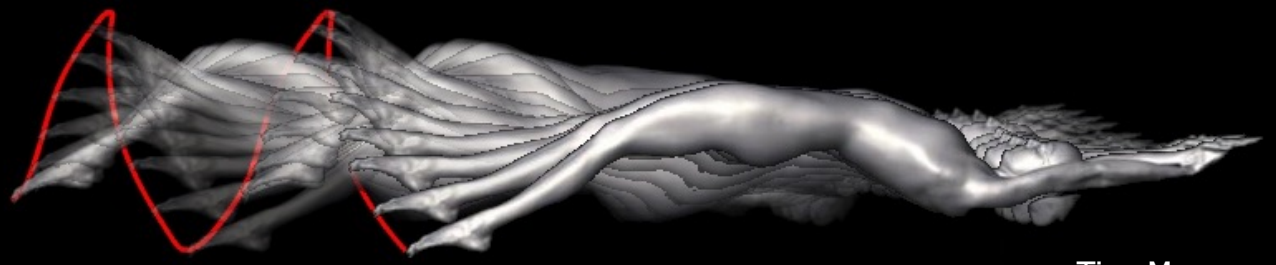

Tina Ma

Institute for Computer Graphics

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Professor of Computer Science

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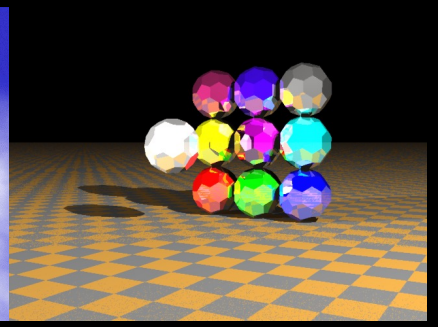
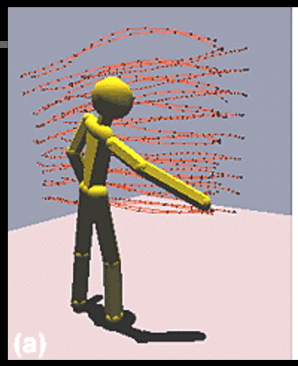
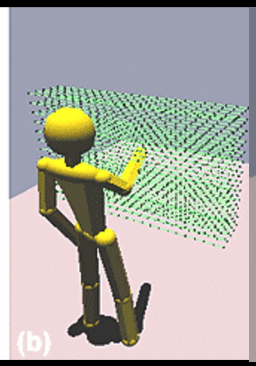
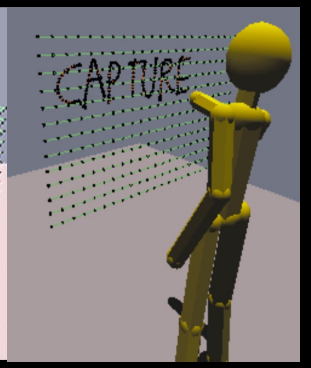
Animation: Motion control

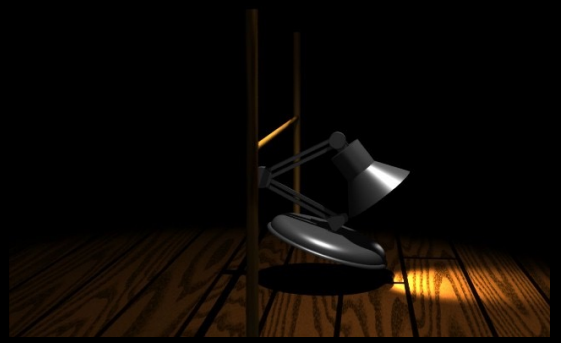
- Physics-based
- Interpolation synthesis from motion capture: Example-based inverse-kinematics
- Derivation of controllers using Genetic Algorithms
- 4-D (shape/time) capture





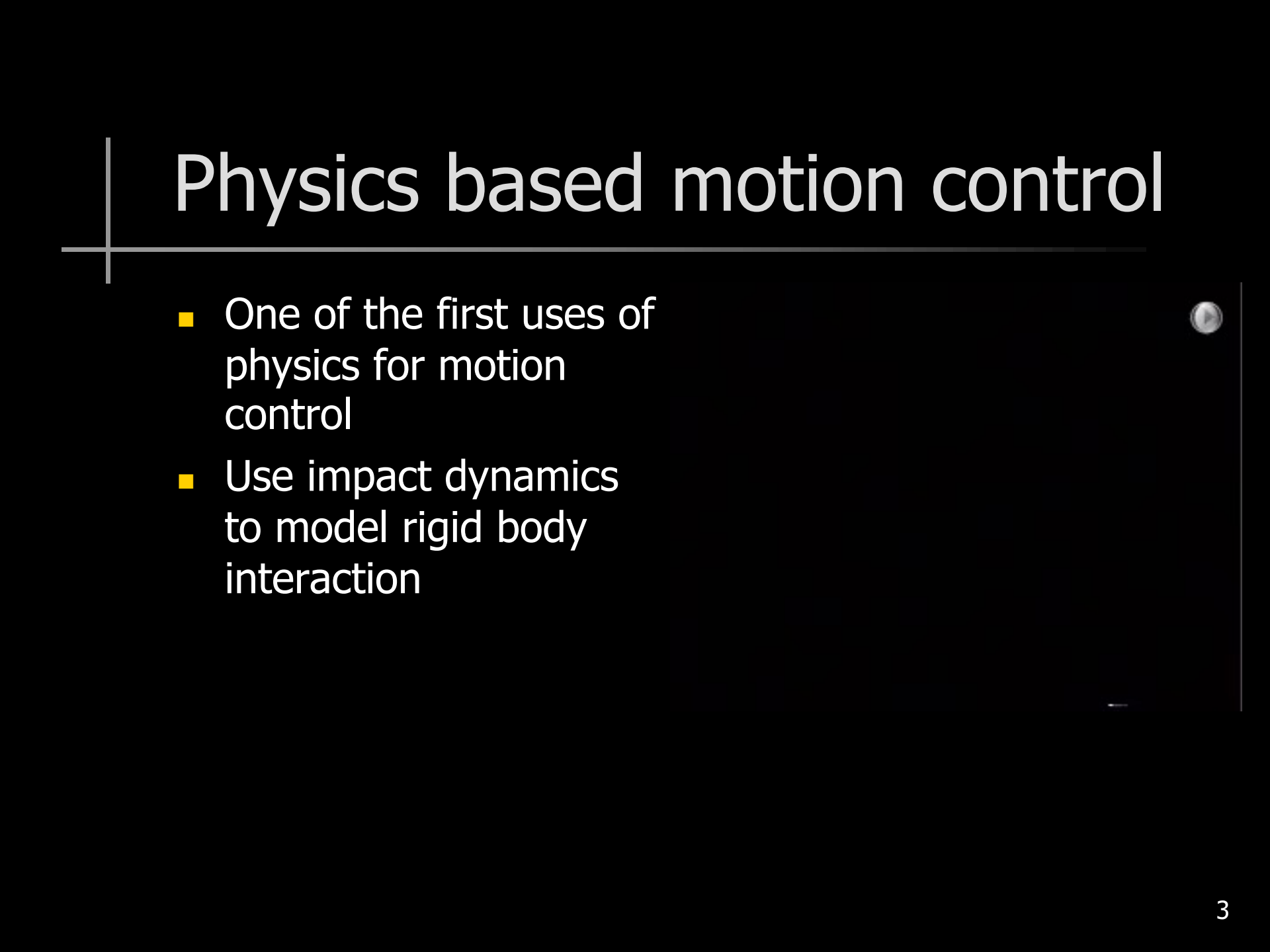




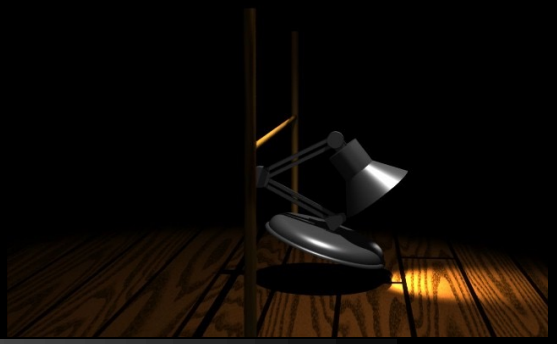


Physics based motion control

- One of the first uses of physics for motion control
- Use impact dynamics to model rigid body interaction



