A Pressure Model for Soft Body Simulation

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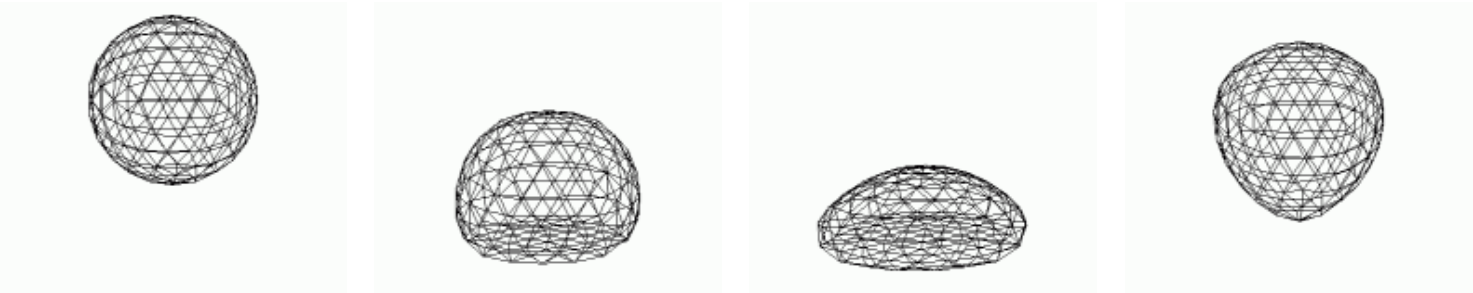
What the Soft Body is?

- three dimensional, dynamic object
- keeps constant volume
- deforms when collision occurs
- back to previous state after deformation
- example: bouncing, deformable ball



Applications for Soft Bodies

- Computer Graphics (Animation)
- Virtual Reality
- Computer Games Engines
- Medical Imaging
- and more...

Existing Soft Body Models

- Spring-Mass based models[a]
  - easy implementation, weak results
- FEM, FEV based techniques[b]
  - great results, complicated implementation, slow
- Fluid based model[c]
  - good results, not for realtime

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[a] i.e. Lander, 1999

[b] i.e. Fedkiw, 2003

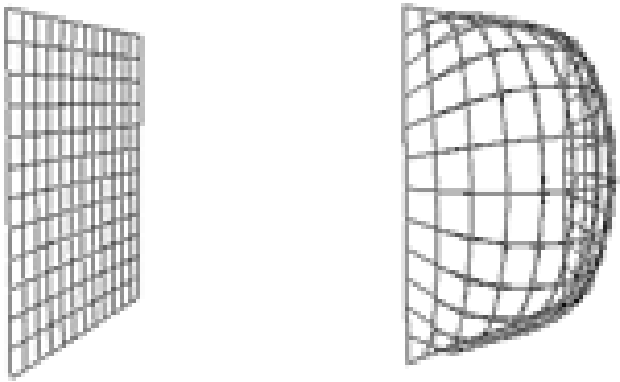
[c] Nixon and Lobb, 2002

Our Goal is..

"...to create model which will be fast,
easy in implementation
and gives good soft bodies behavior."

Background of the Pressure Model

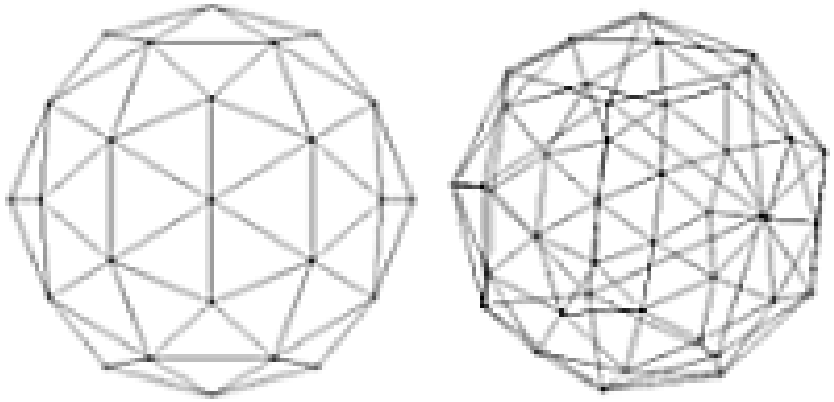
- Use Spring-Mass system
  - Create simple rectangular cloth
  - Apply wind force (left -> right)



