Neonatal Intubation Simulation with Virtual Reality and Haptic Feedback

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BME Design

Neonatal Intubation


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[2]

Dr. Ryan McAdams
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- Intubation may be necessary if the neonate is under respiratory distress
  - Procedure must be done gently, quickly and precisely[1]
- Current training methods are inferior
  - Video Instruction
    - Lack of hands on experience
  - Neonatal Mannequins
    - Inaccurate anatomy
    - Artificially easy


[3]

Specifications and Constraints

Function:

- Client desires virtual simulation of the neonatal intubation procedure
- Includes haptic feedback
- Requires environment which accurately emulates procedure

Performance:

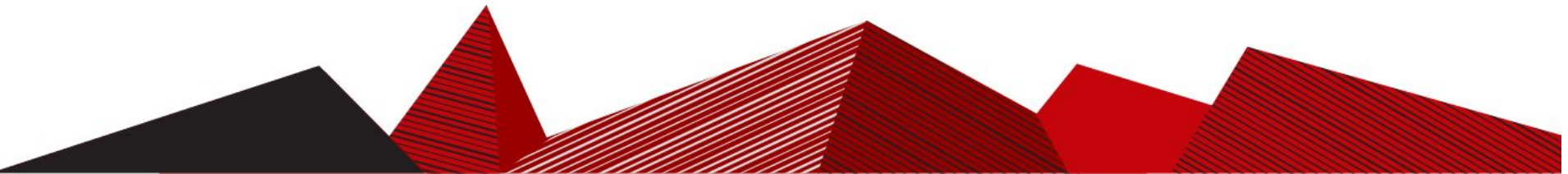
- Must be accurate to 0.02mm to compete with current haptic feedback systems
- Virtual environment must be detailed and load in real time without buffering

Ergonomics:

- Should feel similar to real procedure in regards to tools used and actions performed

Budget:

- $6000 for total simulation



Potential Impact

- 7% of term-newborns undergo respiratory distress[4]
  - Increases substantially in premature infants
- In 2005, nearly 10% of births were premature[5]
  - Highest rates in North America and third world countries
  - Estimated that prevalence increased since 2005
- Anywhere from 30-70% of intubation attempts are unsuccessful[6-8]
- Revolutionize medical procedural training techniques