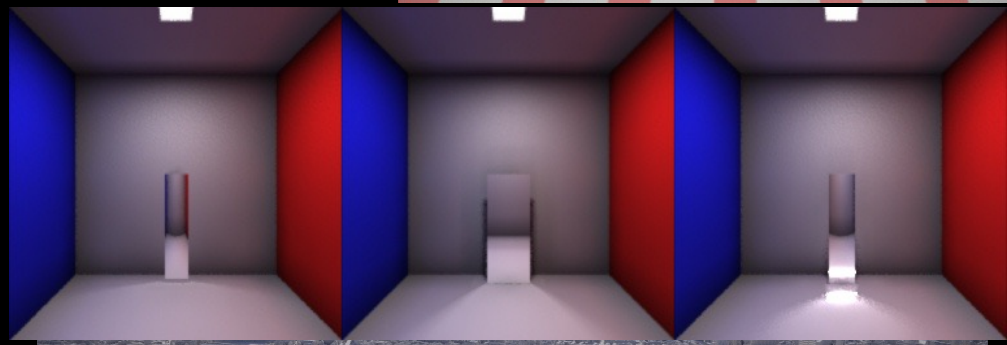
Motion control: Genetic algorithms



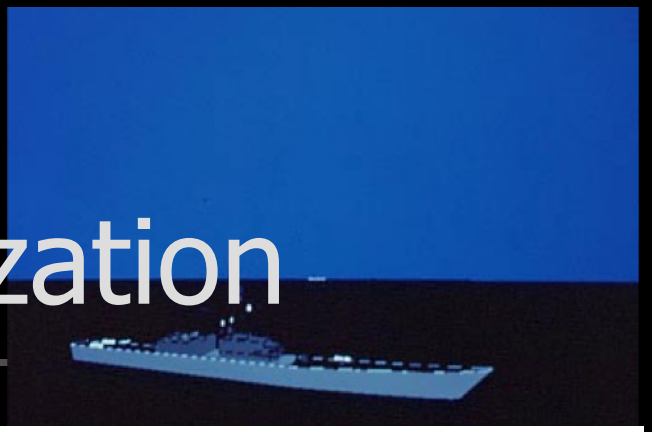
- Evolve controllers
- Analogous to Darwinian evolution
- Start with set of random individuals
- Every generation, selection based on fitness metric (objective function)
- Following generation: reproduction, crossover, mutation

Rendering

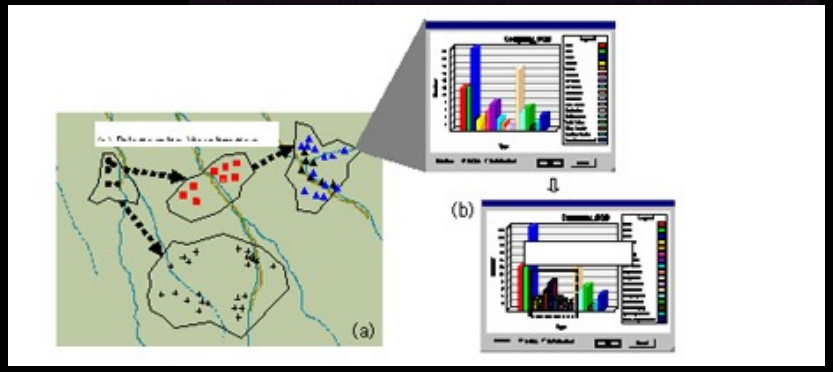
- Diffuse/specular light transport
- Real-time path tracing of large voxelized scenes

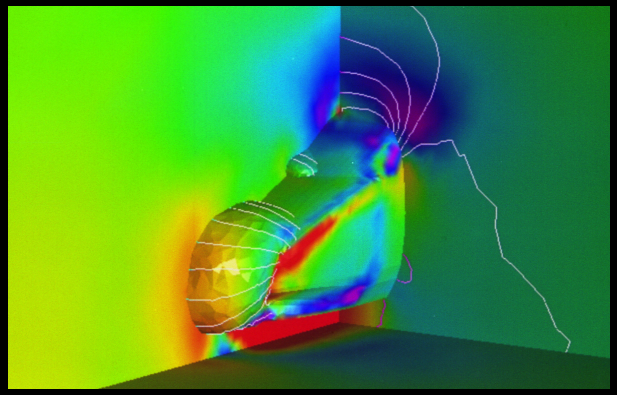


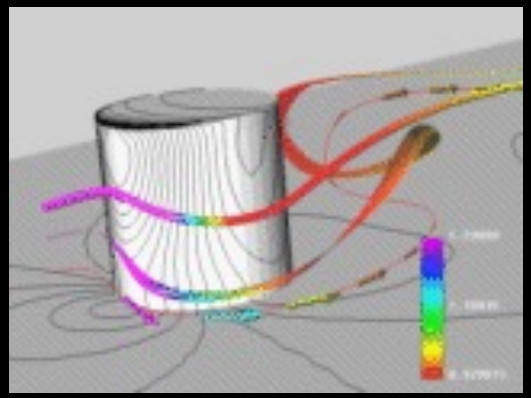
Information Visualization



- NRL: model propagation of infrared energy
- Intelligence agencies: information visualization
- NASA: scientific visualization

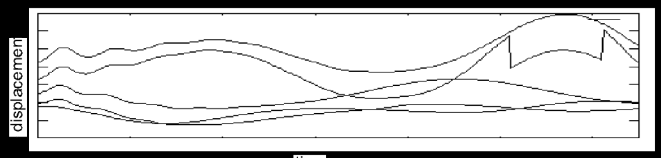


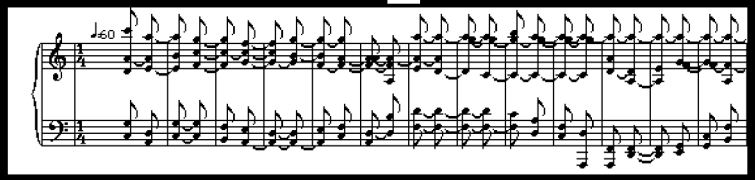


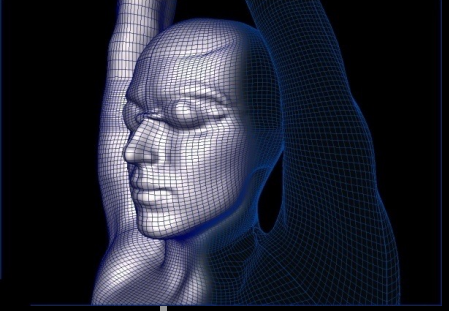


Sound

- Sound synthesis using physics modeling and genetic algorithms
- Sound synchronization matching parameters from motion control to sound synthesis
- The first SIGGRAPH paper on “Sound Rendering”

