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Interpretable Artificial Intelligence-Based Extracapsular Extension Prediction in Head and Neck Cancer Analysis

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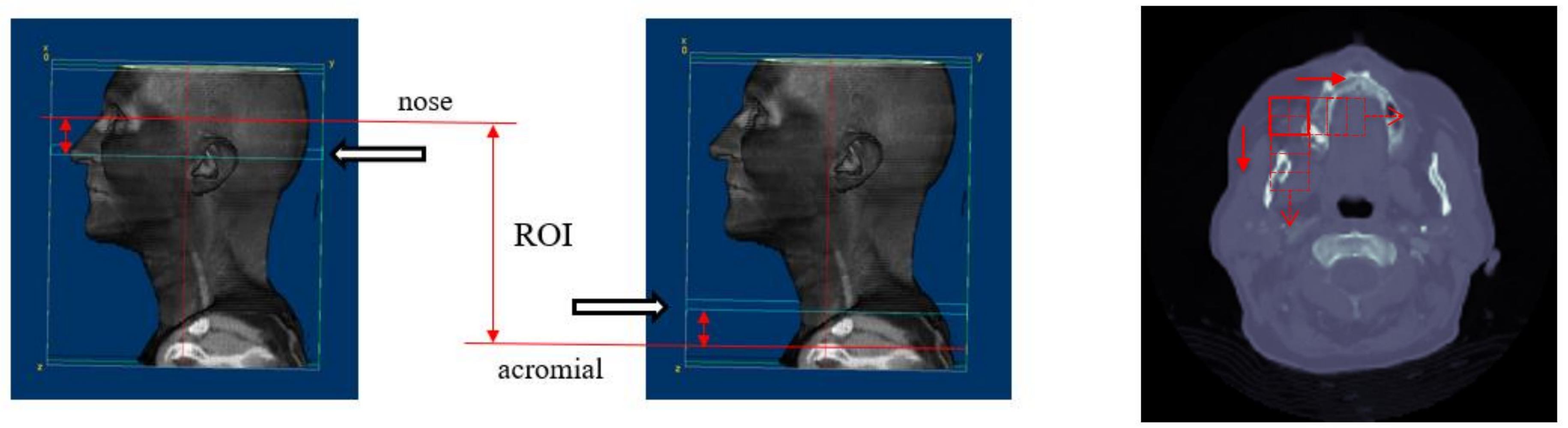
PURPOSE / OBJECTIVES

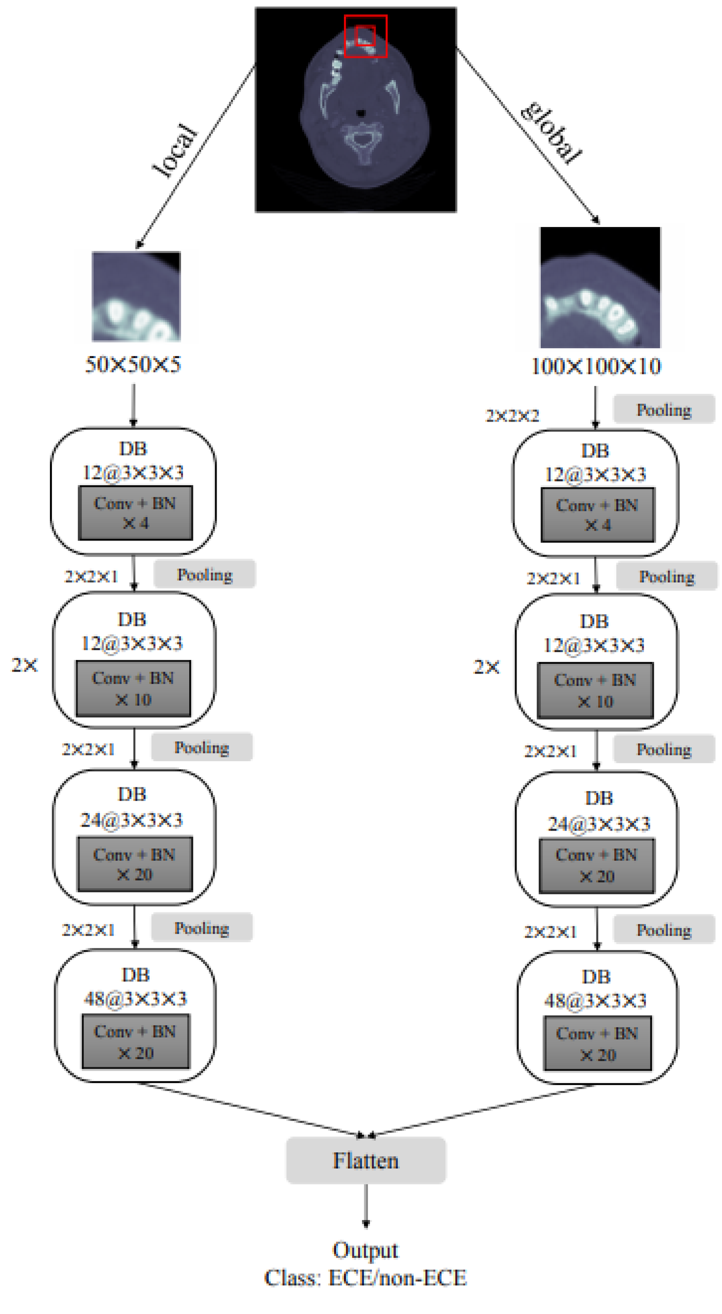
In medical image-based computer-aided diagnosis, various artificial intelligence (AI)-based models have been proposed and demonstrated high performance. However, there is still a gap between the human's understanding and how these models learned, which influence how we understand and trust these AI algorithms. The interpretability of AI models is essential. Our objective is to automatically perform Extracapsular Extension (ECE) detection with an interpretable deep learning technique. ECE is a decisive indication for treatment planning of patients with head and neck squamous cell carcinoma (HNSCC). Current detection practice often requires the visual identification of professionals and ultimately pathologic confirmation. We investigate AI techniques to assist with human identification.

