CNN-Based Model for Improved Detection of Free Abdominal Air

Destina Gizem Aydemir[1], Hannah Kunze[2], Johannes Gebauer[2], Lukas Wimmert[2], Rene Werner[2], Gerhard Adam[1], Haissam Ragab[1]

PURPOSE

To **train and validate a deep learning model based on Convolutional Neural Networks (CNN)** to:

- enhance diagnostic efficiency in detecting free air in abdominal CT scans.
- assist clinical decision-making.

METHODS

- 101 abdominal CT scans from routine clinical practice (contrast-enhanced, 5 mm axial slice thickness) were extracted from the PACS, including:
  - 50 with free air (FA-CT)
  - 51 without evidence of free air
- Free air in the FA-CTs was segmented to generate ground truth masks for model training **(Figure 1)**.
- CNN (3D U-Net) based model was trained to perform the segmentation task automatically.
- Model performance was assessed using a 5-fold cross-validation, comparing model predictions vs. ground truth masks.
- Evaluation measures were overall F1 score, precision, recall and mean Dice coefficients across patients.

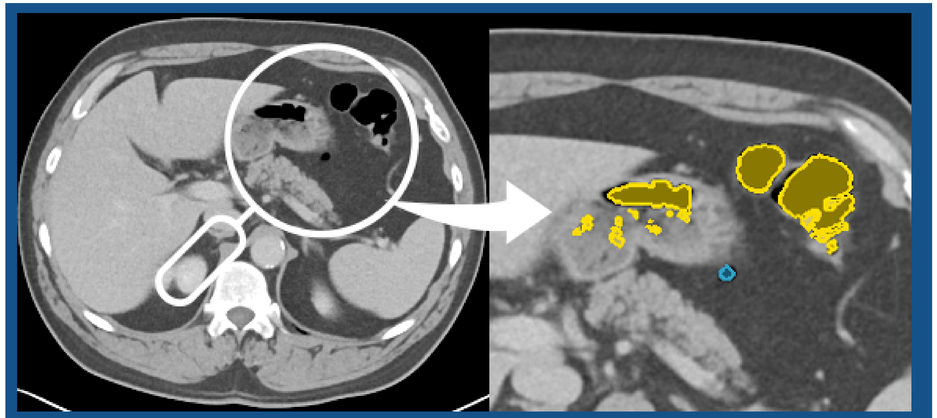


Figure 1: This figure illustrates the segmentation process in abdominal CT scans using a specialized software. On the right, the segmented areas are highlighted: intraluminal air is marked in yellow, and free abdominal air is indicated in blue.

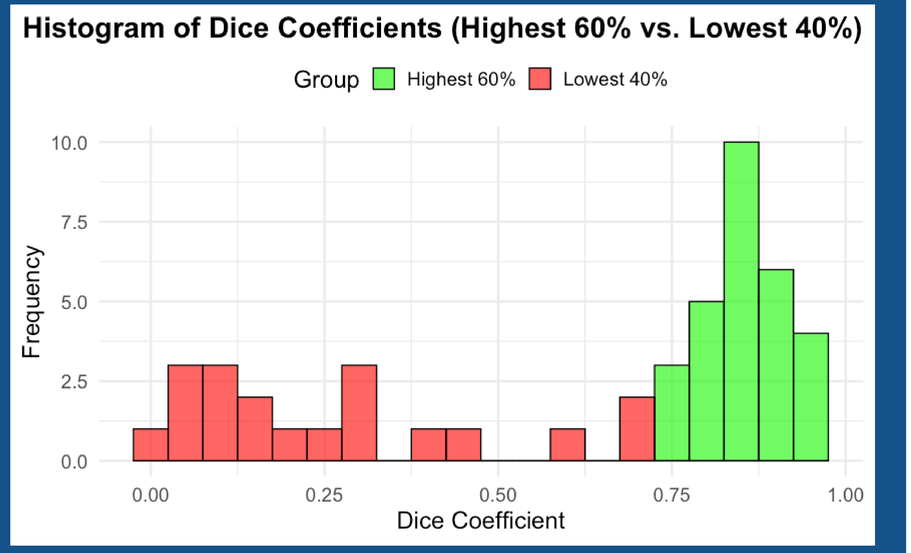


Figure 2: This histogram highlights the difference between the top 60% of CT scans demonstrating a higher mean Dice coefficient, indicating more consistent accuracy, and the rest showing lower mean Dice coefficient, contributing to the overall variability.

RESULTS

- Pixel-wise F1 score achieved was 0.82, with both precision and recall at 0.82 and 0.81, respectively.
- The mean Dice coefficient across patients was 0.58 (± 0.34), indicating significant variability in free air segmentation accuracy among patients.
- Top scoring 60% of the CT scans exhibited a higher mean Dice coefficient of 0.83 (± 0.08) while remaining scans showed lower performance **(Figure 2).**

CONCLUSION

- Our model demonstrates promising results in detecting free air in abdominal CT scans, highlighting its potential for clinical decision-making.
- However, the high variability in the mean Dice coefficients across patients suggests that further improvements are necessary before clinical implementation is feasible.

[1] Department of Diagnostic and Interventional Radiology and Nuclear Medicine
[2] Institute for Applied Medical Informatics

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