Real-time Detection of Particles in Peritoneal Dialysate Using Digital Inline Holography and Machine Learning

Huang, Eric (School: Ossining High School)

Peritoneal dialysis, one type of dialysis for patients with end-stage renal disease, can be complicated by peritonitis, a life-threatening inflammation of the peritoneum typically caused by a bacterial infection. Regular screening for particles in peritoneal dialysis effluents, for example, with digital inline holography (DIH), can allow for early detection of peritonitis and improve survival rates of peritonitis patients. However, this requires a quick, automated method of scanning through peritoneal dialysates. Thus, the aim of this study is to develop a machine learning model that can rapidly detect and locate particles in DIH images of peritoneal dialysates. An image dataset containing DIH images of particles in peritoneal dialysates was manually labeled with bounding boxes. Next, the dataset was resized and augmented, before it was then used to train YOLO11n and YOLO12n object detection models. The models achieved frame rates of 120.9 FPS and 84.6 FPS respectively, and mAP50s of 71.8% and 73.3% respectively. The models also achieved remarkably high precisions of 94.7% and 97.1% respectively. The models developed in this study demonstrate the effectiveness of object detection models for rapid screening of DIH images of peritoneal dialysates. They can be integrated into at-home peritoneal dialysate screening systems to increase the speed of peritonitis detection and improve the survival rates of patients. This serves as a non-invasive screening tool, making peritoneal dialysis a safer treatment.

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