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Kidney Glomeruli Measurement System and Methods

-Advances in medical imaging, particularly image processing tools, have become invaluable in medical practices. Imaging tools have been developed to map and measure individual glomeruli in the kidney using contrast agents and gradient-echo MR images (CFE-MRI). CFE-MRI provides comprehensive, 3D measurements of histologic features of the kidney to aid in early detection of kidney pathology. Glomeruli appear as small blobs in CFE-MR images. While there have been a number of blob detectors developed, they are not robust to noise, leading to high false positive rates.

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Researchers at Arizona State University have developed novel deep learning-based methods and systems to create a multi-threshold, multi-scale small blob detector. A pretrained deep learning model denoises the raw images to generate a probability map and detect the centroids of the blobs. Then, two distance maps with bounded probabilities are derived. Difference of Gaussian filters with an adaptive scale constrained by the bounded distance maps, followed by Hessian analysis are applied for final blob segmentation. This method was tested both in silico and on a 3D MRI dataset of human and mouse kidneys and statistically outperformed the blob detectors it was compared to.

This system is an adaptive and effective tuning-free method for blob detection and segmentation giving it the potential for kidney biomarker identification and greater clinical utility.

Potential Applications

- Kidney biomarker identification
- Blob detection for research or pathology

Benefits and Advantages

- Utilization of U-Net reduces over-detection when used in the initial denoising step
 - Over 100% decrease in error rate of blob detection
- Decreases under-segmentation by U-Net with over 80% increase in Dice and IoU
- Difference of Gaussian scale is adapted to the range of blob sizes to better separate touching blobs

- Outperforms, with respect to precision and F-score, existing blob detectors it was compared to

For more information about this opportunity, please see

[Xu et al - IEEE Trans Biomed Eng - 2021](#)

[Xu et al - Nature Sci Rep - 2020](#)

For more information about the inventor(s) and their research, please see

[Dr. Wu's departmental webpage](#)