1. ParMooN - A Parallel (MPI+OpenMP) In-house Finite Element Package

ParMooN (Parallel Mathematical Object Oriented Numerics) is an in-house finite element package based on Object-Oriented Programming C++, and it will be made availabe in public. Apart from other challenges associated with the parallel implementations, parallel computations require not only efficient parallel algorithms, but also highly scalable numerical methods. For instance, the choice of finite elements in finite element discretization will influence the parallel efficiency. The sparsity structure of the matrices also depends on the type of numerical scheme and can have an influence on the parallel performance of the algorithm. The use of heterogeneous architectures like CPUs and GPUs also needs a rethink on the algorithm side to exploit the full power of the hardware.

The development of robust and efficient high order algorithms and their use in HPC systems is an active research area, which needs more investigation since they have not yet reached a mature stage to be used in applications. The drive towards high order schemes also needs scalable time integration schemes and interesting new ideas are being proposed in the literature, time accurate local time stepping, the swept rule etc.

It is the purpose of this project to develop parallel, efficient and scalable numerical schemes for massively parallel supercomputers, and implement in ParMooN. The main research areas of this project are:

- Scalable and robust high order schemes

- High performance numerical linear algebra

- Efficient parallel implementations

- Scalable time integration strategies

- Algorithms for GPUs, heterogeneous systems

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