Visualizing the Phonon Map

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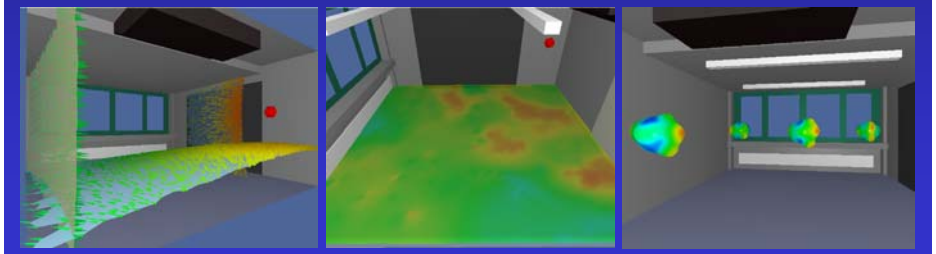
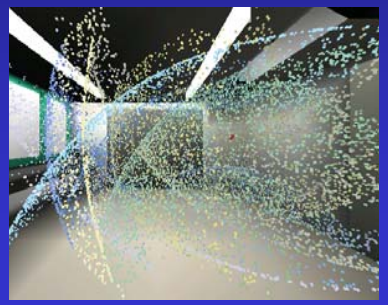


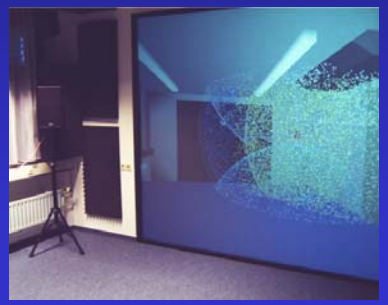
Overview

- The Phonon Map
- 4 Visualization Methods
  - phonons on surfaces
  - reflected wave fronts
  - energy by scattered data
  - energy at listener
- Conclusions

The Phonon Map

- acoustic simulation by particles
- inspired by photon map

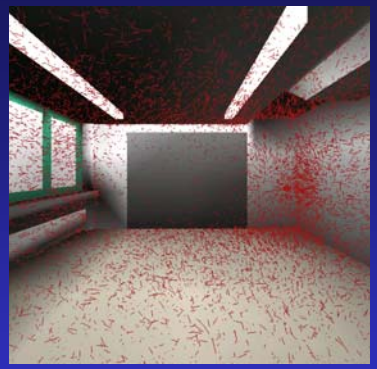




Phonon Tracing

- phonon emission from sound source
  - reflect phonons at walls
  - store them in global phonon map
- phonon collection
  - compute pulse response at listener (FFT)
  - directional sound field synthesis (Huygen´s principle)

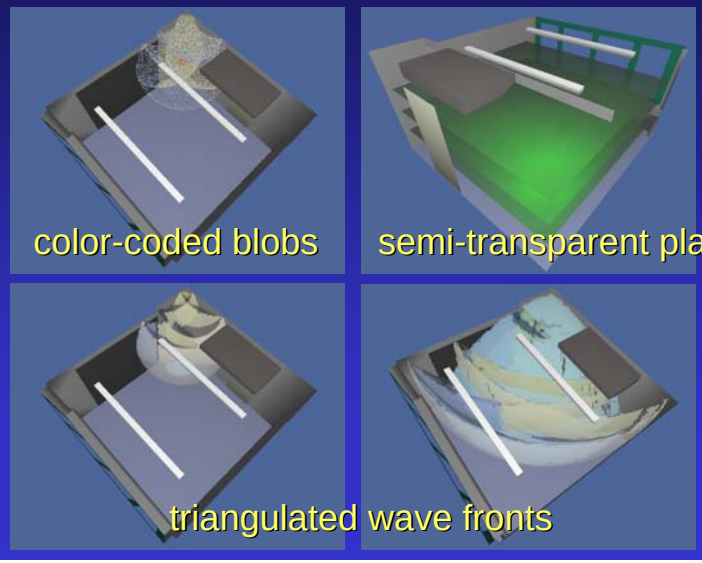
Phonon Map



- phonon position
- outgoing direction
- traversed distance
- energy spectrum

- How to visualize this information?

