MRI data. A recent article published in Radiology explores the creation, methodology and performance of MRISegmenter, highlighting its contributions to automated abdominal imaging.

A Comprehensive Dataset for Model Development

The development of MRISegmenter relied on a robust and diverse dataset curated from the Picture Archiving and Communication System at the National Institutes of Health Clinical Center. The study retrospectively selected patients who underwent both MRI and CT scans on the same day, between January 2019 and October 2021. After exclusions for complex pathological conditions, the final dataset included 195 patients with 780 MRI volumes. Each volume encompassed four T1-weighted sequences: precontrast, arterial, portal venous and delayed phases. Voxel-level annotations were created for 62 structures, including organs, vessels, muscles and bones.

Must Read: ***DL Harmonisation in Abdominal CT Imaging: Advancing Radiomics Reliability***

To generate accurate segmentations, annotations were refined through an iterative learning process supported by pseudoannotations derived from corresponding CT scans. Manual corrections ensured anatomical accuracy and were reviewed by both junior and senior radiologists. The dataset was divided into training and internal test sets, with demographic balance across sex and ethnicity. Importantly, this dataset uniquely includes both detailed acquisition parameters and patient medical histories, offering a rich resource for model training and evaluation.

Model Architecture and Validation

MRISegmenter was built using the three-dimensional nnU-Net framework, a self-configuring deep learning architecture known for its effectiveness in medical image segmentation. The model underwent fivefold cross-validation on the training set, with an ensemble of five sub-models used during inference. The training process accounted for the complexity and volume of data by extending to 2000 epochs. Loss functions combined binary cross-entropy and soft Dice metrics, optimised using the Adam algorithm.

Internal validation on 240 scans demonstrated the model's capability to consistently segment complex anatomical structures. MRISegmenter achieved a mean Dice score of 0.861 and a normalised surface distance (NSD) of 0.924. Organ-wise performance was strongest in muscles and vessels, followed by organs and bones. Additionally, segmentation accuracy was highest in post-contrast phases, reflecting the improved visibility of structures with contrast enhancement.

Comparative evaluations against existing models—including TotalSegmentator-MRI, TotalVibeSegmentator and an nnU-Net trained on AMOS22—demonstrated MRISegmenter's superiority. It delivered higher Dice scores and NSDs across shared organs, particularly outperforming others in challenging cases involving pathologic abnormalities. These findings affirm the model's robustness and adaptability to real-world clinical variations.

External Validation and Broader Implications

Beyond internal testing, MRISegmenter was assessed on two prominent external datasets: AMOS22 and Duke Liver. Despite being trained exclusively on internal NIH data, the model achieved impressive generalisation. On AMOS22, which includes segmentations for 13 organs, MRISegmenter achieved a mean Dice score of 0.829. Notably, it performed comparably with other models directly trained on this dataset, securing the second-highest performance in a validation comparison.

Even greater accuracy was observed on the Duke Liver dataset, where the model achieved Dice scores exceeding 0.9 across all sequences. The lowest performance in precontrast images aligned with known limitations of visibility in such phases, yet even these scores surpassed benchmarks set by other segmentation tools.

The public release of MRISegmenter and its dataset offers a substantial contribution to the field. It provides a valuable foundation for clinical applications such as body composition analysis, liver disease diagnosis and radiation therapy planning. Moreover, it supports future research by enabling broader use of T1-weighted MRI data with consistent, high-quality annotations.

MRISegmenter is a major advancement in automated multi-organ segmentation for abdominal MRI, offering high accuracy and robust performance across datasets. It addresses key challenges by covering 62 anatomical structures and is publicly available, promoting further research and improving clinical workflows. With plans to expand to additional MRI modalities and pathologies, MRISegmenter is expected to advance abdominal diagnostic imaging.

Source: **Radiology**

Image Credit: **iStock**

Published on : Sun, 4 May 2025