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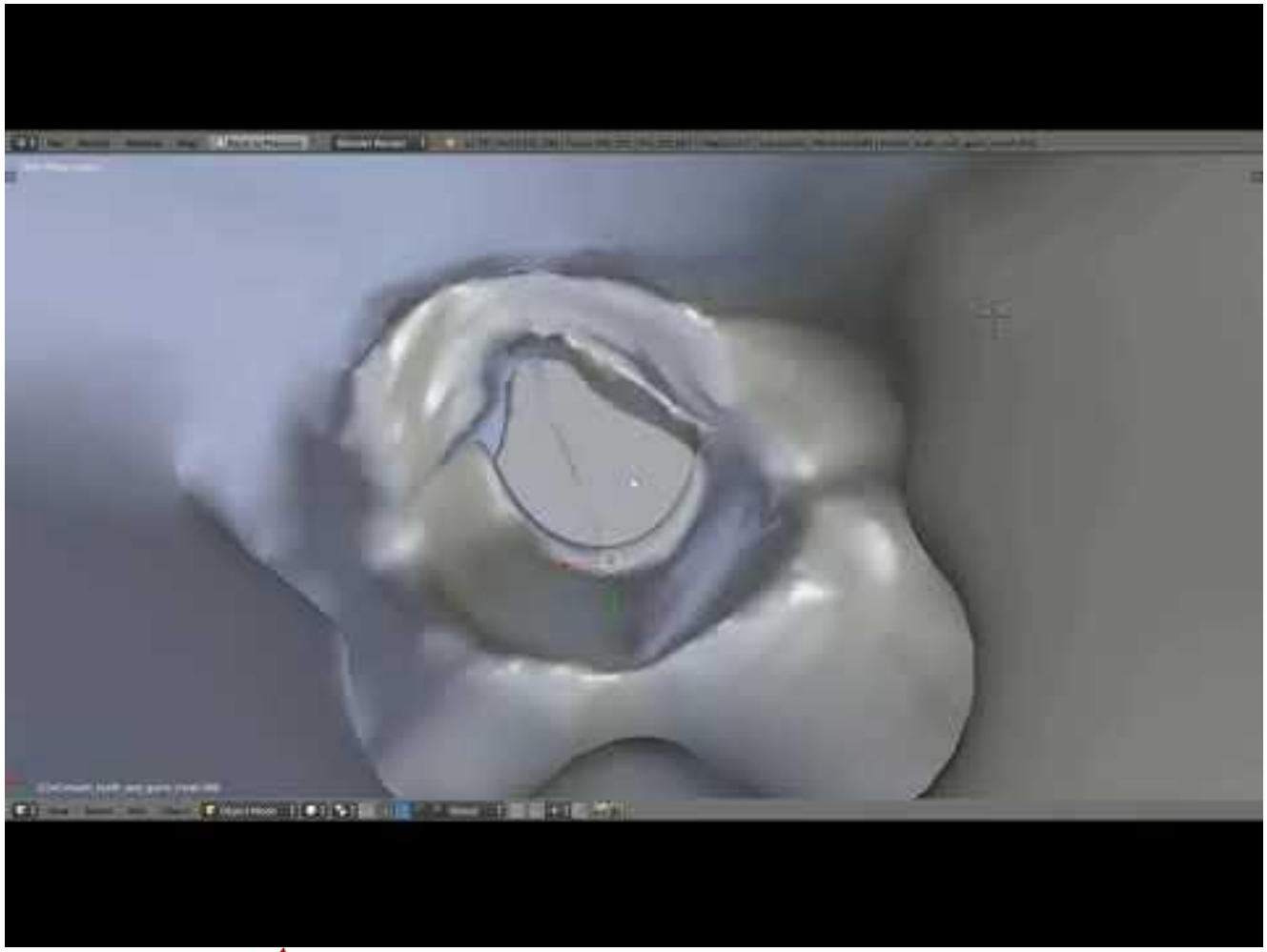
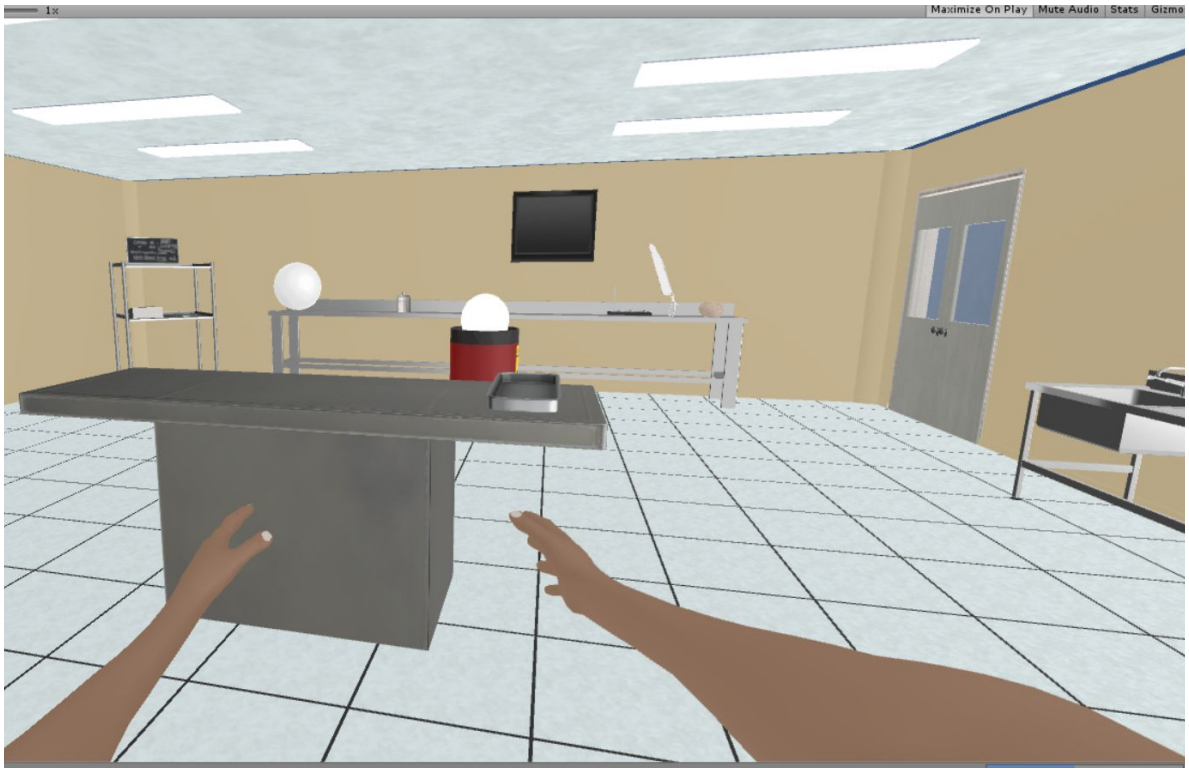
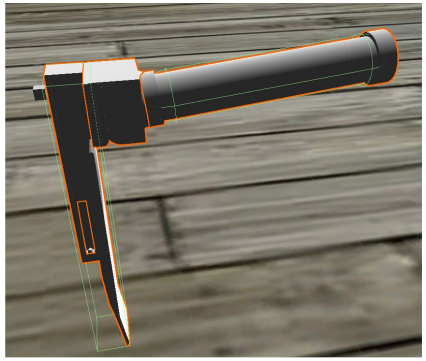
Current Prototype - Neonate