Previous Visualization

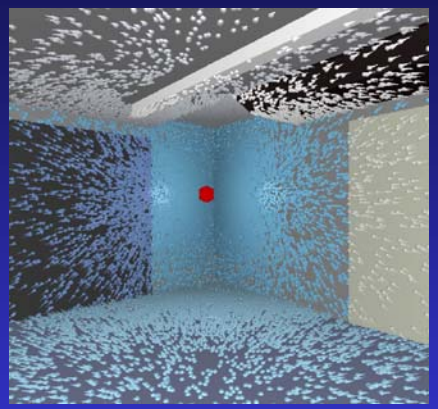


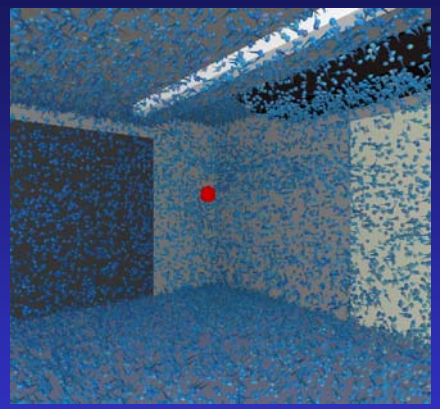
4 Visualization Techniques

- phonons on surfaces
- reflected wave fronts
- energy by scattered data
- energy at listener

Phonons on Surfaces

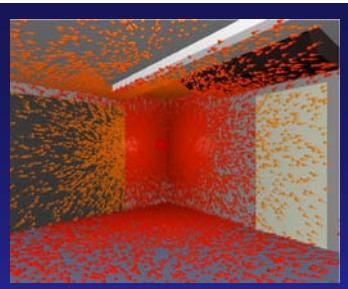
- spheres with cones for direction
- RGB color model showing all data
  (R = high, G = mid, B = low frequencies)
- HSV for specific frequency bands
  – hue (blue...red) : energy (0...max)
  – saturation, value = const.

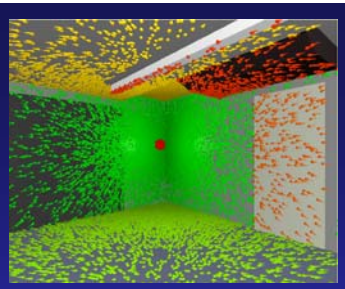




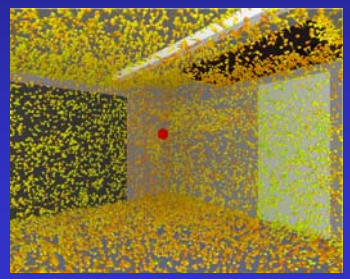
1st reflection 4th reflection

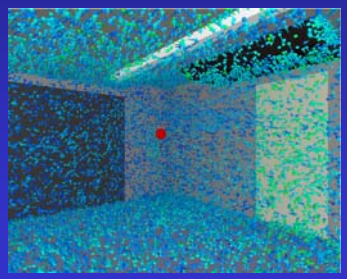
R = high, G = mid, B = low frequencies





1st reflection; 160Hz, 10240Hz (eng.: blue...red)

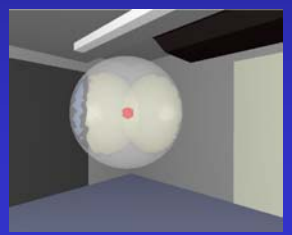


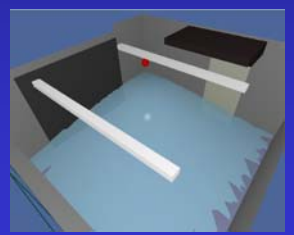


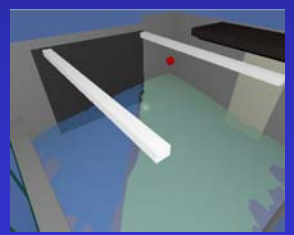
4th reflection; 160Hz, 10240Hz (eng.: blue...red)

