

Interactive deep learning system for myocardial scar mass quantification in post-infarction cardiovascular magnetic resonance

A. Moafi¹, D. Moafi², E M Mirkes³, G P Mccann¹, M. Mehdipour Ghazi⁴, J R Arnold¹

¹University of Leicester, Department of Cardiovascular Sciences, Leicester, United Kingdom of Great Britain & Northern Ireland

²University of Siena, Department of Information Engineering and Mathematics, Siena, Italy

³University of Leicester, Department of Mathematics, Leicester, United Kingdom of Great Britain & Northern Ireland

⁴University of Copenhagen, Department of Computer Science, Copenhagen, Denmark

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Background: Following myocardial infarction, assessment of myocardial scar is critical to effective patient management. Scar extent on late gadolinium enhancement (LGE) cardiovascular magnetic resonance (CMR) provides prognostication and helps guide treatment decisions [1–4]. Despite its value, quantification of scar mass is rarely used in clinical workflows because it requires manual contouring and threshold-based segmentation, which are time-consuming and poorly standardised [5, 6]. Deep learning models have been proposed to automate scar segmentation and quantification, but most show modest accuracy (Dice ~0.63) and limited generalisability, hindering clinical adoption [7]. There remains a need for fast, accurate, and user-adaptable tools to support scar quantification in practice.

Methods: We fine-tuned two pretrained models—a segmentation foundation model and an object detector—on annotated LGE CMR data from multi-centre datasets. The training set included 2,931 short-axis LGE images from 348 patients, with manual scar segmentations used as ground truth. All images were resampled and cropped to a resolution of 256×256 pixels. In a zero-shot setting, we benchmarked three segmentation backbones and several prompt strategies to select the best-performing configuration. This model was further fine-tuned using paired bounding box and point prompts, with the object detector assisting initial localisation. The system was deployed in an interactive interface where users could refine bounding boxes, add point prompts, and trigger segmentation with a single click. Scar mass was computed slice-by-slice using the segmentation mask, DICOM-derived spatial metadata (pixel spacing and slice thickness), and myocardial tissue density. Final scar mass values were automatically aggregated and exported per patient. Segmentation accuracy was evaluated on unseen cases.

Results: The proposed tool (Figure 1) was evaluated on 45 unseen patients. Scar mass estimates were compared with manual reference values based on expert-defined full-width at half-maximum segmentation. Correlation with the reference standard was $R^2 = 0.81$, and the mean absolute error was 2.40 g (mean scar mass: 12.16 ± 8.39 g). The Wilcoxon signed-rank test showed no statistically significant difference between the interactive tool and manual reference measurements ($p = 1.000$), with a median difference of 0.18 grams. Bland–Altman analysis (Figure 2) demonstrated good agreement between the interactive tool and manual reference measurements. The average runtime per patient was 100 seconds, compared to 25 minutes for manual quantification.

Conclusion: This tool enables rapid and accurate myocardial scar mass quantification from CMR images, offering a clinically relevant alternative to manual workflows. By combining deep learning with expert driven interaction, it bridges the gap between automation and usability, supporting real-world integration into cardiac imaging practice.

Figure 1. Interactive tool

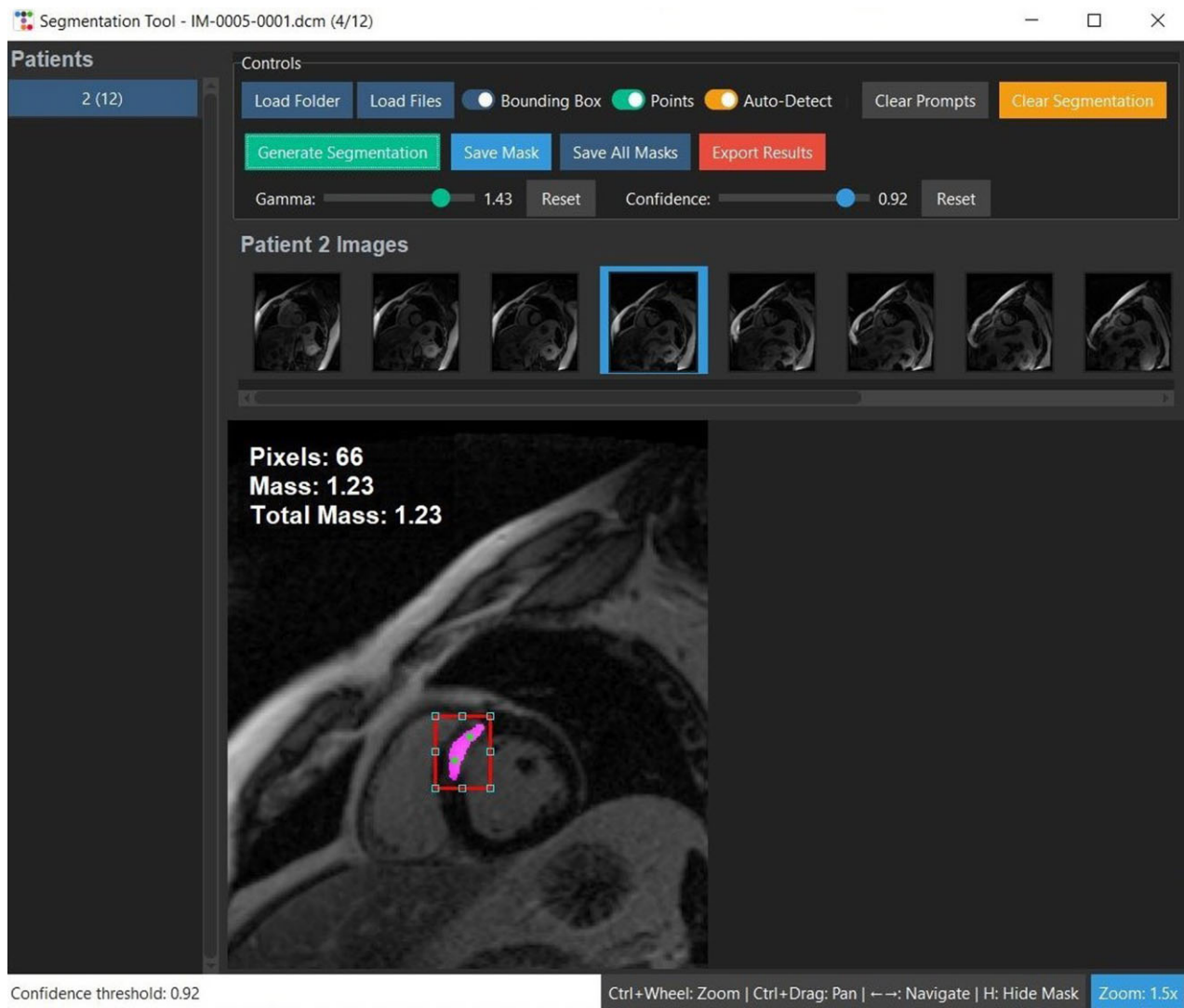


Figure 2. Bland–Altman plot