Current Prototype - Inner Anatomy



Current Prototype - Virtual Environment





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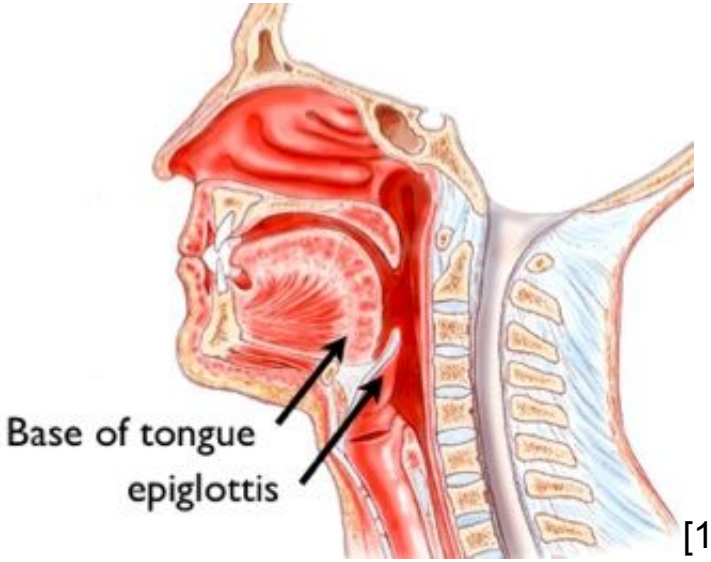
Fabrication Challenges

Programming in Unity provides a challenge

- Extensive knowledge of C# necessary
- Future solution: joint BME/Computer Science design team

Meanwhile, focus efforts on completing neonate model…

- Refining, rigging and texturing
  - Challenges include rigging the tongue and epiglottis, mimicking their flexible and springlike qualities



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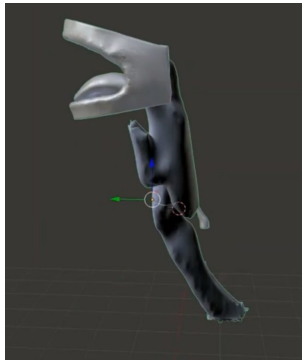
Fabrication Goals



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February

Finish prototype of neonate model mesh

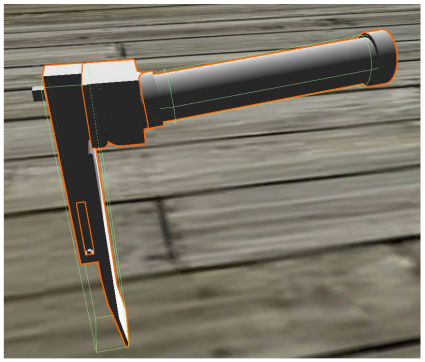
- Clean interior anatomy
- Integrate interior anatomy into exterior shell

March

Complete rigging of internal anatomy

- Refine movement of jaw, tongue, lips, epiglottis and vocal chords

Fabrication Goals



April

Refine anatomy movement and appearance

- Mimic realistic coloring of baby and anatomy
- Mimic the tongue's soft texture

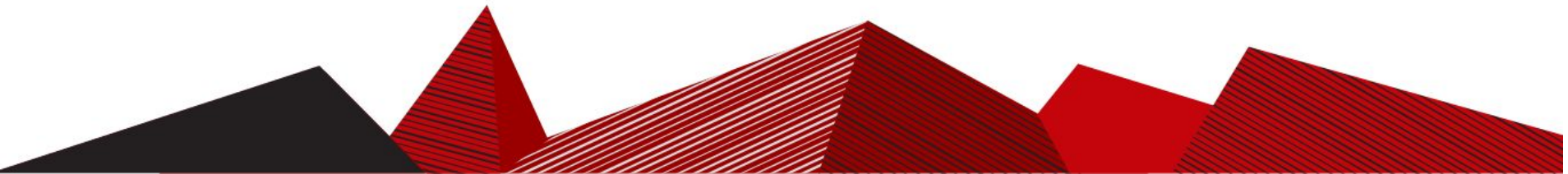
May

Integrate neonate into Unity environment

- Define equations to simulate realistic feedback when haptic stylus interacts with neonate exterior