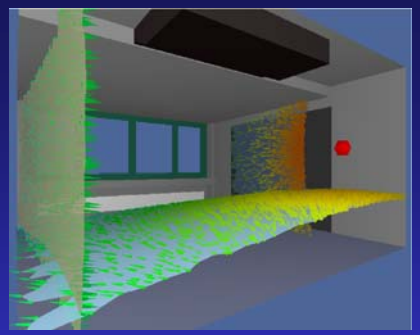
Reflected Wave Fronts

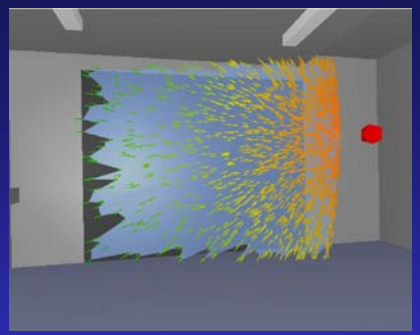
- triangulate wave front on unit sphere
- re-use triangulation for reflected phonons with similar histories







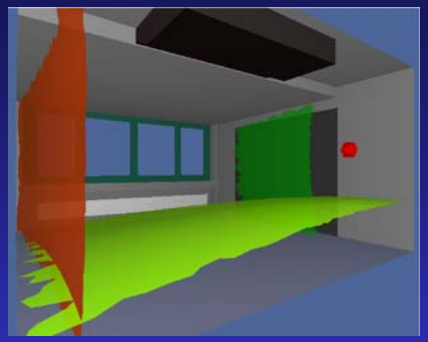


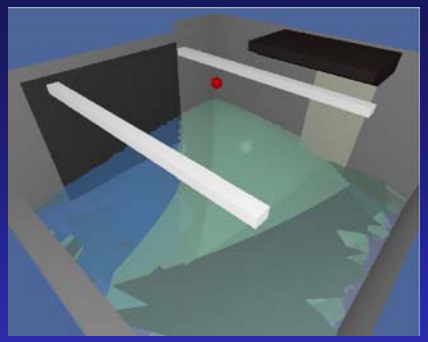


1st reflected wave front (warped distance)