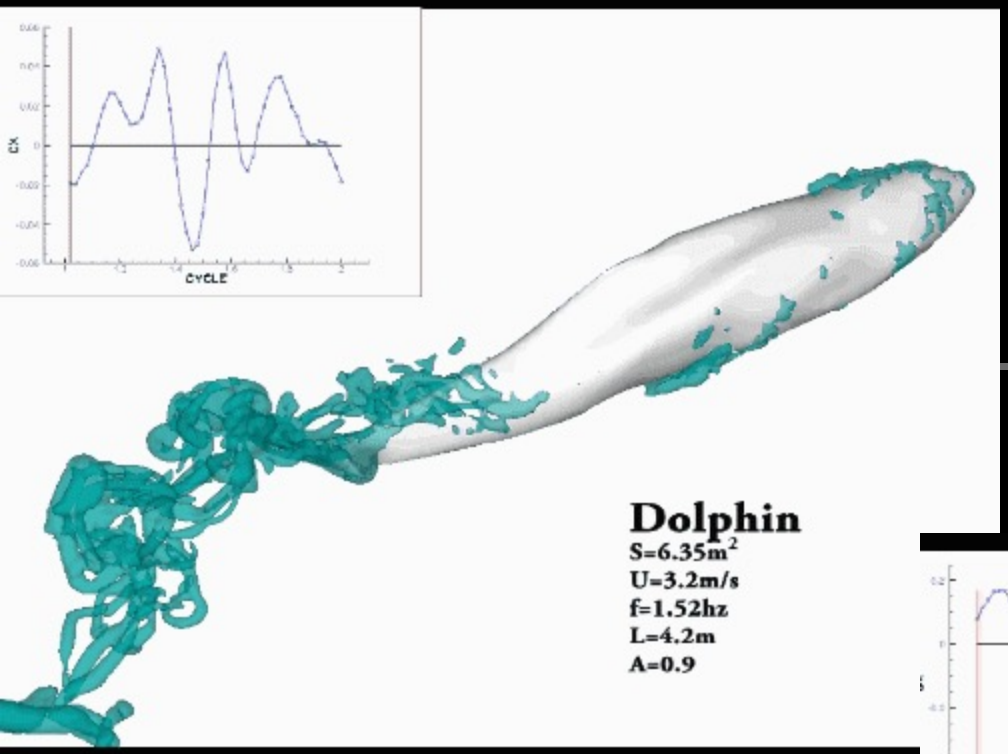


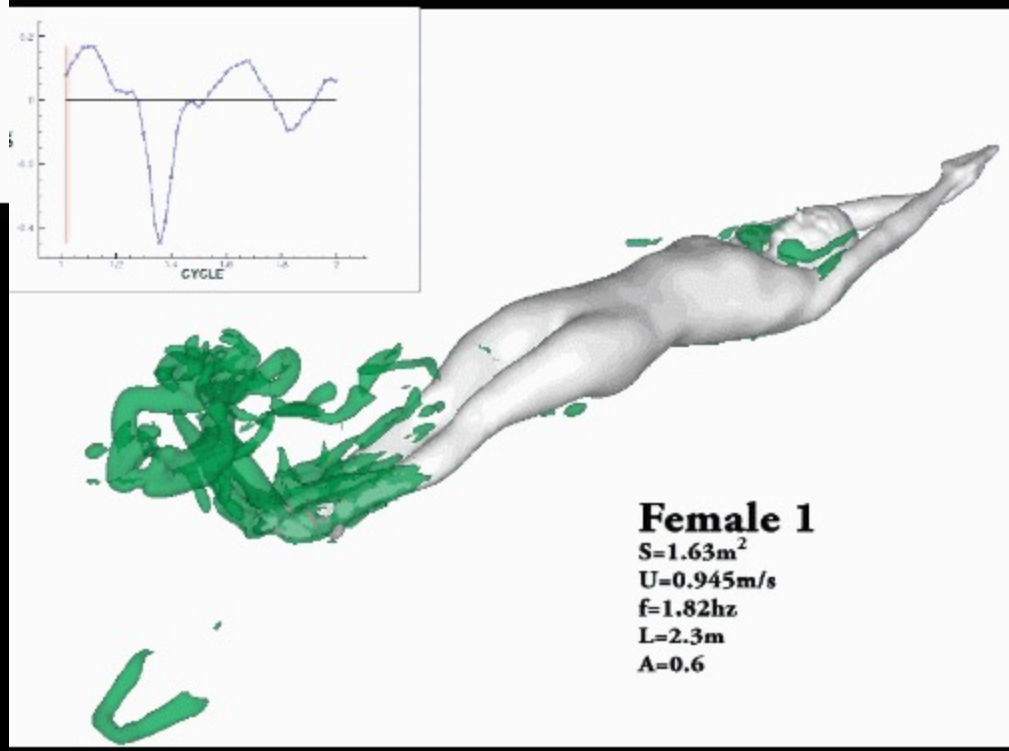




Analysis of swimming USA Swimming funding

- Collaborators
  - US Olympic Swimming
- Generate 3D virtual representation of real swimmer





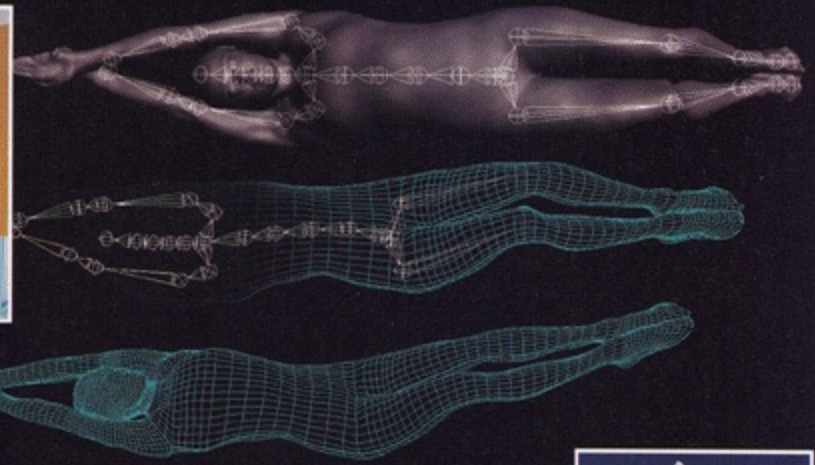
- CFD simulaton:
  Prof. Rajat Mittal, JHU

Stroke Science

Talent + tech = gold for the U.S. swim team, which is wiring its way to success in Athens and beyond

