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Automatic Identification of Glomerular in Whole-Slide Images Using a Modified UNet Model
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Abstract
Glomeruli are interconnected capillaries in the renal cortex that are responsible for blood filtration. Damage to these glomeruli often signifies the presence of kidney disorders like glomerulonephritis and glomerulosclerosis, which can ultimately lead to chronic kidney disease and kidney failure. The timely detection of such conditions is essential for effective treatment. This paper proposes a modified UNet model to accurately detect glomeruli in whole-slide images of kidney tissue. The UNet model was modified by changing the number of filters and feature map dimensions from the first to the last layer to enhance the model's capacity for feature extraction. Moreover, the depth of the UNet model was also improved by adding one more convolution block to both the encoder and decoder sections. The dataset used in the study comprised 20 large whole-side images. Due to their large size, the images were cropped into 512 × 512-pixel patches, resulting in a dataset comprising 50,486 images. The proposed model performed well, with 95.7% accuracy, 97.2% precision, 96.4% recall, and 96.7% F1-score. These results demonstrate the proposed model's superior performance compared to the original UNet model, the UNet model with EfficientNetb3, and the current state-of-the-art. Based on these experimental findings, it has been determined that the proposed model accurately identifies glomeruli in extracted kidney patches.

Author Keywords
deep learning; detection; glomerular; kidney tissue; UNet; whole-slide images

Index Keywords
Article, automation, controlled study, deep learning, digital imaging, feature extraction, glomerulus, human, human tissue, kidney biopsy, kidney tissue, measurement accuracy, measurement precision, microscopy, whole slide imaging

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