

Thesis offer

## Parameter Study for Ultrasound Beamforming Algorithms

**Type of Thesis:** MA/BA/Diplom

**Suitable for:** Robotics, Applied computer science, some experience in signal processing and Python programming is required.

### Motivation & Background:

At MSE Lab, we are developing an ultrasound method that allows us to measure the speed of sound in biological tissue. A precise measurement of the speed of sound at a high spatial resolution would enable new tools for medical diagnosis, e.g. in hyperthermia therapy for cancer treatment. Our work is focused on developing beamforming algorithms for the echo signal data acquired with ultrasound arrays as illustrated in Figure 1.

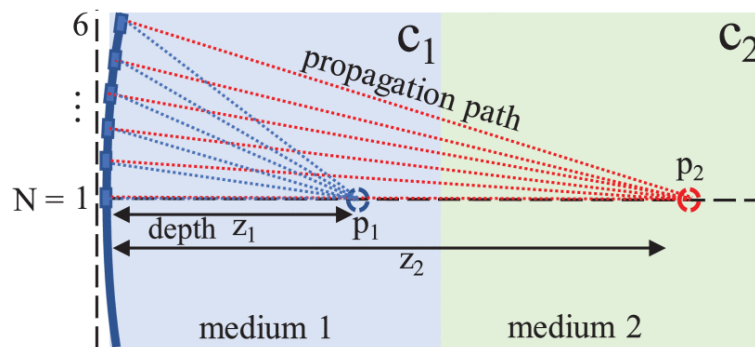


Figure 1: Geometric focusing model showing two example focal points  $p_1$  and  $p_2$ ,  
image from: <https://doi.org/10.1109/OJIM.2025.3636682>.

### Goals & Objectives:

The goal of the thesis is to identify and evaluate the critical parameters affecting the accuracy and robustness of the speed-of-sound estimation. Measurement and simulation data as well as a Python implementation for the speed of sound calculation are available. Based on this, the speed of sound and relevant intermediate results will be computed for a large set of input parameters using at least two different beamforming metrics. By evaluating the sensitivity of the result to each parameter, the thesis should provide guidance for further development of the beamforming algorithms.

### Milestones:

- M1: Understanding the measurement principle and the corresponding python code in detail.
- M2: Definition and explanation of a parameter set to investigate.
- M3: Choice of a method for the parameter study.
- M4: Implementation of the method in Python.
- M5: Presentation and evaluation of the results.
- M6: Discussion of the implications for further development of the method.



**Character of the work:**

The work is focused on data evaluation and algorithm development in Python. Measurement and Simulation data will be provided.

50 % programming (Python), 30 % data evaluation, 20 % literature research.

**Supervision & Workflow:**

- **Meetings:** weekly meetings between student and supervisor to evaluate status and progress and identify need for support; time and location (also possibly online) will be determined at the beginning of the work.
- **Weekly reports:** The student is required to write a weekly report at the end of each week and to send it to his advisors. The idea of the weekly report is to briefly summarize the work, progress, and any findings made during the week, to plan the actions for the next week, and to bring up open questions and points. The weekly report is also an important means for the student to get a goal-oriented attitude to work.
- **Mid-term presentation:** Students are encouraged to give a mid-term presentation as a preparation for the final presentation of the thesis. This is an opportunity to discuss the results with a broader audience and get important feedback on the current state of the work.

**Supervisor:** Dr.-Ing. Jakob Sablowski