Simulation of paintball shot

A project by Kevin Wallimann, Andri Schmidt and Marc Maetz

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Introduction
Approach
Implementation
Demonstration
Conclusion

Inspiration
Expected challenges

- Initial project idea:
  Paintball shot on wall

- Final project:
  Paintball shot on simple objects

Video

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Expected challenges

- OpenGL
  - showing simple objects
- SPH solver
  - time to make it work as expected

Approach

- SPH solver

- Collision handling with axis aligned boundary boxes

Why?

- SPH solver
  - splashes and droplets
- Collision handling with axis aligned boundary boxes
  - lately attacket
  - risk of heavy time investition

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Low level
High level
Specific difficulties
Tricks

Low level

- C++ 11
- Eigen
- OpenGL
    - GLSL (OpenGL Shading Language)
    - GLM (OpenGL Mathematics)

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High level

1. Shot with gravitation
2. Collision detection
3. On impact the SPH simulation starts

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Low level
High level
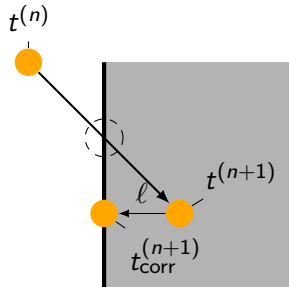**Specific difficulties**
Tricks

Difficulties

- (general code debugging)
- (parameter tuning)
- (coordinates: simulation space $\leftrightarrow$ window space)
- many particles behaving like a ball
- particles pushed and trapped inside object
- sticky paint on object with given resolution

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Tricks

- many particles behaving like a ball
  - $\rightarrow$ particle-particle forces ignored before collision
- particles pushed and trapped inside object
  - $\rightarrow$ projection further than on surface
- sticky paint on object
  - $\rightarrow$ velocity dependent trace on object

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Particles pushed and trapped inside object

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Particles pushed and trapped inside object

naive method

$t^{(n)}$

$t^{(n+1)}$

ℓ

$t_{\mathrm{corr}}^{(n+1)}$

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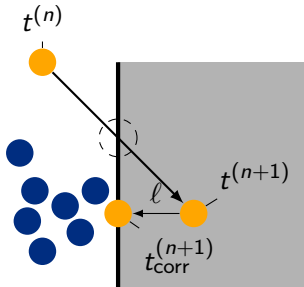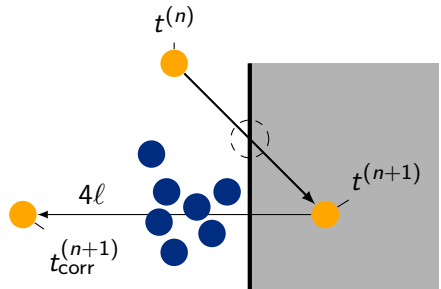
Sticky paint on object

Trace handling

Velocity split

SPH particle

$\mathbf{v}_\perp$

$\mathbf{v}_\parallel$

$\mathbf{v}$
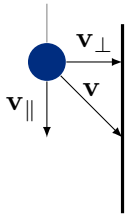
Resulting trace

$\mathbf{v}_\parallel = 0$
$|\mathbf{v}|$ big

$\mathbf{v}_\parallel \neq 0$
$|\mathbf{v}|$ big

$\mathbf{v}_\parallel = 0$
$|\mathbf{v}|$ small

$\mathbf{v}_\parallel \neq 0$
$|\mathbf{v}|$ small

Demonstration

Performance

- Real time simulation for simple objects (500 vertices)
- For complex objects substantionally slower

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Limitations

- resolution and number of collision objects
  - $\rightarrow$ bottleneck collision handling
- number of particles
  - $\rightarrow$ bottleneck SPH simulation

What we learned

- OpenGL

- Blender

What we learned

- OpenGL

- Blender

What we would do different

- Start collision handling earlier