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Fracture simulation for visual effects with peridynamics and MPM

Biswajit Banerjee[1]*, Bryan G. Smith[2] and Andreas Soderstrom[3]

[1] Callaghan Innovation, 24 Balfour Rd. Parnell, Auckland, NZ, b.banerjee.nz@gmail.com
[2] Callaghan Innovation, 24 Balfour Rd. Parnell, Auckland, NZ,
Bryan.Smith@callaghaninnovation.govt.nz
[3] Weta Digital Ltd., P.O Box 15208, 9-11 Manuka Street, Miramar, Wellington, NZ,
asoderstrom@wetafx.co.nz

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Visual effects simulations have started to play a dominant role in motion pictures. These simulations have to contend with complex scenarios containing rigid and deformable solids and both compressible and incompressible fluids. Physics-based algorithms and unified simulation frameworks are increasingly being used for visual effects.

The rapid simulation of fracture effects is of interest to the motion picture, computer gaming, and medical device industries. Fracture in this context can include the fragmentation of wood, glass, concrete, brick walls, bones (brittle materials) and also the failure of skin, rubber, muscle (soft materials). At present, a lot of artistic input goes into the process of portraying fracture in computer graphics animations.

One possible simulation scenario is the failure a ship's mast in a storm. The ship, the sea, and the air may be assumed to be interacting within a unified framework that uses the material point method. If the mast is made of wood, anisotropy of the grain will cause splinters to form in the region of failure. Standard methods based on continuum mechanics need a large amount of book keeping (and large computational costs) to predict the formation of splinters. Our approach has been to use the peridynamics method to compute the creation and growth of fractures with the material point method providing the underlying connection to continuum mechanics.

In this paper we discuss preliminary results on the advantages and disadvantages of our approach in the context of massively parallel computation. We also discuss future directions that this research will explore.