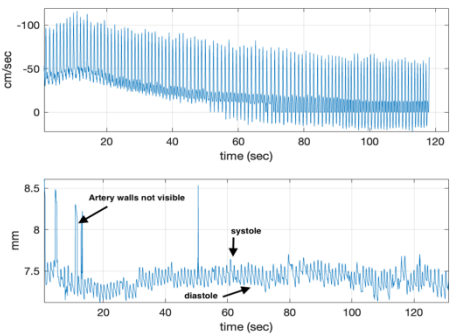
A pipeline for processing ultrasound image and Doppler videos: Application to dynamic arterial flowmetry and diameter measurement.

Olivier Meste, Colin Lavigne, Fatimah Syam, Gregory M Blain

Université Côte d'Azur, CNRS, Laboratoire I3S, Nice, France.
Université Côte d'Azur, LAMHESS, Nice, France.

Aims: The assessment of human vascular function can be performed through the measurement of transient changes in blood flow and/or vessel diameter during various experimental conditions such as reactive hyperemia (RH), passive leg movement (PLM), or rapid onset vasodilation (ROV). Such measurements can be non-invasively accomplished via acquiring duplex ultrasound images and continuous Doppler velocity. These evaluations offer prognostic insights into patients' cardiovascular health and fitness. Additionally, they provide valuable information on mechanisms linked to exercise tolerance, blood pressure regulation, or vasomotor function. The aim of this study was to develop a novel method to enhance the analysis of duplex ultrasound videos, enabling frame-by-frame measurements of blood flow and vessel diameter to better capture acute changes in these variables.

Methods: The portions of B-mode and Doppler velocity of each frame are processed separately based on the pixel intensities and converted to cm/sec and mm according to the scales included in the frames. The measurement of the artery diameter is performed by assuming that the two artery walls are parallel and approximated by two lines. Thus, a pseudo-optimal alignment is first computed on the lower wall, followed by rotations and a second alignment of the upper wall. The doppler is computed taking a reference column on the image and assuming that the pixel intensities are modeled as a probability density function with a corresponding mean value.



Results: Our method has been applied to a femoral artery RH experiment (see figure with the cuff-release) where the [min;max] diameter (mm) & velocity (cm/sec) values are [7;7.4] & [-60;20], [7.2;7.7] & [-25;8], [7.1;7.7] & [-116;20] for the baseline, cuff-occlusion and the cuff-release phases, respectively. This new method allows to accurately track the hyperemic effect as well as the systolic and diastolic variations on blood flow and artery diameter.