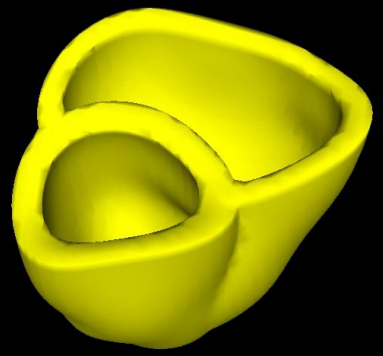
ATHENS 2004

Sports Illustrated

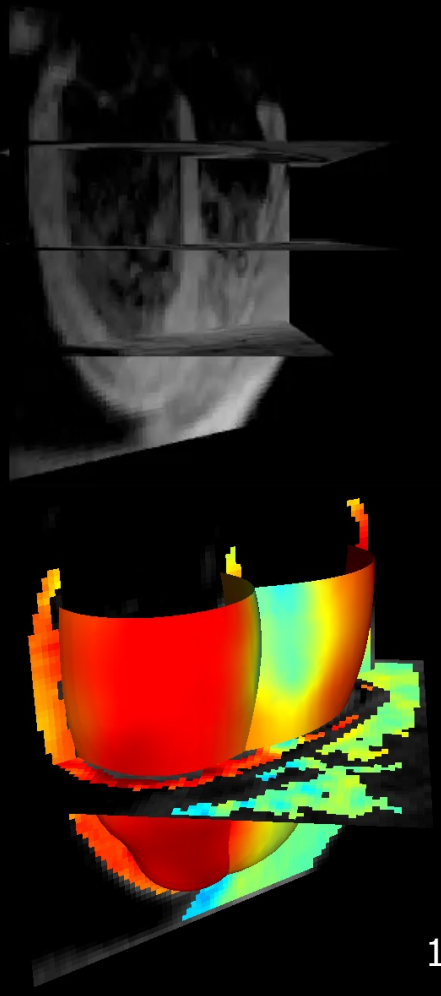


In computational fluid dynamics, a full-body scan of Gabrielle Rose creates a digital model used to analyze water flow around a swimmer.

Heart

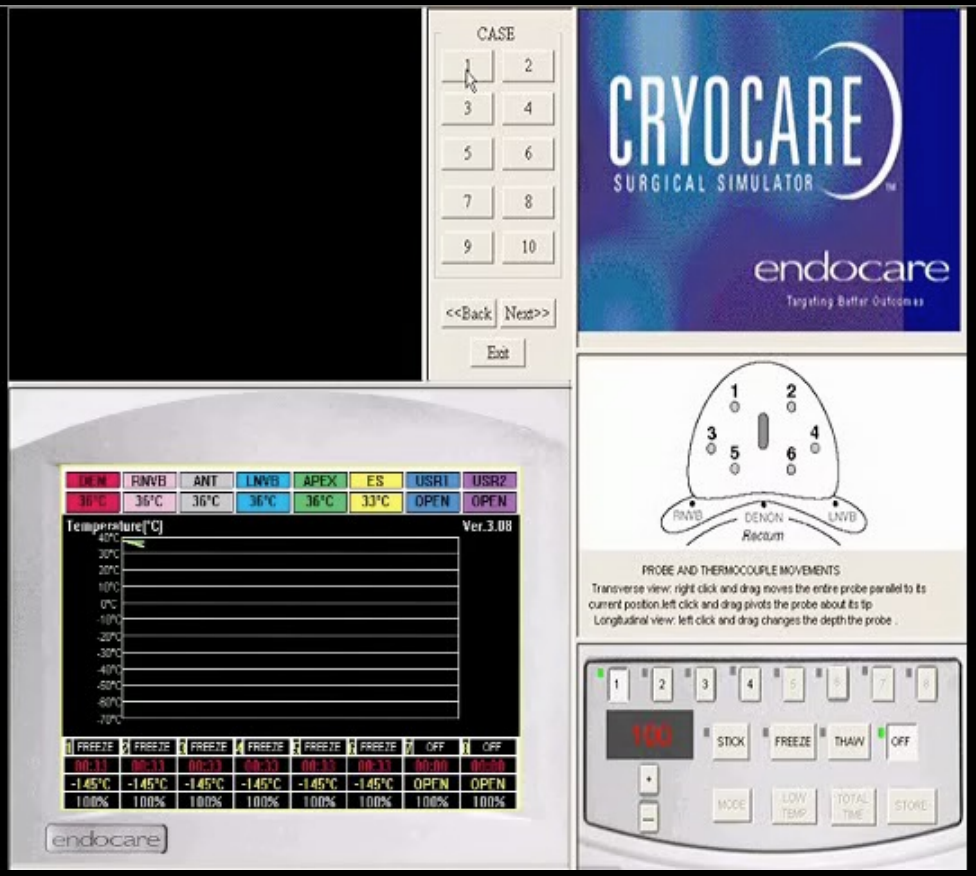


- Collaborators
  - National Heart, Lung and Blood Institute, NIH
  - GW Cardiology
- Capture shape and motion of beating heart using DENSE - Displacement Encoding with Stimulated Echo MRI
- Simulate and visualize heart and surrounding fluid blood
- Calculate strain



Medical simulation (Industry funding)

- Simulate freezing cancerous cells
- Treatment of prostate cancer
- Simulated ultrasound
- Simulated freezing as a result of Liquid Argon



Medical visualization using gestures (NIH funded)

