Computer modeling of whale-trap line encounters

Laurens Howle, Duke & BelleQuant Engineering
Doug Nowacek, Duke University Marine Lab
Andy Read, Duke University Marine Lab
Anna McGregor, Ph.D. Candidate, Duke Univ.

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BELLEQUANT
Engineering, PLLC

New England Aquarium
Protecting the blue planet

Goals

- Model entanglement encounters
- Model trap line physics given various line properties (stiffness, diameter, friction coefficient).
- Large amplitude rope deflection with axial loading and bending stiffness at wrap site.
- Generate computer animations of cetacean-line encounters at various swim speeds, currents, ascent/descent angles at various heights in the water column.
- Generate an interactive modeling system.

Methods

- Custom written C#.NET program with XNA graphics output.
- Read and animate dive profiles from Dtag data.
- Interactive system to allow scientists to easily try encounter scenarios.
- Accurately model rope physics.
- Whale-line collision detection.
- Trap line physics recorded for analysis.

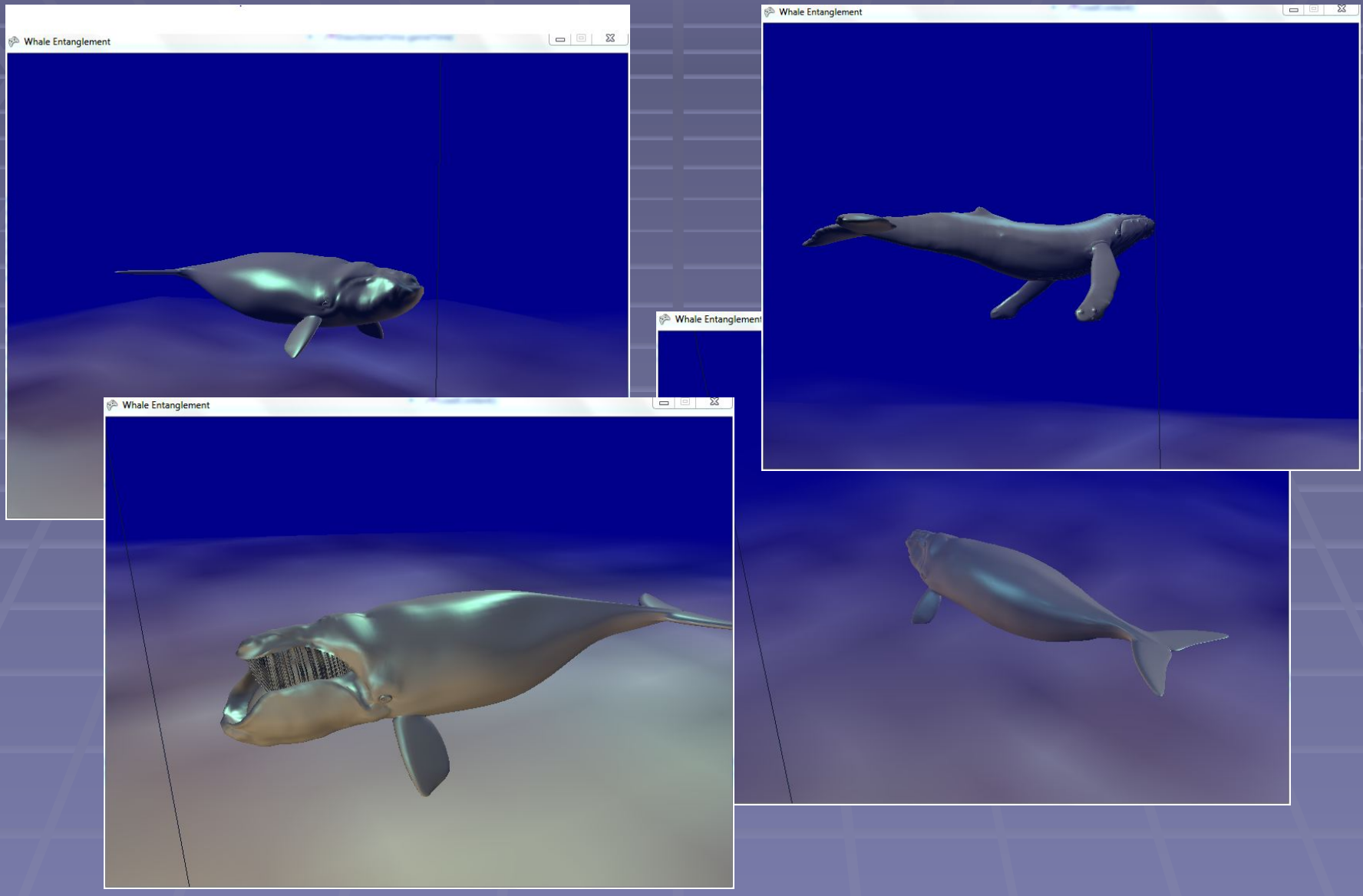
Deliverables

- Computer animations of entanglement events.
- Testing of physics-based entanglement hypotheses.
- From post-entanglement field observations and trap line scarring, generate hypotheses on how the entanglement occurred.
- Interactive entanglement modeling system.

Rope/Cable Models

- Cable models, transverse and axial loading, no bending loading.
- Beam models, transverse and bending loading, no longitudinal, small or intermediate loading.
- Timoshenco beam model, medium deflections, nonlinear deflections.
- Axial and lateral friction.
- Variable properties.
- Friction models along contact line.

Whales


Whale Entanglement
Whale Entanglement
Whale Entanglement
Whale Entanglement

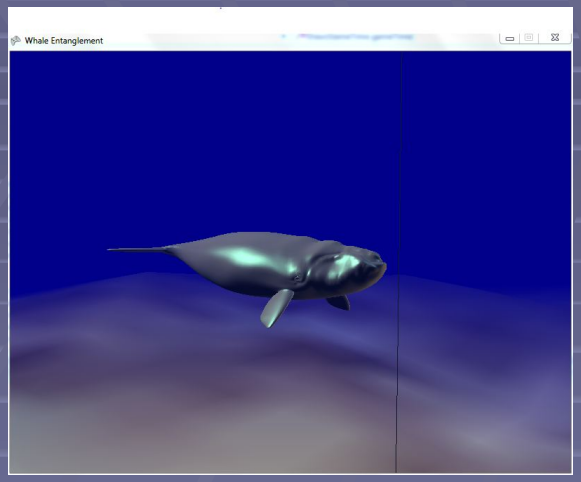
Whales continued

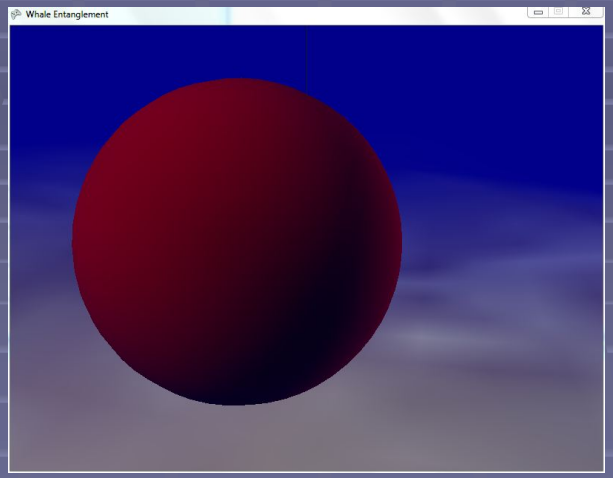
- Humpback, Right whale models at present.
- Currently not animated - animation near future.
- Kinematic/Kinetic at present.
- Kinetic/Kinetic near future.
- Game quality graphics.
- Acoustics.
- Behavior.

