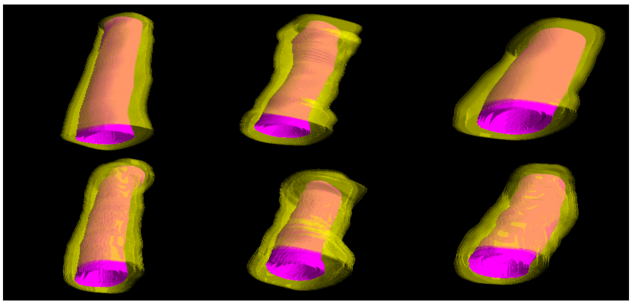
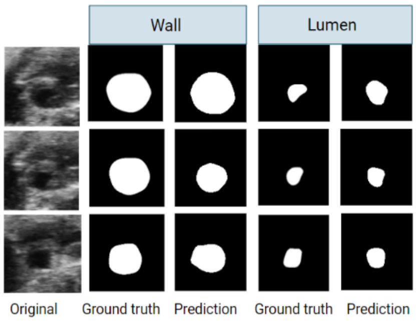
Internship opportunity at LUMC department of surgery

Background

Cardiovascular diseases are characterized by long term (decades) of non-symptomatic gradual vascular remodeling, eventually resulting in acute disease such as myocardial infarction, stroke or aneurysm[1]. Especially after a surgical intervention to improve blood flow through a compromised blood vessel excessive vascular remodeling occurs. The underlying mechanisms of vascular remodeling are yet unclear however from both clinical and pre-clinical research it is known that hemodynamics and changes in matrix structure are crucial factors. Up until recently the possibilities to study vascular remodeling were limited to end point histology. However, vascular remodeling is an active process. It is affected by dilatation and compression of the vessel wall in combination with wall thickness, which can best be studied in vivo. Ultrasound is a noninvasive imaging technique that enables in-vivo real-time imaging with excellent resolution without using harmful ionization. In our preclinical research we use various animal (mouse) models to study vascular remodeling and recently have retrieved an ultra-high- frequency ultrasound system to study in vivo remodeling in time[2].

To obtain the 3D geometry (fig1) to study vascular remodeling including the lumen (through which the blood flows) and the vessel wall, handmade annotations on the border lines were drawn on stacks of images throughout a blood vessel segments. Since this is very time consuming and error prone strategy we developed an application for automated segmentation of blood vessels in 3D using deep learning techniques. For this we have trained and tested a 2.5D Unet model for straight vessels and developed a user interface to generate 3D renderings of the vessel and lumen wall.





For this project, we would like to extend the initial model with more complex blood vessel structures including blood vessels with curvatures and side branches. It should also be investigated whether other deep learning models are more suitable for this task. Besides, the current initialization of the volume of interest is done manually which should be replaced by automatic selection using a deep learning technique. Furthermore, we would like to extend the user interface and quantify the volumetric measurements of the lumen and vessel wall to compare different time points.

We offer an enthusiastic multidisciplinary work environment consisting of a diverse team of scientists (vascularresearch.nl) that can guide you on both content-related as technical support.

Supervision team consist of Kayleigh van Dijk (PhD candidate and daily supervisor) Dr. Margreet de Vries (Assistant Professor and specialist in vascular remodeling and imaging) and Dr. Jouke Dijkstra (Associate Professor specialized in image analysis and AI).

[1] P. Libby, and G.K. Hansson, Inflammation and immunity in diseases of the arterial tree: players and layers. Circulation research 116 (2015) 307-11.
[2] V.Q. Sier, A. de Jong, P.H.A. Quax, and M.R. de Vries, Visualization of Murine Vascular Remodeling and Blood Flow Dynamics by Ultra-High-Frequency Ultrasound Imaging. International journal of molecular sciences 23 (2022) 13298.