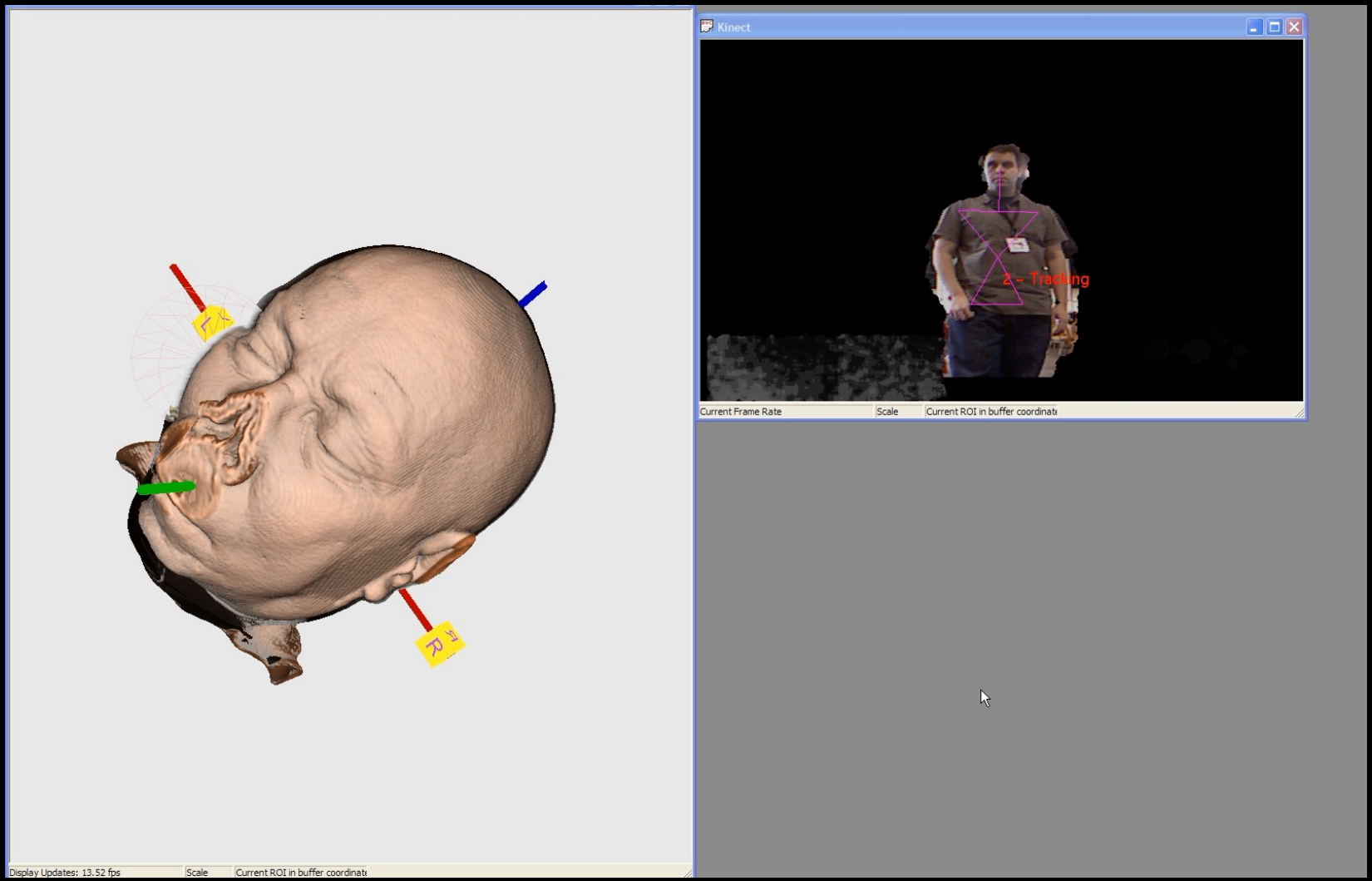
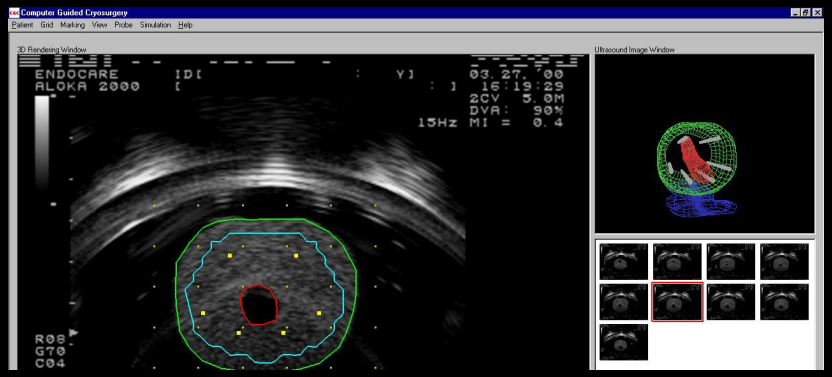
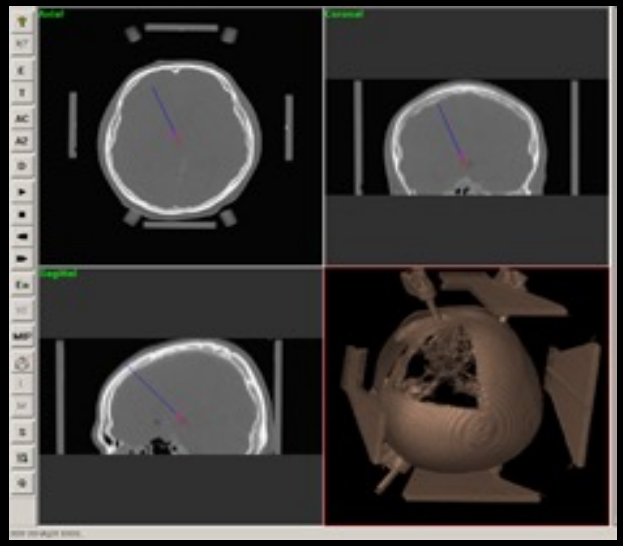


Image-guided Surgery

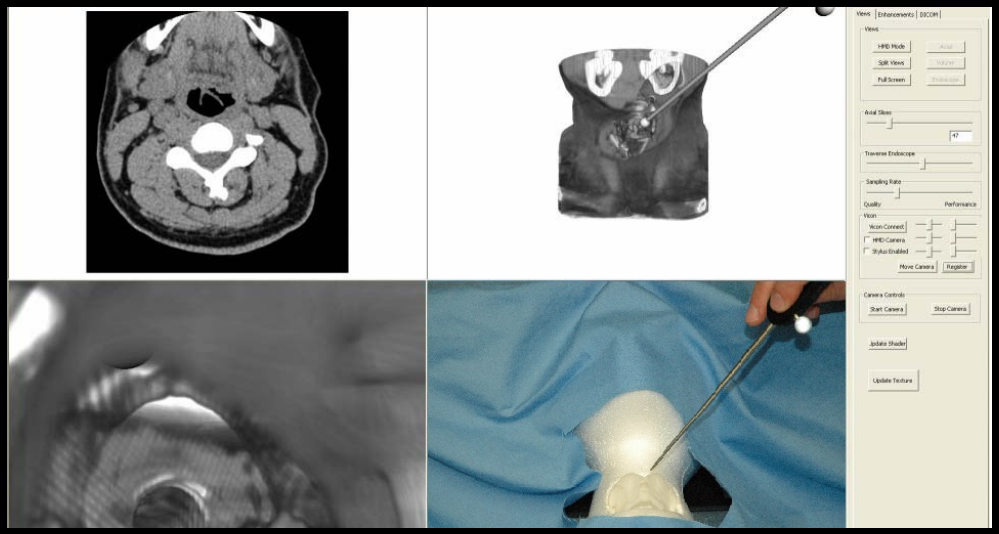
- Old way: cut then see
- New way: see then cut
  - “see” done using MRI/CT/Ultrasound, etc.

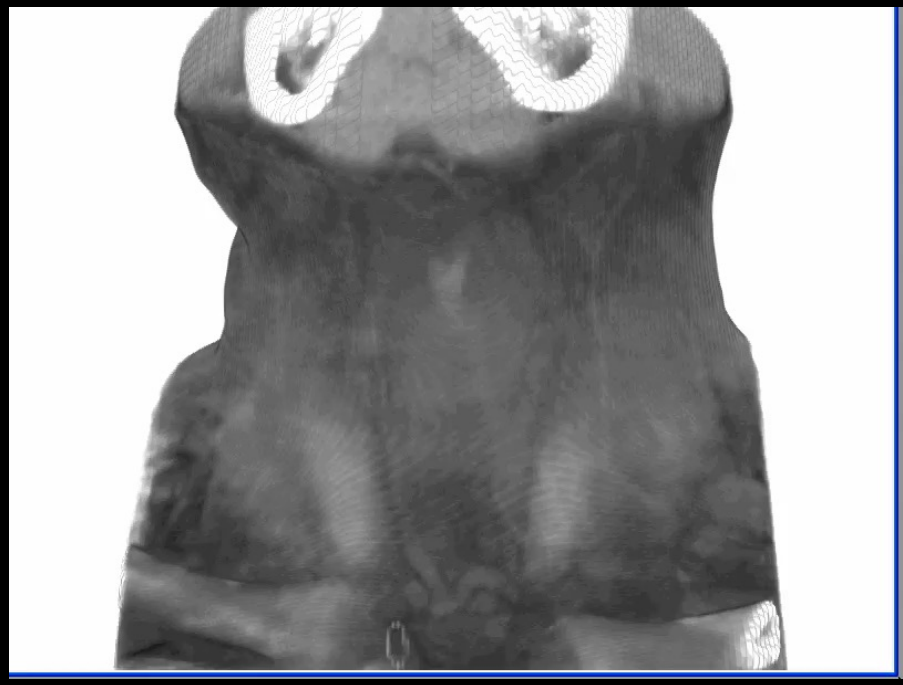




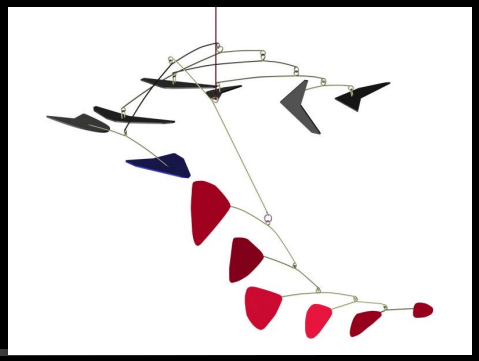
Medialization Laryngoplasty (NIH funded)