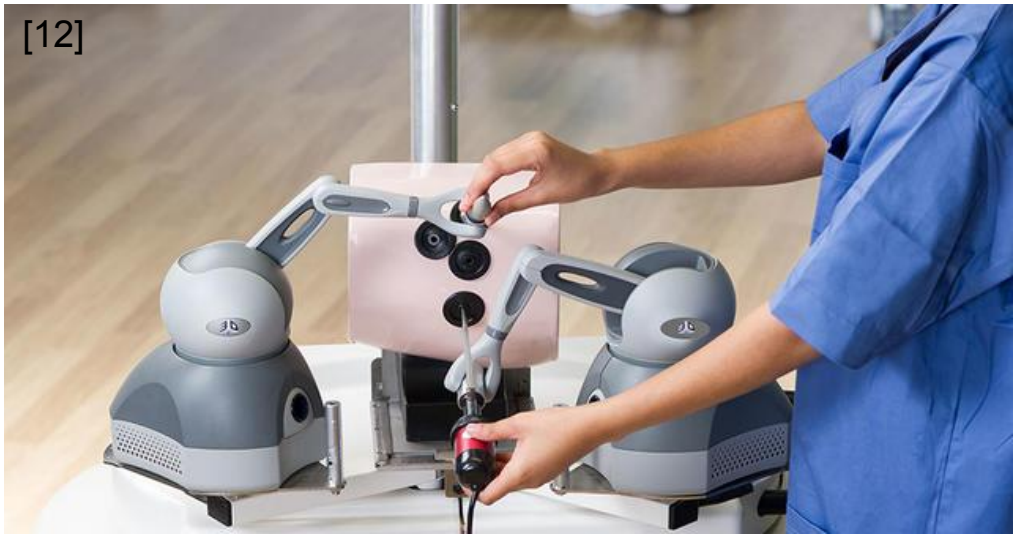
Future Testing

- Ultimately, we wish to use this device as a certified surgical training tool
- Objective testing difficult and impractical
- **Stage 1:**
  - Subjective refinement of environment based on expert feedback (clients, students, other experts)
- **Stage 2:**
  - Train medical students and residents using either:
    - Traditional methods only
    - Traditional methods + VR simulation
  - Evaluate trainees based on intubation success rates



Final Product Overview

- Final product will consist of:
  - Software
    - Unity simulation with user-friendly interface
      - Multiple difficulty settings
      - User feedback
  - Hardware
    - Dual haptic devices
    - VR headset
    - Access to server
  - Documentation
    - User manual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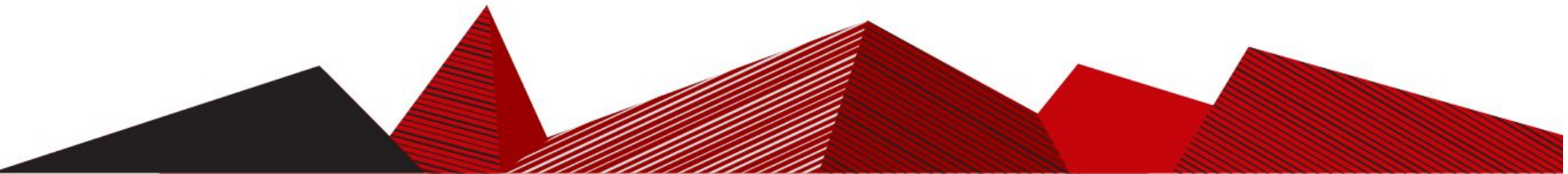
Final Product Overview

- Overall cost estimate:
  - Haptic devices ($2200 each, maybe more): $4,400 - $20,000 [13]
  - Virtual anatomical models: $69 [14]
  - Unity assets: ~$200
  - Oculus Rift: $349 [15]
  - Server access
    - Could build server for: ~$1,200 - $3,000 [16]
    - Rent from IBM: $0.39/hour for 8 cores, 32 GB RAM [17]

Total: $6,000 - $25,000



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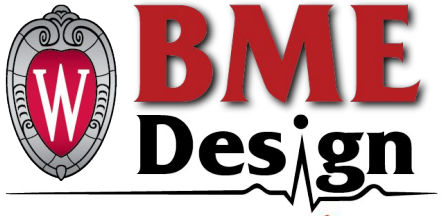

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Questions?