NephroNet: A Novel Program for Identifying Renal Cell Carcinoma and Generating Synthetic Training Images With Convolutional Neural Networks and Diffusion Models

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Renal cell carcinoma (RCC) is a type of cancer that originates in the kidneys and is the most common type of kidney cancer in adults. It can be classified into several subtypes, including clear cell RCC, papillary RCC, and chromophobe RCC. In this study, an artificial intelligence model was developed and trained for classifying different subtypes of RCC using ResNet-18, a convolutional neural network that has been widely used for image classification tasks. The model was trained on a dataset of RCC histopathology images, which consisted of digital images of RCC surgical resection slides that were annotated with the corresponding subtype labels. The performance of the trained model was evaluated using several metrics, including accuracy. Additionally, in this research, a novel synthetic image generation tool, NephroNet, is developed on diffusion models that are used to generate original images of RCC surgical resection slides. Diffusion models are a class of generative models capable of synthesizing high-quality images from noise. Several diffusers such as Stable Diffusion, Dreambooth Text-to-Image, and Textual Inversion were trained on a dataset of RCC images and were used to generate a series of original images that resembled RCC surgical resection slides, all within the span of fewer than four seconds. The generated images were visually realistic and could be used for creating new training datasets, testing the performance of image analysis algorithms, and training medical professionals. NephroNet is provided as an open-source software package and contains files for data preprocessing, training, and visualization. Overall, this study demonstrates the potential of artificial intelligence and diffusion models for classifying and generating RCC images.

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