Simulation of Food Cutting Process

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What we want to do and why?

Cut food into bite-size and feed human:
- ➔ Around 1 million people in the U.S.need assistance with feeding according to a 2010 survey [1]
- ➔ A solution: Robot-assisted feeding but current methods assume food is already bite-sized
- ➔ Our goal: Cut food into bite-sizes with different tools (fork, spoon) and feed human

Simulator for food items:
- ➔ Huge variety in food items: Different size, shape, compliance, texture, etc.
- ➔ Difficult to model, thus need data-driven methods
- ➔ Getting data from real robot physical interaction is costly - leverage simulation?

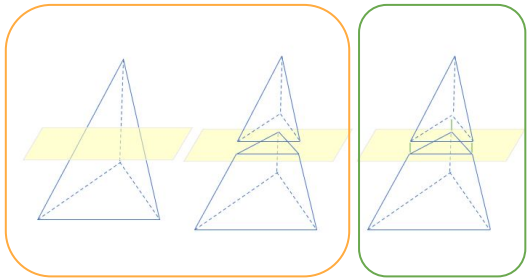
In this project, we:
- ➔ Present an overview of available physics simulation engines and find an appropriate simulator for simulating physical interactions with food
- ➔ Simulate the cutting process on a soft body

[1] M. W. Brault, "Americans with disabilities: 2010," Current population reports, vol. 7, pp. 70–131, 2012.

Which simulator is the best? Sofa

-	DART	Bullet	Chrono	SOFA	PhysX	Taichi
MPM	✗	✗	✗	✗	✗	✓
FEM	✗	✓	✓	✓	✗, promised in 5.0	✓
Photo Realism	Gazebo	Gazebo/OpenGL	irrlicht/OpenGL	Qt/Unity	OpenGL/Unity/Unreal	OpenGL
Physics Realism	contact force not real	seems ok	seems ok	seems ok	Since 4.0, it introduce the Coriolis for articulated body	mpm cannot compute force realistically
Support Availability/document	not so good	good	ok	good	good	access to developer
Soft body/cloth	spring-mass	spring-mass/neo-hookean	✗	✓	✓	mpm-based
Particle System	✗	✗	✓	✓	✓ (flex)	✓
Programming Language	C++	C++	C++	C++	C++	C++/cuda
Cutting Demo	✗	✗	✗	✓ (FEM-based)	✗	✓ (MPM-based)
ROS Support	✓	✓	✓	✓	✓	✗

How to simulate in Sofa?



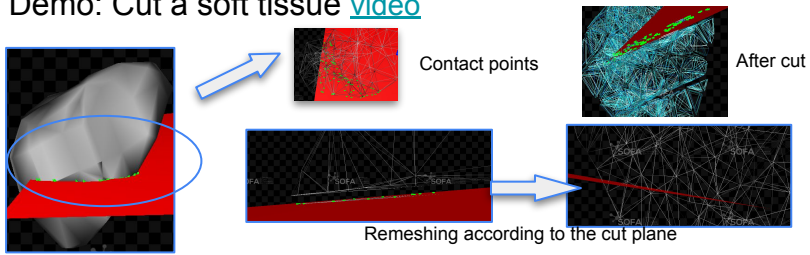
Geometric: Topological modification Physics: Contact force modeling

SOFA Simulation Open Framework Architecture

Topological modification
- ➔ Get contact point
- ➔ Separate existing mesh
- ➔ Add new mesh

Contact force modelling
- ➔ Insert springs between cutting elements
- ➔ Calibrate simulation with real data

Demo: Cut a soft tissue video



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