SonoVascAR: A Vascular Access Aid: Automated Real Time Ultrasound Vessel Detection With Augmented Reality 3D Projection

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Ultrasound(US)-guided vascular access requires a high level of expertise as the clinician must understand the spatial relationship between US probe, imaging, and the patient's anatomy. Further, the imaging is often displayed away from the procedure site. The objective of the project was to reduce the expertise requirement through a real-time ultrasound-based vessel detection algorithm integrated with augmented reality, creating a 3D superficial overlay of the vessel. US data was collected from a vascular access phantom using an ultrasound probe, resulting in 43,200 frames. The frames underwent a series of image processing techniques (e.g., blurring, morphological operations, Hough circle transform) to identify the vessel location, center, and diameter. Vessel detection accuracy was validated on 1,800 frames using the Vessel Localization Classification (0–2 scale) with high interobserver agreement (?=0.91–0.95, 96% percent agreement). The system identified vessels in 75% of frames containing a vessel. For 0.6 cm vessels, mean predicted diameter(MPD)=0.48 cm, mean absolute error(MAE)=0.118 cm, standard deviation(SD)=0.05 cm, percent error(PE)=19.6%. For 0.4 cm vessels, MPD=0.37 cm, MAE=0.037 cm, SD=0.10 cm, PE=-6.8%. The detection algorithm was integrated with a proof-of-concept augmented reality application via the Apple Vision Pro. The detection algorithm processed US frames in real time and streamed the vessel properties to the augmented reality application, resulting in a 3D projection of the vessel on the phantom. Results demonstrate feasibility of real-time vessel detection that may reduce the training needed for US-guided procedures. This system provides a foundation for faster, safer vascular access and potential future semi-automated procedures.

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