- Image guidance



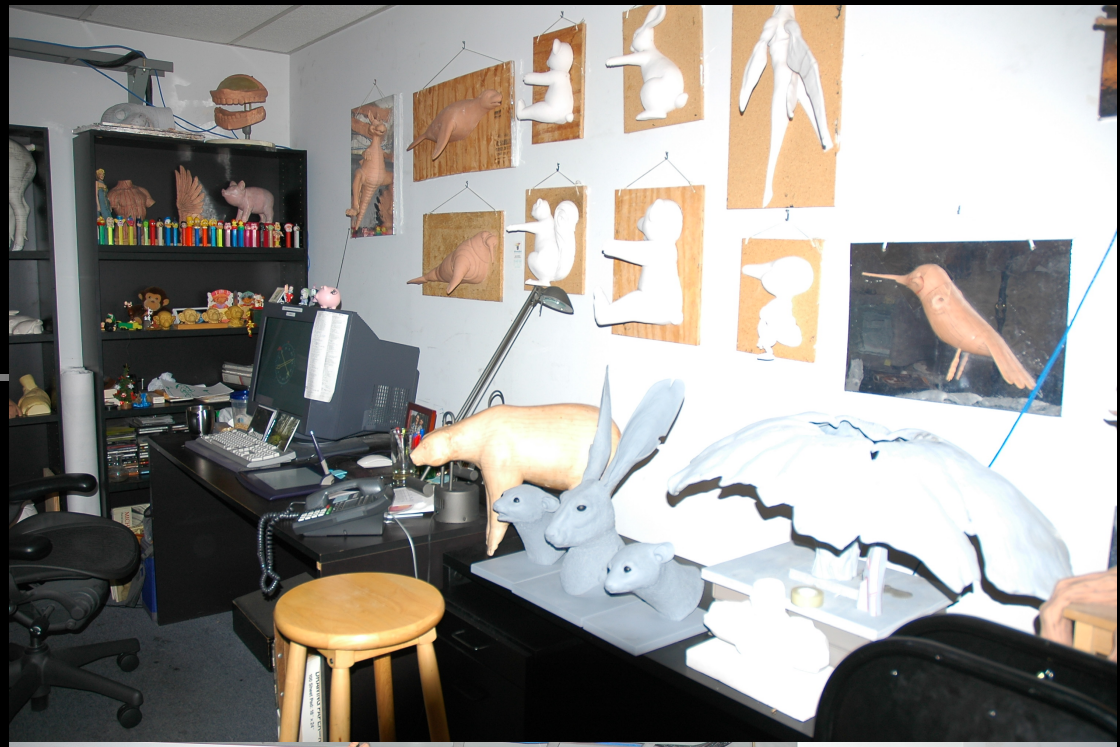


Museum visualization (Smithsonian funded)



- Virtual walkthrough for Smithsonian Institute

Modeling



Rhythm & Hues

Large-scale dense scene capture (NSF MRI funded)

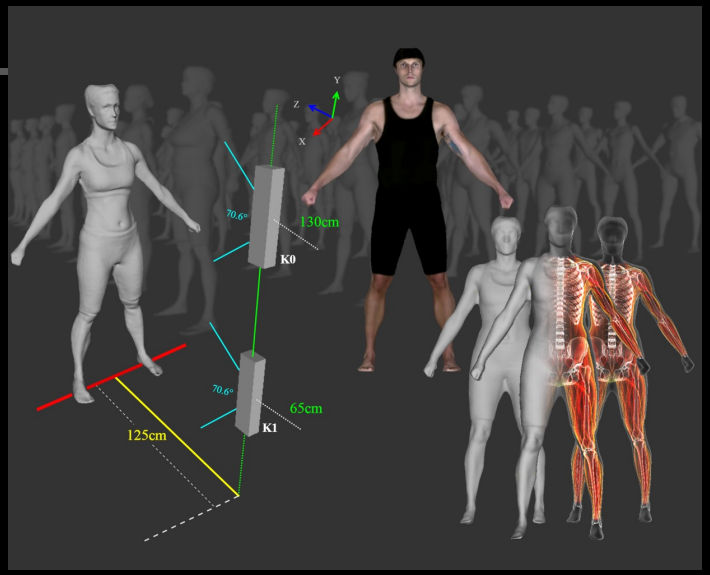
- Multi-modal sensors used to capture shape and motion in large space

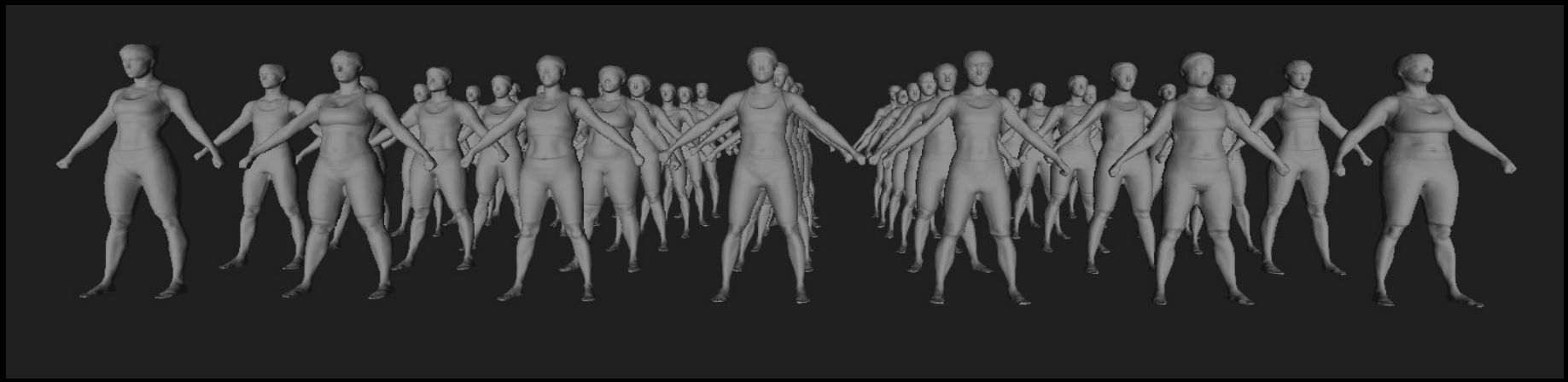
Capture shape and motion

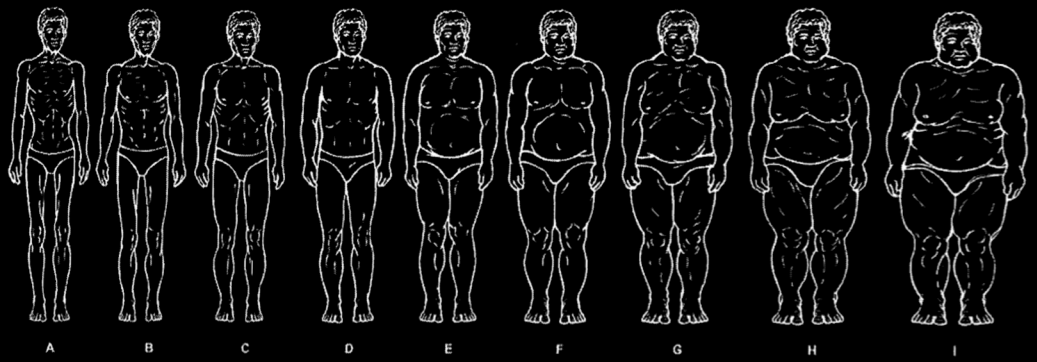
Walking around

Body composition (NIH funded)

