Using Explainable AI in Immunohistochemistry Cell Images for Cancer Diagnosis

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Immunohistochemistry is a popular method for diagnosing diseases like cancer. To make a diagnosis, pathologists manually analyze every cell in a tissue sample, which is time-consuming and prone to human error. AI and machine learning have made it possible to automate this process, but their use in medical settings is still challenging since pathologists cannot verify how the model reaches its conclusions. This research develops a convolutional neural network (CNN) model with two explainability methods to analyze breast cancer immunohistochemistry images. The dataset was publicly available and contained 1,338 chromatically stained images with over 181,000 annotated cells labeled as cancerous or non-cancerous. The CNN model used a ResNet-50 backbone and was evaluated on accuracy, loss, precision, recall, F1-score, and AUROC. Two explainable AI techniques, SmoothGrad Saliency Maps and Grad-CAM, were used to analyze the model's decisions at both the pixel and regional levels. The model achieved an AUROC score of 98.83%, a precision of 91.72%, and an F1 score of 85.37%. Grad-CAM showed a strong understanding of tumor regions, with an Intersection over Union (IoU) of 0.6705, a Dice Coefficient of 0.8000, and an accuracy of 81.63%. SmoothGrad Saliency Maps had a lower alignment, with an IoU of 0.3307 and a Dice Coefficient of 0.4027. These results show that AI-assisted immunohistochemistry can reduce diagnostic time and minimize human error while maintaining transparency through explainable AI. Rather than replacing pathologists, AI can assist them by improving accuracy and efficiency, potentially leading to earlier cancer detection and better patient outcomes.

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