Stage M2: Development of ultrasound techniques with 2D and 3D probe to quantify flow applied to valvular heart disease (mitral valve regurgitation) with a left heart simulator

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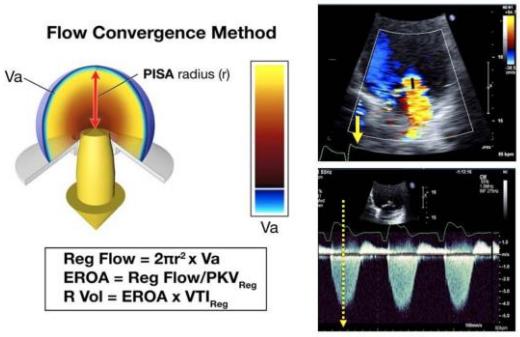
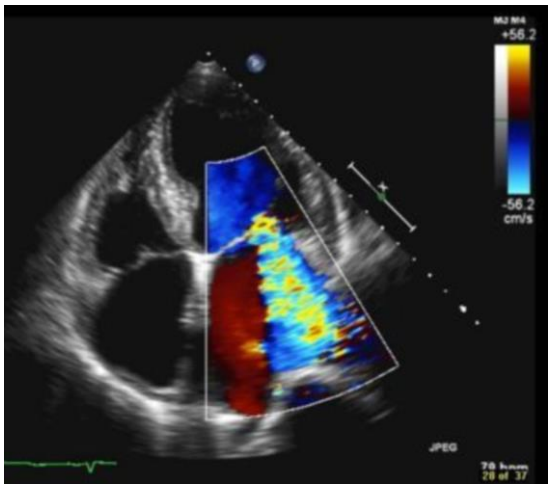
Poursuite de thèse possible

Background: Mitral valve regurgitation (MVR) is a leak through the mitral valve. Together with aortic stenosis, it is the most common valvular heart disease in western countries. This leak leads to backflow of blood from the left ventricle into the left atrium and eventually to pulmonary edema or heart failure and can eventually cause the death of the patient. Therefore, in case of severe MVR, a treatment of the mitral valve should be considered. Hence a precise diagnosis is very important. The diagnosis of MVR is performed with echocardiography which is a very powerful, cost-effective tool used every day in cardiology. Echocardiography can record both images of the heart as well as measure the flow both in 2D and 3D. Its results are used to choose which patient should benefit from a mitral valve repair/replacement. The parameter used to assess the severity of the regurgitation is the volume of the regurgitant flow through the mitral valve. Current echocardiographic techniques are slow and are imprecise as they heavily rely on geometrical assumptions. Ultrafast ultrasound is a new technology allowing to sample faster and more precisely the regurgitation volume of MVR. We aim at developing new Ultrafast ultrasound techniques to precisely quantify MVR. This will be performed in-vitro in a left heart model and eventually will be used in patients. The goal is to implement this technologies in the clinical setting of a hospital.





Aim: The aim of this master thesis will be:

1. To program the ultrasound acquisition and post-processing sequences to measure the flow through the mitral valve with 2D and 3D ultrasound probe to further developing a flow-loop mimicking a left heart with MVR.
2. Acquire ultrasound signals in the heart phantom
3. To further build the major components of a heart phantom composed of the different heart cavities (left ventricle, left atrium, aorta), the aortic valve connected to a pump to generate the flow

Duration: 6 months / expected start Spring 2025

Candidate profile:

- Student in last year of Master 2 or Engineering school
- Strong background in programming and signal processing (Python/Matlab)
- Knowledge of Linux, git, microcontroller (e.g. Arduino programming)
- Knowledge in Ultrasound/Acoustic physics
- Knowledge in Computer aided design (CAD/CAO)
- Problem solving mind set / ability to work unsupervised
- Eager to learn new concepts in physics / programming
- Ability to work in a team