- Develop accurate system to scan surface of body
- Calculate body composition using machine learning
- Study self perception






A
B
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I

Psychological study of self perception (NIH funded)

- Compare self-perception using different modalities of visualization

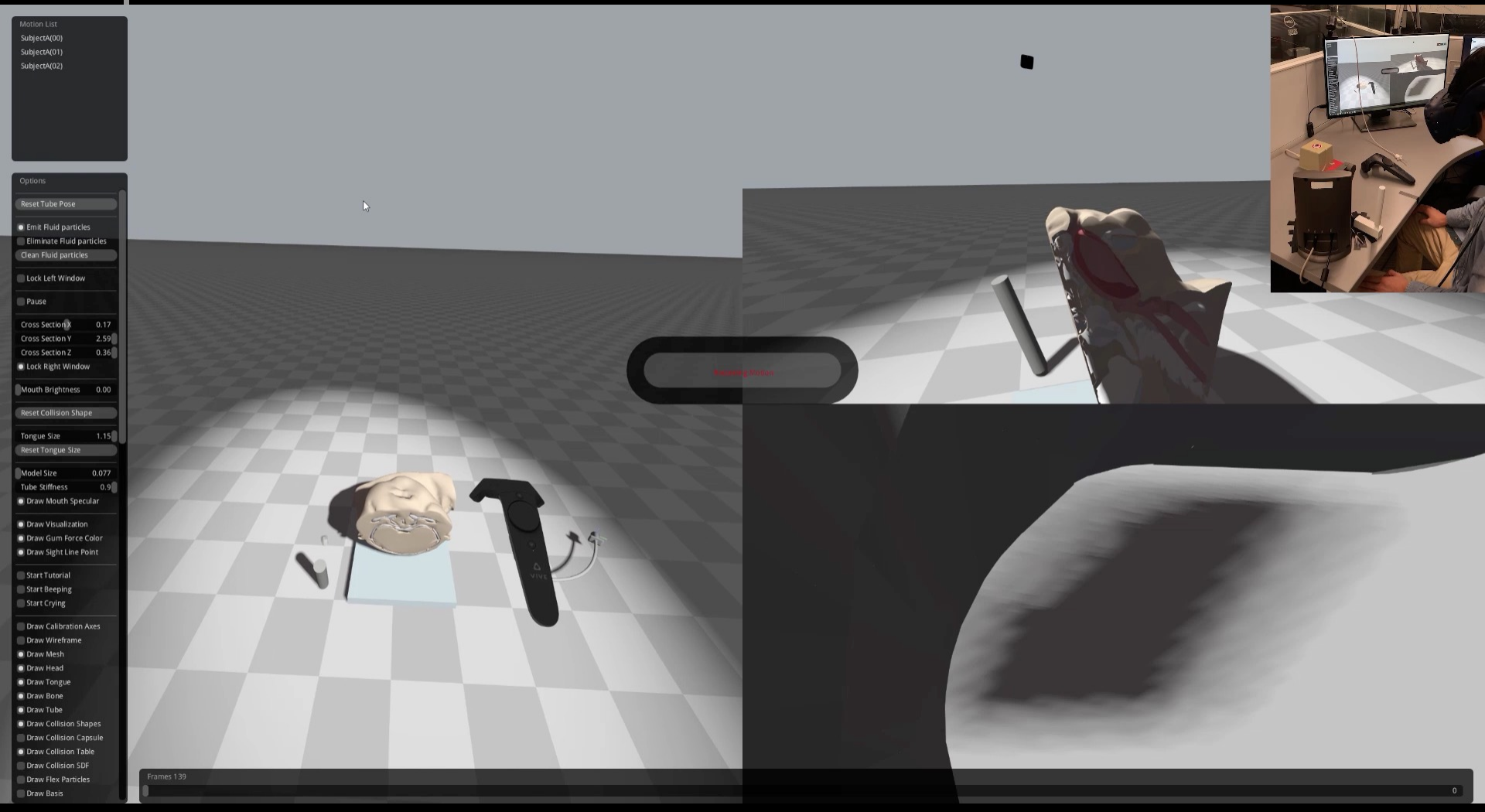
Neonatal endotracheal intubation Augmented reality (NIH funded)

Self Practice with Our XR System

Neonatal endotracheal intubation VR (NIH funded)

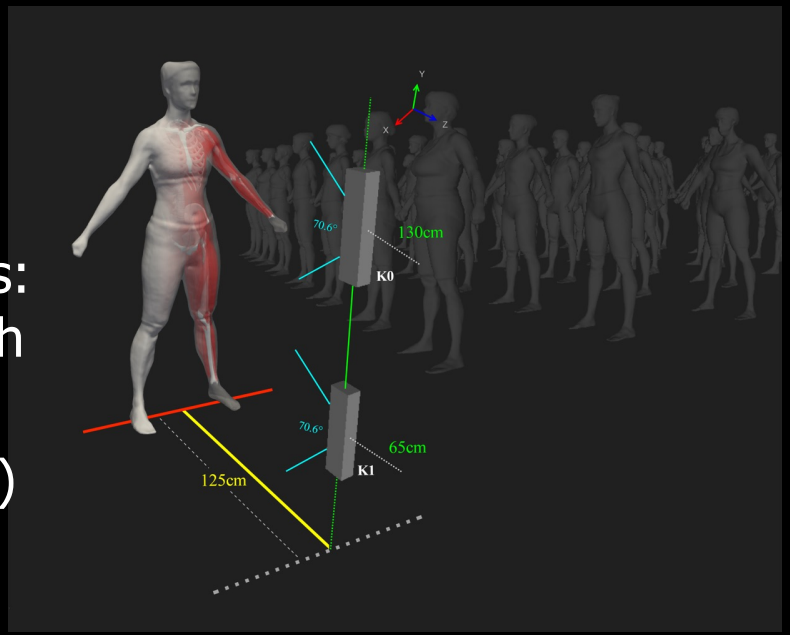
- Extract virtual anatomy from CT/MR of real neonates
- Simulate physics of tissue
- Validate using residents at Children's National Hospital
- Automated scoring and coaching using machine learning

Neonatal endotracheal intubation VR (NIH funded)



