

Physically based sound

Simple Bar element case

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Overview of Physically base sound rendering

Synthesize realistic sounds from physical models of the geometry and material properties of objects.

- **Factors**

1. Shape
2. Location of impact
3. Force of impact
4. Material of object

Model Vibrating object using FEM (Finite Element Method)

Assue a simple bar model with shape function

$$\ddot{u}(x, t) = c^2 u''(x, t)$$

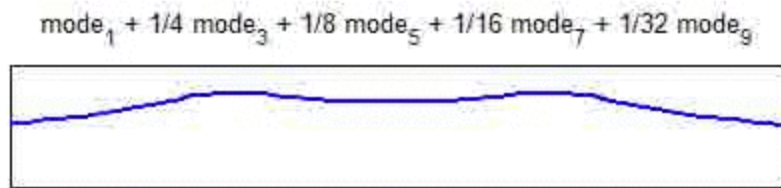
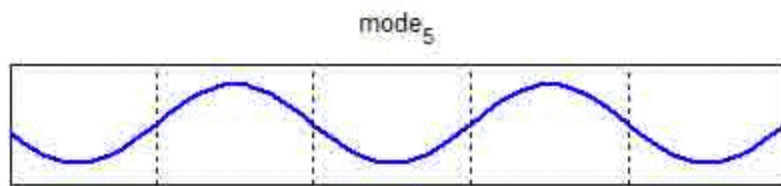
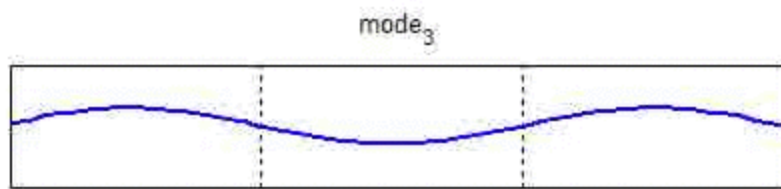
We want to transform it in to a system of ODE so the computer can solve it efficiently.

$$M\ddot{u}(t) + C\dot{u}(t) + Ku(t) = \vec{F}(t)$$

From the simple shape function we can calculate the mass and stiffness matrices by boundary conditions.

Then we can solve the system of ODE to get the fundamental frequencies of different vibration modes.

Then by adding up each vibration modes we can get the final wave function.



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Limitations

- Can't model nonlinear sound such as acceleration noise (Chadwick2012) and thin shell sounds
- Require knowledge of material properties
- Needs precomputing of sound model

Other things in the rendering pipeline

- Acoustics Transfer (James 2006)
- Physics simulation engine (PhysX, Havok. etc)