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Conclusion

In this work, we propose a strategy for GPU-based parallel fracture, microbranching, and fragmentation simulations based on the extrinsic cohesive zone model. Such parallel simulations impose two main challenges. First, we need to be able to handle mesh modifications, since cohesive elements are inserted adaptively along the simulation. Second, we need to efficiently perform intensive numerical computation, with numerous memory accesses, in parallel. Using a simple topological data structure, shared memory, kernel splitting, texture fetch, and minimizing global memory accesses, we could effectively map and optimize the CPU implementation of a fragmentation simulation to a GPU environment, taking advantage of CUDA benefits. Mesh coloring proved to be an effective means to avoid race conditions and simplifying algorithms that would generate complex kernels if not used.

We leave the simulation of 3D tetrahedron models on the GPU for future implementation, although our solution can be extended to three dimension. Fragmentation simulation could also be extended to a multi-GPU approach, where we would need to consider mesh partition subdivision and communication among them. Another future approach is the extension of the GPU implementation to adaptively perform mesh refinement and coarsening. One challenge we would have in mind is the implementation of a parallel coloring method on the mesh since the mesh structure changes at each step. Maintaining consistency of the topological changes of the mesh would also be challenging, since bulk elements would be also be inserted and removed from the mesh. Finally, fragmentation simulation could extend further than engineering applications. If the timestep can be greatly increased, the implementation of breaking objects in computer animation could be done using a simplified version of our model, relaxing physical accuracy.

Figure 8.1: 3D view of fragmented 2-dimensional bar with 74,257 nodes and 36,864 bulk elements.

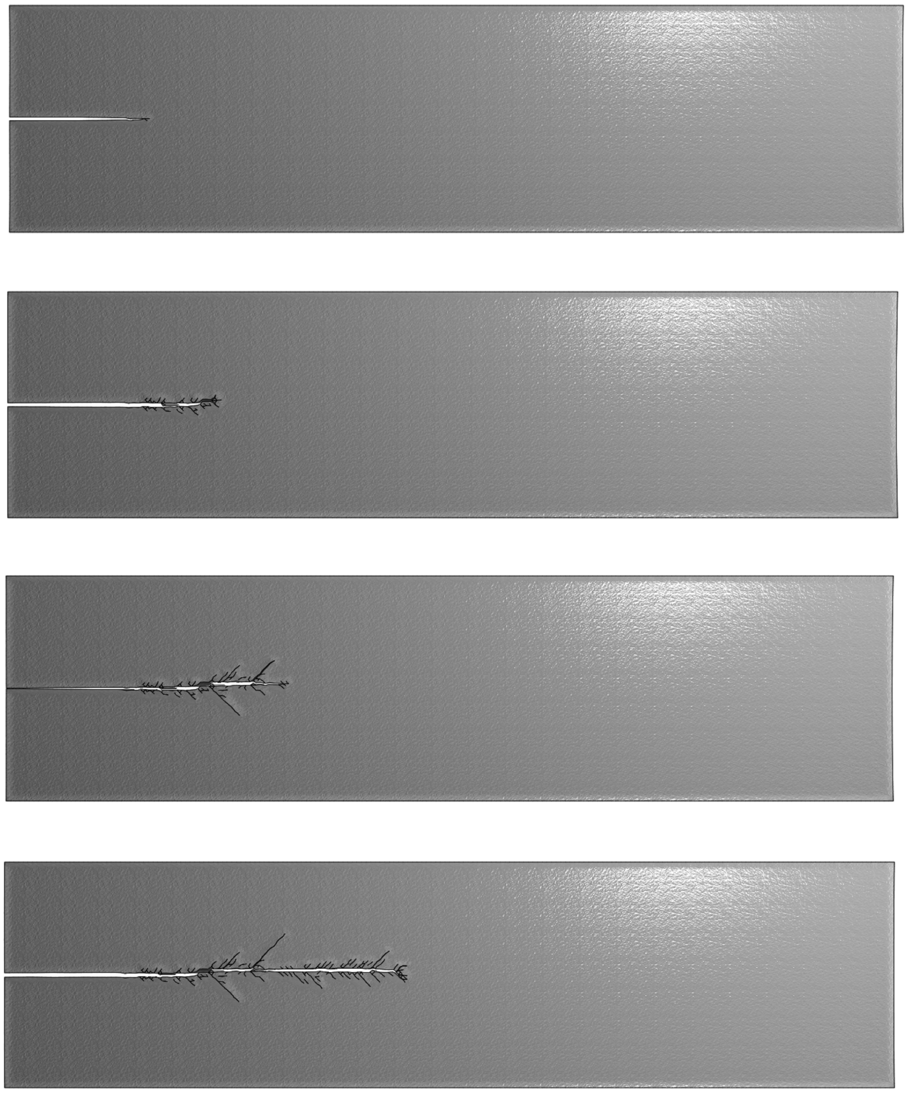

Figure 8.2: Crack propagation on a 2-dimensional bar with 74,257 nodes and 36,864 bulk elements.