ENHANCING WEAKLY SUPERVISED SEMANTIC SEGMENTATION FOR FIBROSIS VIA CONTROLLABLE IMAGE GENERATION

Zhiling Yue[1], Yingying Fang[1]*, Liutao Yang[1], Nikhil Baid[1], Simon Walsh[2], Guang Yang[1,2]*

[1] Bioengineering Department and Imperial-X, Imperial College London, London, UK

[2] National Heart and Lung Institute, Imperial College London, London, UK

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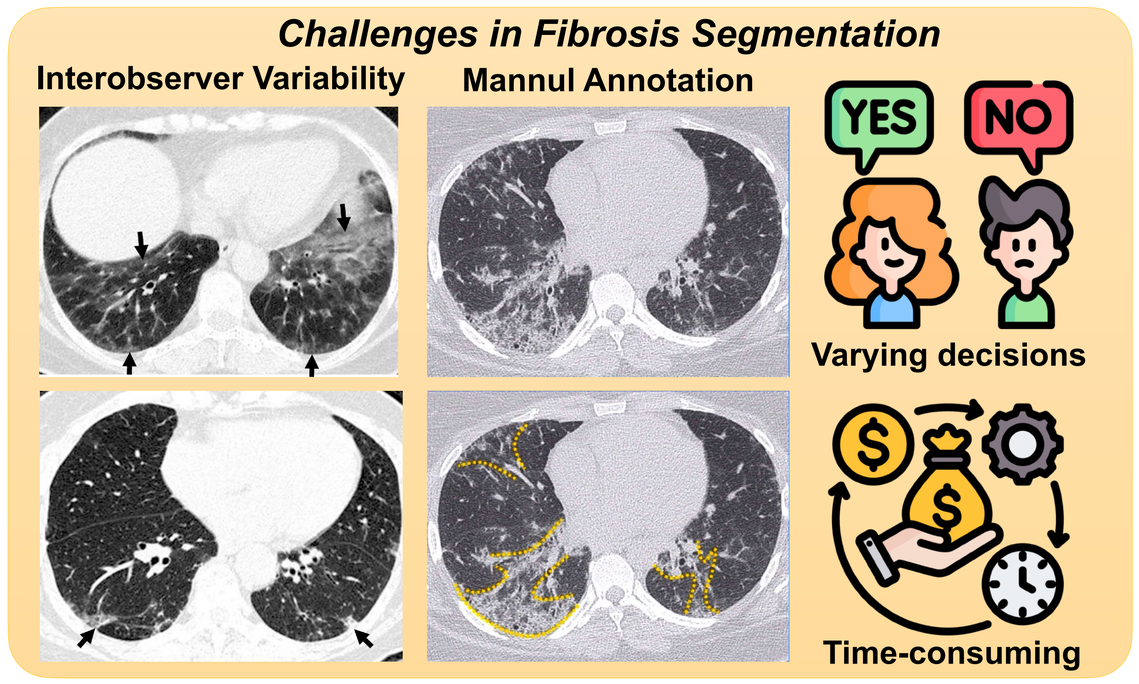
INTRODUCTION

Fibrotic Lung Disease (FLD) is a severe condition marked by lung stiffening and scarring, leading to respiratory decline, responsible for 1% of UK deaths in 2021.

However, fibrosis appears as irregular, diffuse patterns with unclear boundaries, leading to high interobserver variability and time-consuming manual annotation.

We aim to develop an automatic, consistent segmentation tool for fibrosis, while requiring least manual annotations