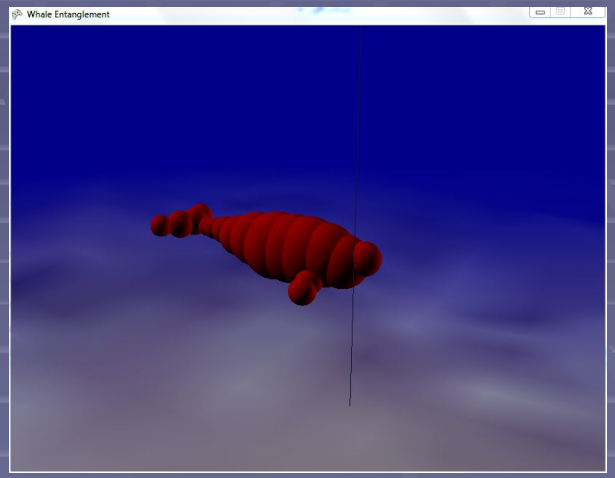
Environment

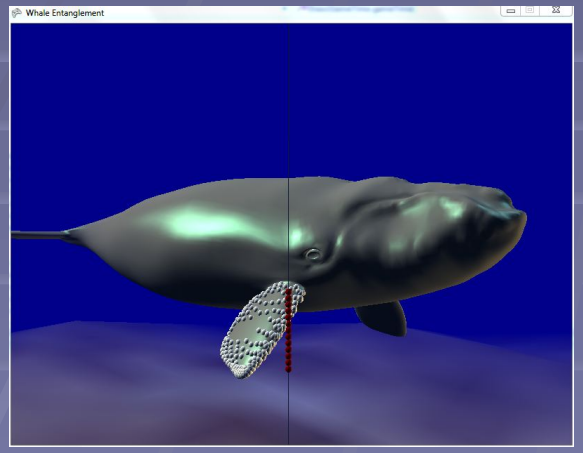
- Various trap gear types.
- Game quality rendering.
- Water surface.
- First person (first whale) point of view.
- Third person POV.
- Whale-realistic dynamics (swim speed, turn radius …)

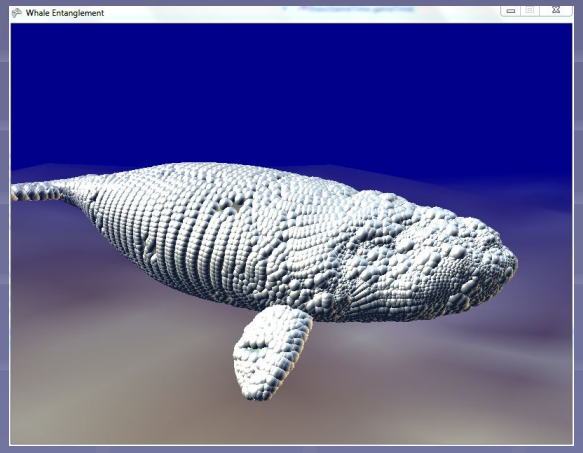
Collision Mechanics

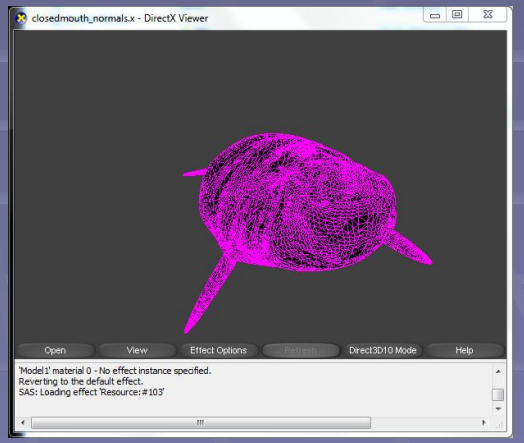












Only then do we calculate the barycentric collision test.

Conclusions

- Code to be made available to researchers.
- Please give me your feedback/input.
- Demo if time permits.

This investigation is supported by U.S. DOC-NOAA Grant # NA09NMF4520413.

BELLEQUANT
Engineering, PLLC