MATERIAL & METHODS

The proposed model has multi-input that captures information with different scales. The deep convolutional neural network (DCNN) structure has been implemented. To check the explainability of the model, 3D possibility map is utilized to highlight the possible ECE region. Then, the results can be compared with the locations of lymph node region.

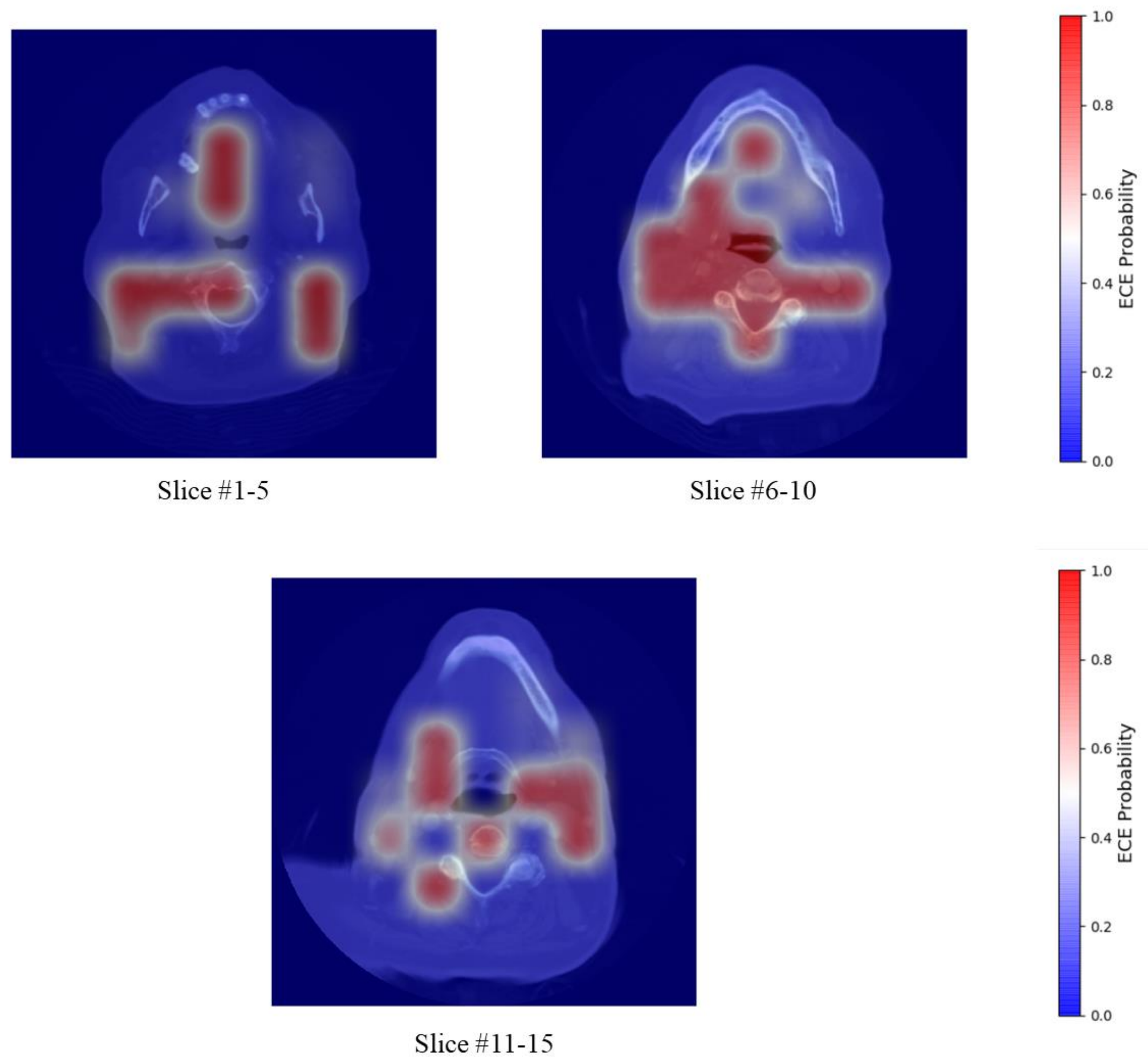


Multi-scale patches extraction from patients with different overlap settings.



Conv: convolutional layer; BN: batch normalization; DB: dense block

Both local and global information algorithm learning.



For model interpretability, the above figure shows the areas contribute to ECE.

RESULTS

Our model can identify ECE and non-ECE patients. Specifically, we have achieved the ECE detection with 96.92% accuracy, and 98.84% AUC. ECE probability maps are generated showing ECE high potential regions enhancing the interpretability of the model.

DL Model	3D DenseNet		3D Baseline CNN		
	Single-input local	Multi-input	Single-input local	Single-input global	Multi-input
Training accuracy	0.9044	1.0000	0.9020	0.9947	0.9925
Validation accuracy	0.6918	0.9532	0.8540	0.9160	**0.9692**
Training AUC	0.9367	1.0000	0.9458	0.9990	0.9961
Validation AUC	0.7152	0.9824	0.9055	0.9562	**0.9884**

SUMMARY / CONCLUSION

The research demonstrates the capability to use artificial intelligence for ECE detection. By introducing the possibility map, we can identify where ECE has possibly occurred. Therefore, this will contribute to the explainability of the proposed model. The outcome of this study is expected to promote the implementation of interpretable artificial intelligence-assist ECE detection.