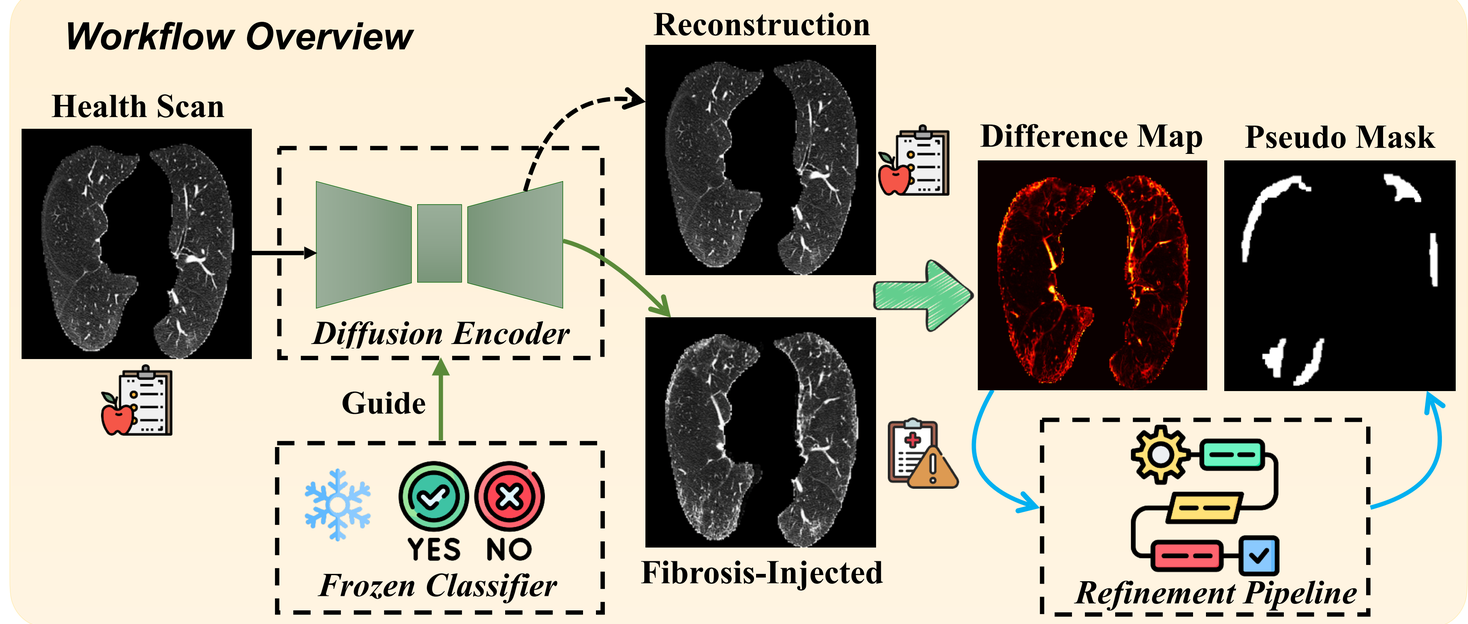


PROPOSED METHOD

We propose a novel diffusion-based weakly supervised semantic segmentation method (DiffSeg,).

Instead of using pixel-level annotations, DiffSeg relies solely on image-level binary labels (yes/no), significantly reducing the need for manual labelling.

It also employs a diffusion model to synthesise HRCT images with varying fibrosis severity from healthy slices, producing paired fibrosis-injected images and corresponding fibrosis locations.



RESULTS

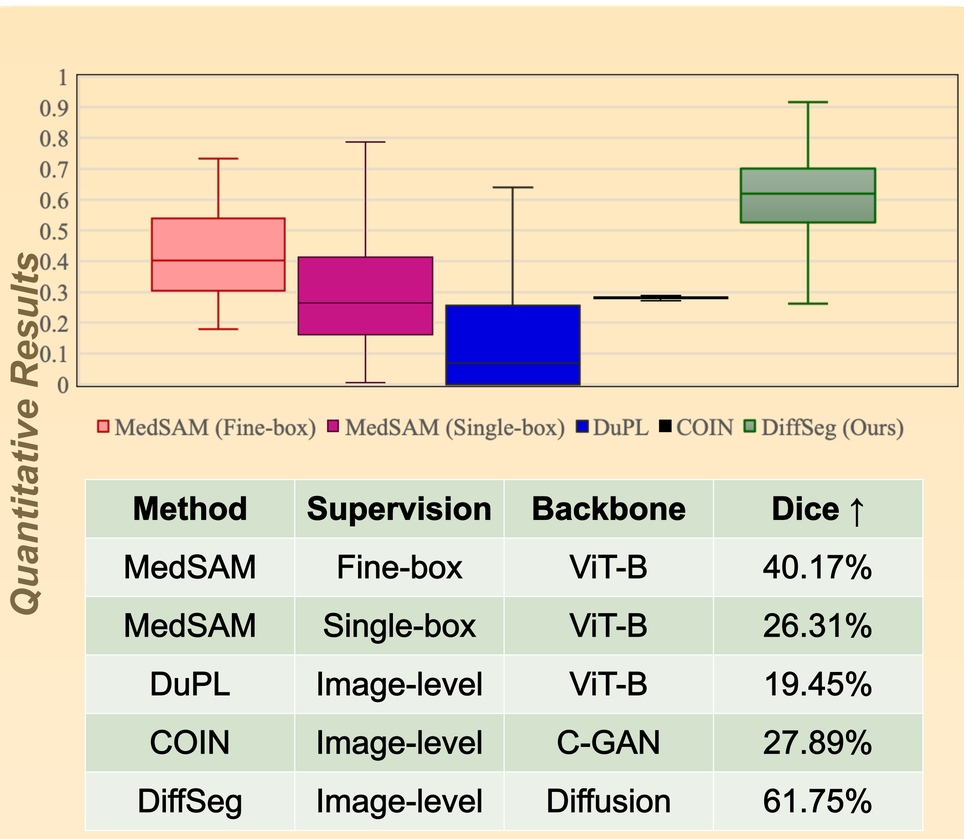
Quantitative Results

DiffSeg achieves state-of-the-art performance, with the highest Dice score of 61.75% (IQR: 52.37–70.02%).
It tends to excel in fine-grained segmentation and surpasses the interactive foundation model MedSAM by up to 35.4%—all without manual annotation.

