Master Thesis

Efficient Implementation for Explicit Dynamics

For explicit dynamics, an efficient formulation and implementation of internal force calculations is critical, as these calculations are repeated very often. For example in a simulation with \(10^5\) time steps and 1000 elements with 5 integration points across the thickness for each element, each calculation on integration point level is repeated \(5 \cdot 10^6\) times. Within this framework, even minor code optimizations can have a considerable effect on the overall simulation time. One of the most efficient element formulations is the Belytschko-Lin-Tsay shell [1], which is also implemented in LS-DYNA. The aim of this master thesis is to implement this shell element formulation into a standalone C++ code and optimize the implementation for speed such that the simulation time for simple test cases is comparable to LS-DYNA.

```cpp
for (int i=0; i<number_of_elements; i++)
{
    // integration point loop
    for (int k=0; k<ngp;k++)
    {
        // calculate contribution to force vector efficiently
    }
}
```

The specific tasks are

- Literature study on Belytschko-Lin-Tsay shell and efficient implementation in C++
- Implementation of the aforementioned element formulation and verification of the implementation
- Optional: Parallelization or comparison with other element formulation
- Interpretation and evaluation of results

Recommended fields of interest

Finite elements, explicit dynamics, C++ (knowledge required, e.g. from lecture “Implementation and Algorithms for Finite Elements” or comparable)

Literature