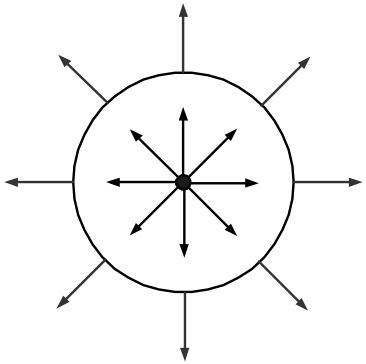
  - We get nice deformation of the cloth
  - How we can use it?

First idea was to...

- Create closed shape of the cloth



- And.. put "source of the wind" inside...



"Wind Source???"

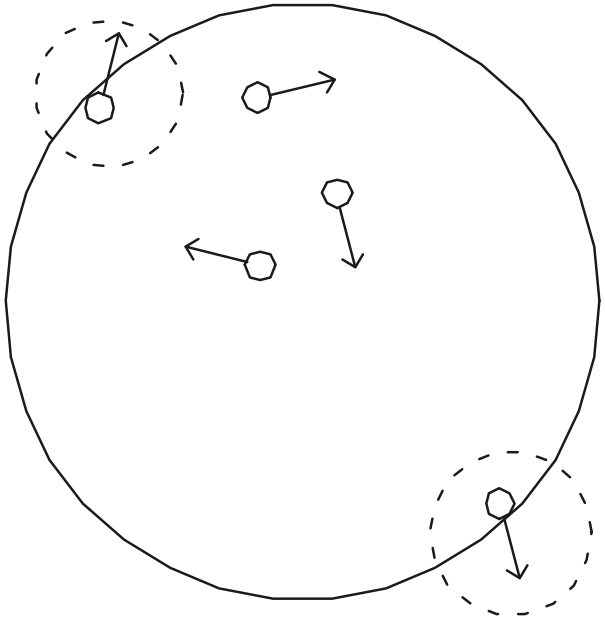
- But what "Wind Source" really means? Physically?
- We need a pressure force .
- What about the Physics:

  - Let us put a gas inside of the body

  - And introduce some simple physics to describe it...

Gas

- We have a gas inside of the body



  - we care only about macroscopic
  - we don’t care about micro-collisions
- We can use Ideal Gas Approximation

Ideal Gas Approximation

- Pressure value is described by Ideal Gas Equation:

$$PV = nRT \tag{1}$$

  - P - pressure value
  - V - volume of the body
  - n - particles number
  - R - gas constant
  - T- gas temperature

Pressure Force Calculation

- How do we calculate pressure force for the point of the shape?

1. We use an expression:

$$\vec{P} = P \cdot \hat{n} \left[\frac{N}{m^2} \right] \tag{2}$$

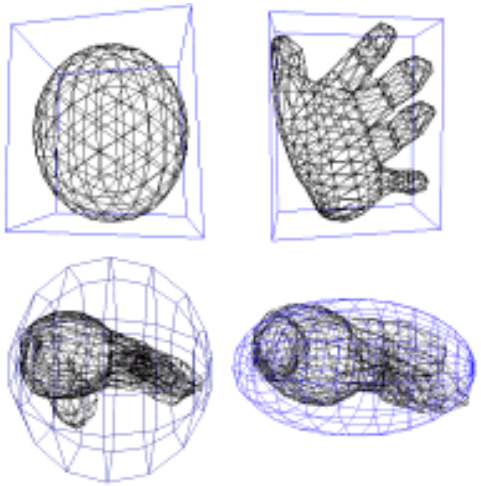
2. And for P value, from Ideal Gas Equation:

