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Computer Graphics 1
Wednesday, April 18, 2018

Literature Review 3

In this paper I'll explore the two papers titled *"Example-based Plastic Deformation of Rigid Bodies*" and "*Simulating Liquids and Solid-Liquid Interactions with Lagrangian Meshes.*" In the first paper, the authors: Jones et al. explore how physics based animation is used to animate scenes containing destruction of near-rigid, man-made materials. In these applications, the most important visual features are plastic deformation and fracture. They support their work using Clausen et al.'s work in the second paper that describes a Lagrangian finite element method that simulates the behavior of liquids and solids in a unified framework. Clausen and his team use a method that conserves volume and momentum, locally and globally, by assigning to each element an independent rest volume and adjusting it to correct for deviations during remeshing and collisions. I'll proceed t explain how Jones' work draws from the methods Clausen et al. describe in their paper.

Jones et al. explore baseline works based on continuum mechanics models that must perform elasticity computations that are computationally expensive, even though the elastic deformations are imperceptibly small for the rigid metals. In their work, Jones and team introduce a plasticity model based on linear blend skinning that will allow artists to author simulation objects using tools they're already familiar with. Linear blend skinning is an algorithm used to deform a mesh using skeletal structures. It's apparently used in game engines such as Unreal and Unity.
Jones and his team use an unmodified simulator for rigid bodies which help make their method computationally efficient and also easy to integrate in already existing pipelines.

Clausen et al. describe their method as a fully Lagrangian fluid simulator that employs a dynamically changing tetrahedral mesh to discretize simulated material. This is the technical description they give but in short, the transformation functions, models, equations and variables are transferred first in discrete steps, derived by solving Lagrangian equations of the first kind.

They model liquids as perfectly plastic, incompressible materials in which the elastic shear stresses are always zero so that the material flows freely with a specified viscosity. Remeshing is kept to a minimum amount because over doing it introduces interpolation errors. They also simulate splitting events caused by excessive stresses and thinning, and merging events when fluids or sticky materials collide.

The kind of physics-based animation described and used in Clausen's work is the baseline for animations that require creating scenes containing large scale destruction. Jones' team claim this work uses a fair amount of computational resources even for objects that demonstrate limited elastic deformations. However, using Clausen's method for fractures in rigid bodies remains relatively unexplored.

Clausen et al. let an artist rig their model with 'bones' and proceed to use this rig to deform their input mesh into a set of characteristic poses for whichever character/model is being used. This is where their pipeline kicks in. These objects are then modeled as rigid bodies with shapes computed via modified linear blend skinning (described above).

In the recorded results, Clausen et al. demonstrate the potential of their approach to use arbitrary deformations as input to their system. They animated five complex scenes that may appear in games or movies. For example, in one simulation they had a car pummeled by cannonballs and then another car falling from the sky. I observed that the deformations changed over time which is the best example of the most recent impulse changes. In the second example a driver rammed into a bunch of barrels and a wall. The barrels all had the same deformations because they all had the same material.

Despite using a small number of deformations, Clausen's method demonstrated that they were able to use a achieve better results compared to the rather computationally expensive deformations that use Lagrangian meshes that Jones et al. use.

Bibliography

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 author = {Jones, Ben and Thuerey, Nils and Shinar, Tamar and Bargteil, Adam W.},
 title = {Example-based Plastic Deformation of Rigid Bodies},
 journal = {ACM Trans. Graph.},
 issue_date = {July 2016},
 volume = {35},
 number = {4},
 month = jul,
 year = {2016},
 issn = {0730-0301},
 pages = {34:1--34:11},
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 numpages = {11},
 url = {http://doi.acm.org/10.1145/2897824.2925979},
 doi = {10.1145/2897824.2925979},
 acmid = {2925979},
 publisher = {ACM},
 address = {New York, NY, USA},
 keywords = {deformation, example-based simulation, local blending, plasticity, rigid body simulation, skinning},
}
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Title: Simulating Liquids and Solid-liquid Interactions with Lagrangian Meshes

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@article{Clausen:2013:SLS:2451236.2451243,
 author = {Clausen, Pascal and Wicke, Martin and Shewchuk, Jonathan R. and O'Brien, James F.},
 title = {Simulating Liquids and Solid-liquid Interactions with Lagrangian Meshes},
 journal = {ACM Trans. Graph.},
 issue_date = {April 2013},
 volume = {32},
 number = {2},
 month = apr,
 year = {2013},
 issn = {0730-0301},
 pages = {17:1--17:15},
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 url = {http://doi.acm.org/10.1145/2451236.2451243},
 doi = {10.1145/2451236.2451243},
 acmid = {2451243},
 publisher = {ACM},
 address = {New York, NY, USA},
 keywords = {Simulation, dynamic mesh generation, finite element method, fluid dynamics, local remeshing, melting, physically based computer animation, solid-fluid interface, surface tension, thermoelasticity},
}
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