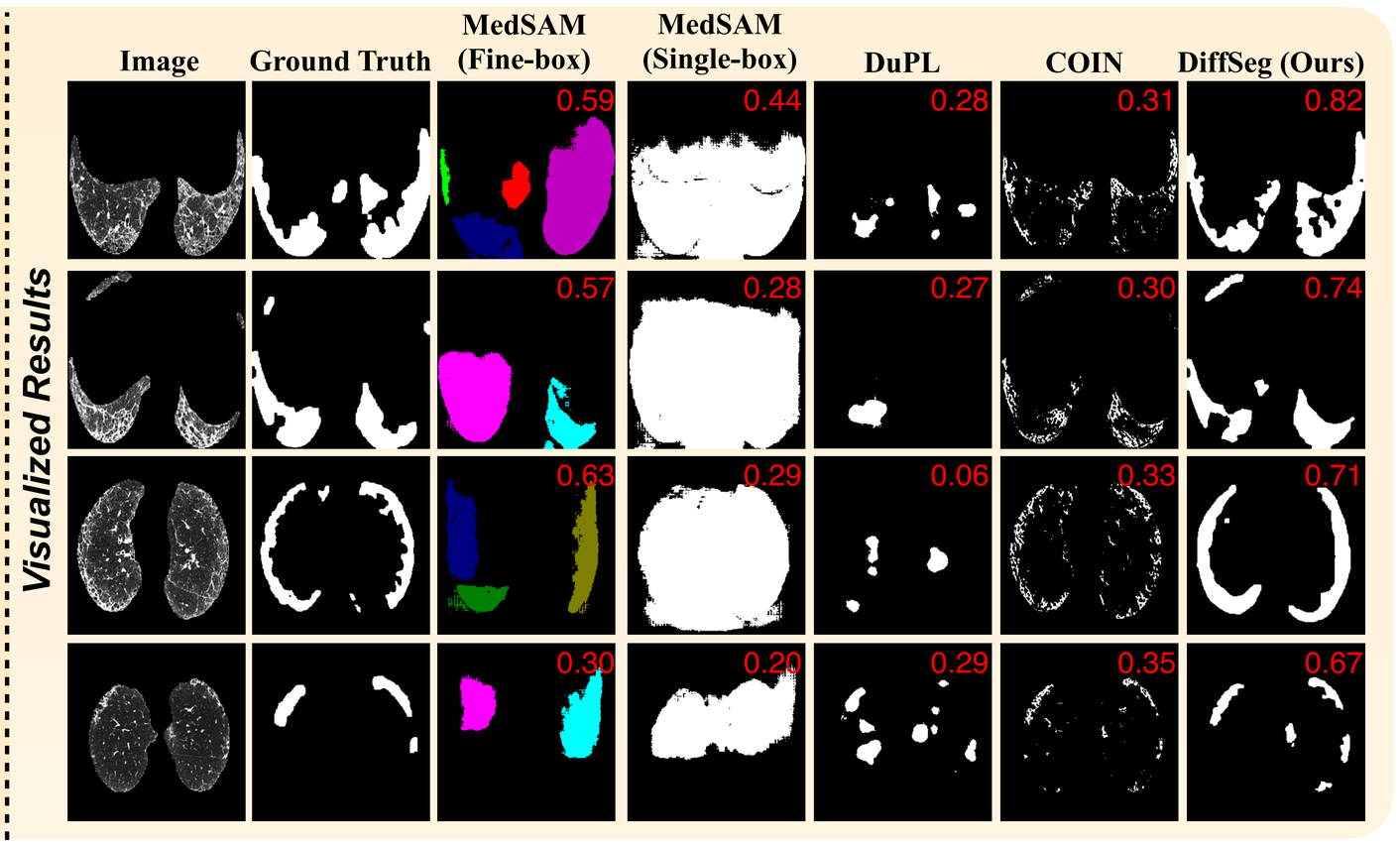
Visualized Results

DiffSeg model produces segmentation that most closely resembled the ground truth with minimal noise.

Additionally, DiffSeg demonstrates the potential to identify more detailed and complex target patterns (e.g., first and last rows, further expert evaluation required.



Method	Supervision	Backbone	Dice ↑
MedSAM	Fine-box	ViT-B	40.17%
MedSAM	Single-box	ViT-B	26.31%
DuPL	Image-level	ViT-B	19.45%
COIN	Image-level	C-GAN	27.89%
DiffSeg	Image-level	Diffusion	61.75%



CONCLUSION

DiffSeg introduces a novel weakly supervised approach using diffusion models for fibrosis segmentation. It demonstrates strong performance using only image-level labels, significantly reducing annotation effort while maintaining competitive accuracy through diffusion-based pseudo mask generation. DiffSeg shows promise as an efficient and practical solution for fine-grained, complex segmentation tasks.

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Contact

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zhilinggavin@gmail.com
y.fang@imperial.ac.uk
g.yang@Imperial.ac.uk

www.linkedin.com/in/gavin-yue
www.linkedin.com/in/yingying-fang
www.linkedin.com/in/gyangmedia