$$P = \frac{nRT}{V} \tag{3}$$

3. Assume constant n, T.
4. So we calculate volume V of the body only.

Volume Calculation

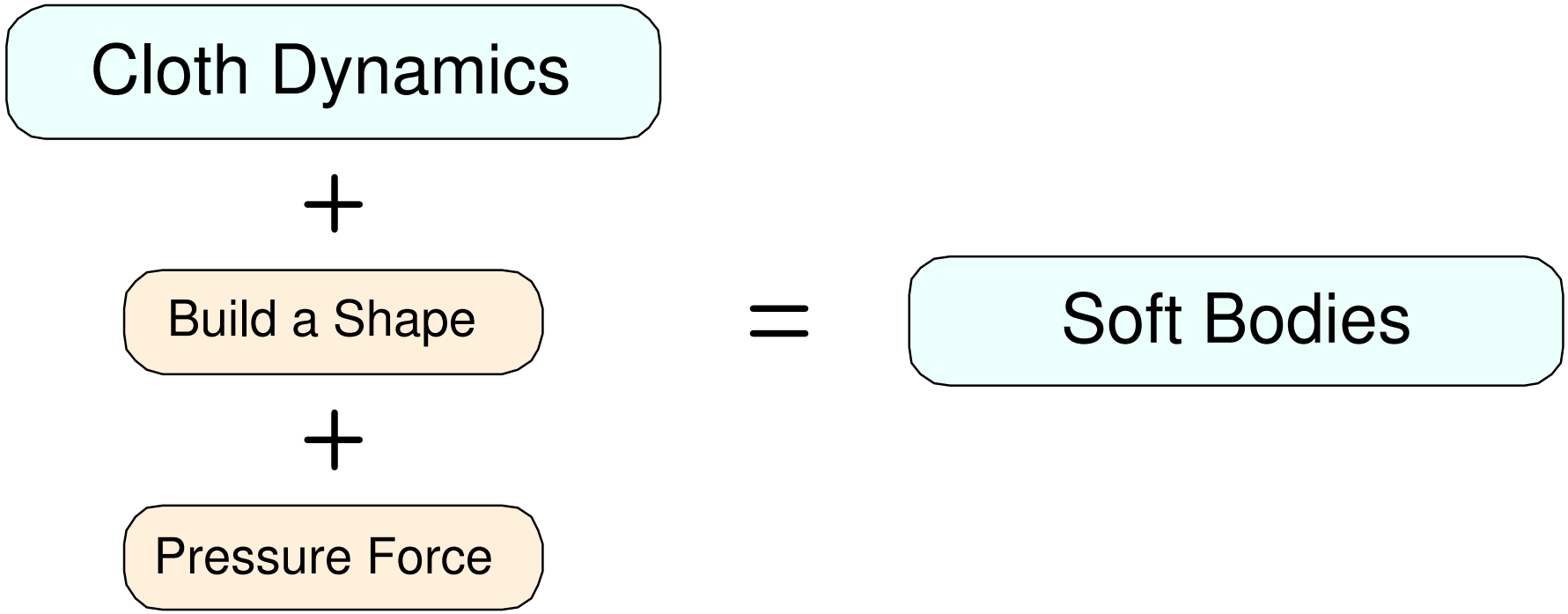
- For Volume calculation we use bounding ellipsoids



