Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
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Modeling:
Mathematics:
Programming:
Science:

Software Lab:

Modelling scalar wave equation in time and frequency domain

Description

The goal of this project is to model and simulate the scalar wave equation in the frequency and time domain using Finite element methods. The partial differential equation for the wave equation is dependent on the space and time. Usually, the wave eqation is solved in the time domain in a step wise manner [1]. However, the same PDE can also be solved in the frequency domain by taking the fourier transform where the solution for each frequency is calculated separately [2]. The advantage of this method lies in the fact that it is completely parallizable which can potentially speed up the process. This approach has already been applied in geophysics where earth-quake waves used to construct the structure of the subsurface of the Earth. Recently this method has gained attention for the health monitoring of structures thus making it an active area of research.

Our proposal focuses on comparing the advantages and disadvantages of time and frequency domain methods. By understanding their strengths and weaknesses, we aim to identify optimal use cases for each approach. This research will contribute valuable insights into the practical applications of these methods

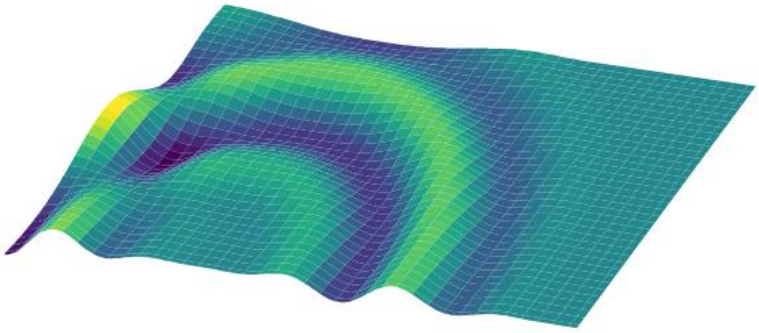

Figure 1 Wave propagation in a 2D domain

Task

The following is the breakdown of the tasks in the proposed topic:

- **Background study:** Literature survey of the scalar wave equation solvers
- **Code building:** Using a finite element solver to generate waves both in time and frequency domain
- **Post processing results:** Comparing the results using specific test cases
- **Code optimization (Optional):** Implementing steps to speed up the code (such as implementation on a GPU)

Supervisor

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References

1. Shorr, Boris F. *The wave finite element method*. Springer Science & Business Media, 2012.

2. Belonosov M, Kostin V, Neklyudov D, Tcheverda V. 3D numerical simulation of elastic waves with a frequency-domain iterative solver. *Geophysics*. 2018;83(6). doi:10.1190/geo2017-0710.1