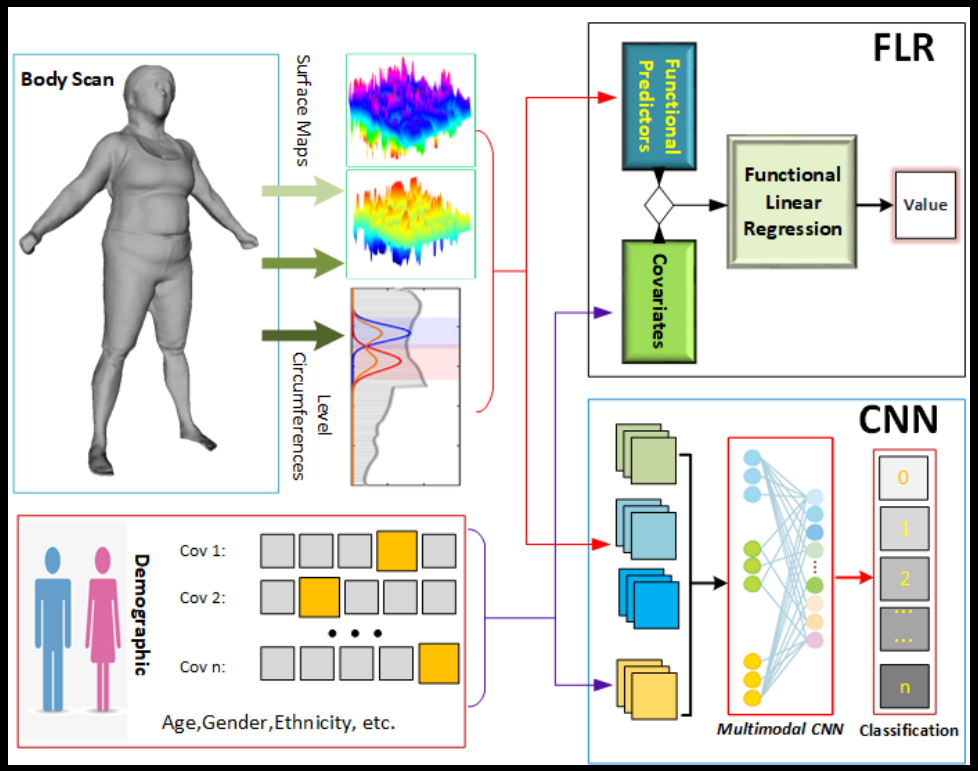
Determine health indicators of obesity(NIH funded)

- Shapes from low-cost commodity RGB-D cameras
- Potential for telemedicine/in-home use
- Correlate shape to key indicators of health
- 250 subjects from GW Weight Loss Surgery Center
  - Hepatic steatosis and fibrosis: key morbidity associated with obesity
  - Body composition (e.g., VAT)
  - Serum biomarkers



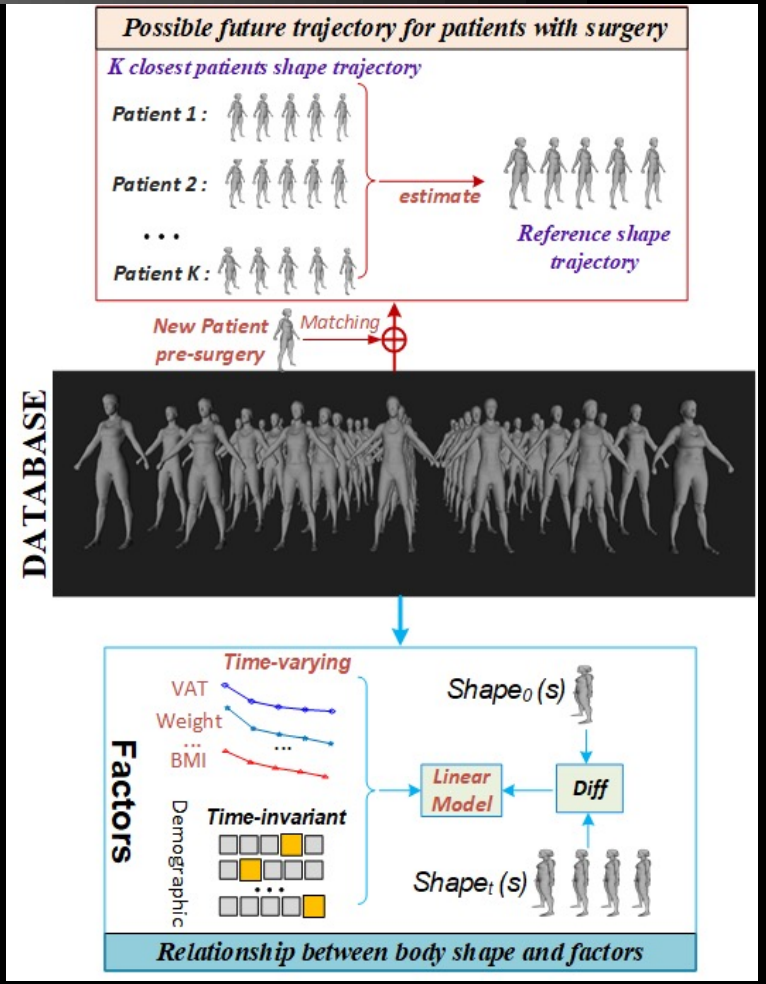
Effects of obesity

- Effects of obesity
  - Current approaches lack sensitivity (e.g., BMI), invasive (e.g., biopsy), expensive (e.g., MRI/CT/DXA)
- Machine learning to correlate shape to:
  - Hepatic steatosis and fibrosis: key morbidity associated with obesity
  - Body composition (e.g., VAT)
  - Serum biomarkers



Data mining shape vs obesity

- Cross sectional and longitudinal study: 1 year
- Measure common patterns of bariatric post surgery
  - Useful to predict surgical outcomes
- Time dependence between shape and obesity related factors



Former students

- Software architect, Sony Pictures
- Rhythm & Hues: Visual effects supervisor
  Academy Awards for "Golden Compass"
  and "Life of Pi"
- Industry: Apple, Google, Microsoft, Amazon, etc.
- Computer Games:
  CEO, Designer, Management, Sound producer
- Engineering, Medical, Business
- Government
- Professor
- University president





Computer graphics courses

- Less technical
  - Computer Graphics (non programming) CSCI 4551
  - Computer Animation (non programming) CSCI 4552, CSCI 4553
  - Augmented and Virtual Reality CSCI 4454
  - Game Design (programming) CSCI 4455
- More technical
  - Computer Graphics I and II CSCI 4554, CSCI 6554
  - Computer Animation CSCI 6555
  - Advanced Topics CSCI 8554

Thanks to:
Current funding

- NIH R01DK129809, Advancing 3D optical body surface scan technology to assess physiological and psychological effects in highly obese population
- NIH R01HD091179, Neonatal Endotracheal Intubation: Enhancing Training Through Computer Simulation and Automated Evaluation
- GWU Cross Disciplinary Research Fund

Thanks to:
Past funding

- Army Research Laboratory
- C-Motions, Inc.
- Children's National Medical Center
- Electronics and Telecommunications Research Institute
- Endocare
- Google
- National Aeronautics and Space Administration-Goddard Space Flight Center
- National Institutes of Health
- National Science Foundation
- MedImmune/AstraZeneca
- Naval Research Laboratory
- Office of Naval Research
- Samsung Electronics Co. LTD
- SERI
- U.S. Department of Homeland Security
- USA Swimming

Thanks to: Doctoral students

- Jean M. Favre, 1994
- Douglas J. Wiley, 1997
- Hesham Fouad, 1997
- Larry Gritz, 1999
- Robert Lindeman, 1999
- Shih-Kai Chung, 2000
- Dongho Kim, 2002
- Nadia Al-Ghreimil, 2002
- Sang-Joon Lee, 2006
- Ge Jin, 2007
- Jae Woo Kim, 2008
- Can Kirmizibayrak, 2011
- Edward M. Wakid, 2011
- Nadezhda Radeva, 2013
- Manal Alassaf, 2015
- Yao Lu, 2018
- Samar Alsaleh, 2020
- Xiao Xiao, 2020
- Wei Li, 2020
- Shang Zhao, 2021
- Qiyue Wang, 2022
- Rehab Alahmadi, 2022
- Yan Meng
- Yijiang Zheng
- Ruting Cheng
- Boyuan Feng
- Chuhui Qiu

Then and Now

- www.icg.gwu.edu
- Festival of Animation (Since 1991)