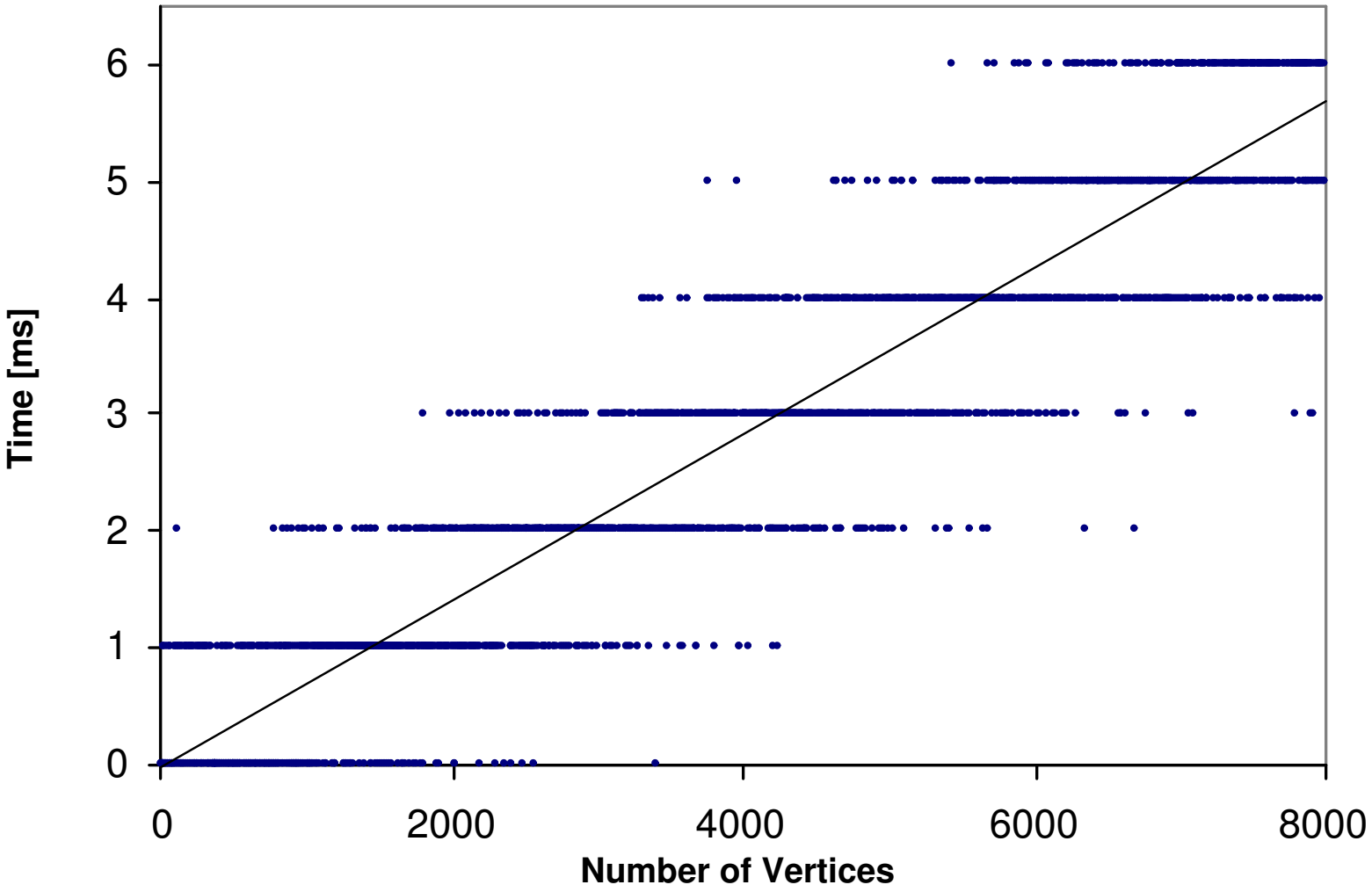
$$V_{el} = \left(\frac{4}{3}\right) \cdot \pi \cdot r_x r_y r_z \tag{4}$$

- Bounding objects used also for Collision Detection & Response (see article)

Implementation



Computation Time



Results

results.

Conclusion & Future Work

- Pressure Model of Soft Body behavior
  - it is fast (a couple of ms for thousands of vertices)
  - gives good Soft behavior in realtime
  - it is easy for implementation
- Future Work
  - Implicit Integration (not for realtime)
  - Monte Carlo volume calculation
  - Self Collision Detection & Response
  - and much more...

Thank you

more info... see http://panoramix.ift.uni.wroc.pl/ maq