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Using deep learning to predict ankle-brachial index from Doppler sounds in diabetic patients

Stanford researchers have developed AutoABI, a deep learning system that predicts ankle-brachial index (ABI) from Doppler ultrasound sounds. This approach offers a new method for ABI measurements, particularly useful for patients with non-compressible arteries, such as those with diabetes. By analyzing Doppler sounds, AutoABI provides a straightforward way to assess peripheral artery disease (PAD) risk without traditional blood pressure cuffs. The system could improve the accessibility and efficiency of PAD diagnosis in point-of-care settings, where quick and accurate assessments are valuable.

Ankle-brachial index (ABI) is a crucial diagnostic tool for peripheral artery disease (PAD), but current measurement methods face significant limitations. Traditional ABI assessment requires inflating a blood pressure cuff while using Doppler ultrasound to measure blood flow in the tibial arteries. However, this technique proves unreliable in patients with non-compressible arteries, a common condition in diabetics with PAD. These patients often have medial arterial calcification, leading to falsely elevated and unreliable ABI readings. The prevalence of diabetes and the increasing need for accurate PAD diagnosis underscores the importance of developing more versatile, point-of-care ABI measurement techniques. An improved method that can provide reliable ABI estimates without relying on blood pressure cuffs could significantly enhance PAD diagnosis and management, particularly in challenging patient populations.

AutoABI, a deep learning system integrated into a hand-held Doppler device, successfully predicts ankle-brachial index (ABI) directly from audible Doppler sounds without the need for blood pressure cuffs. This innovative approach enables ABI measurements in patients with non-compressible arteries, a common issue in diabetics with PAD. The device's on-board computer processes Doppler signals in real-time, displaying results on an integrated touch screen for immediate clinical use. By offering a more versatile and accessible method for ABI assessment, AutoABI has the potential to significantly improve PAD diagnosis and management across various healthcare settings, from hospital wards to vascular labs.

Stage of Development:
Prototype
Continued research: fully integrating the computer and deep learning computation within the Doppler device itself, eliminating the need for external processing and creating a self-contained, portable ABI measurement system.

Applications

- Diagnosis and monitoring of peripheral artery disease (PAD)
- Ankle-brachial index (ABI) measurements in patients with non-compressible arteries, such as diabetics
- Point-of-care vascular health assessments in clinics and hospital wards
- Integration into existing vascular lab equipment for enhanced capabilities

Advantages

- Eliminates the need for blood pressure cuffs in ABI measurements
- Provides reliable ABI estimates for patients with calcified arteries
- Increases accessibility of ABI testing in various clinical settings
- Offers real-time, on-device processing and results display
- Simplifies the ABI measurement process for healthcare providers
- Potential for improved PAD diagnosis rates and patient outcomes

Publications

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- Arash Fereydooni, Adrit Rao, Akshay Chaudhari, Kevin Battenfield, Oliver Aalami. Preliminary Clinical Validation Results of a Deep Learning Approach for Ankle Brachial Index Prediction in Noncompressible Tibial Vessels. *Journal of Vascular Surgery*, Volume 76, Issue 4, e85.
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- Rao, A., Chaudhari, A., Aalami, O. (2021). Development of the Next Generation Hand-Held Doppler with Waveform Phasicity Predictive Capabilities Using Deep Learning. In: Oyarzun Laura, C., et al. Clinical Image-Based Procedures, Distributed and Collaborative Learning, Artificial Intelligence for Combating COVID-19 and Secure and Privacy-Preserving Machine Learning. DCL PPML LL-COVID19 CLIP 2021 2021 2021 2021. Lecture Notes in Computer Science(), vol 12969. Springer, Cham.

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