surfaces: RGB color for energy spectrum

cones: HSV (red...blue) for traversed distance



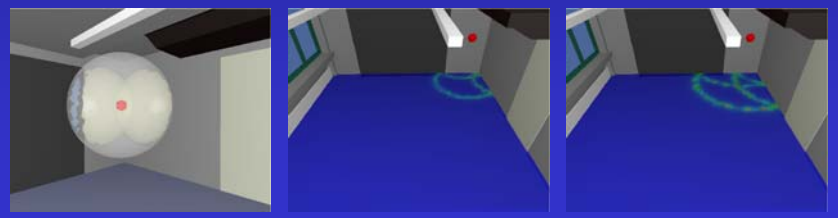


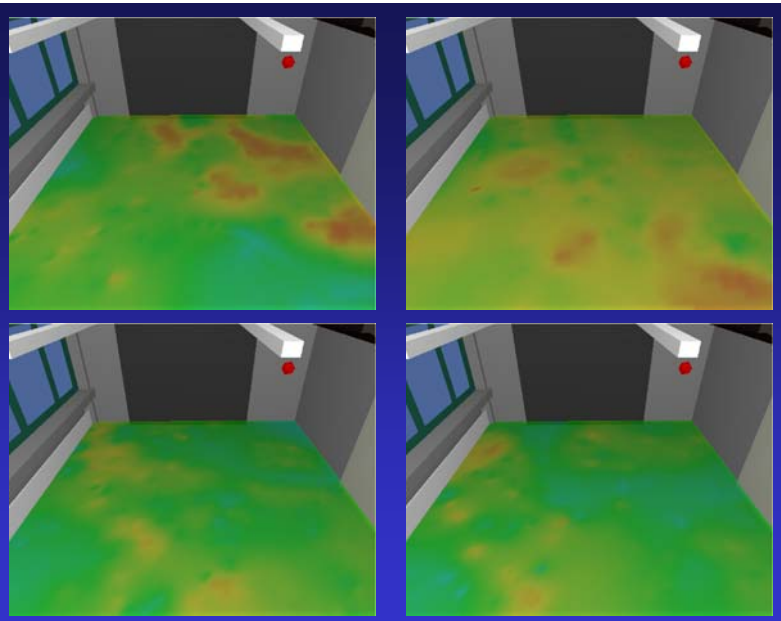
energy (HSV) + distance (offset) for 10240Hz

all 2nd reflections on floor as transparent surfaces

Energy by Scattered Data

- problem: fragmentation of wave fronts
- approximate energy of all phonons ignoring directions
- use RBF´s (Franke-Little)

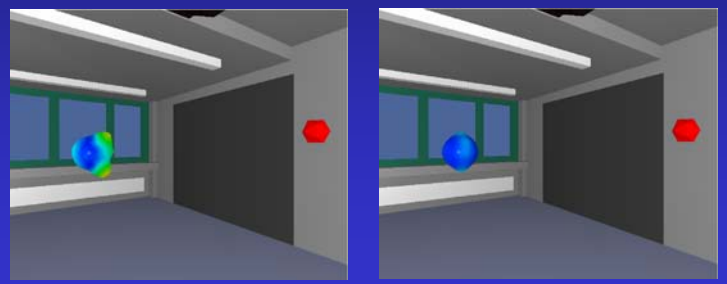




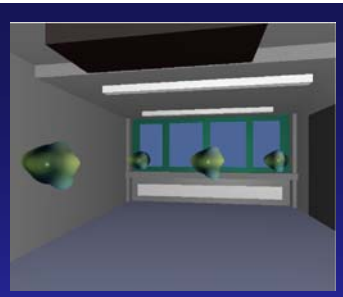
energy on floor (HSV) at time steps 20-23 ms

Energy at Listener

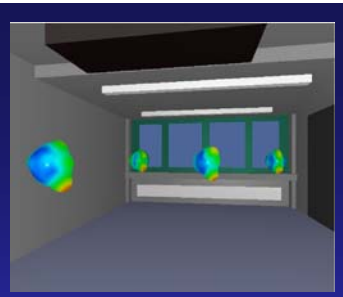
- show incoming flux on deformed sphere
- selection of time intervals + frequencies



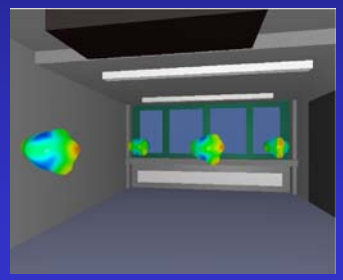
energy at 80 hz, < 50 ms > 50 ms



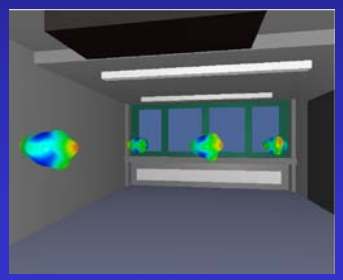
energy spectrum (RGB)



energy at 80Hz (HSV)



1280Hz



10240Hz

Conclusions

- What information is necessary to characterize directional sound?
- 4 visualizations for directional sound
- can show wave fronts only after few (<5) reflections
- show average information (energy) for a larger number of reflections

Acknowledgements

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Questions?