Neonatal Intubation Simulation with Virtual Reality and Haptic Feedback

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BME Design

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Overview

- Neonatal Intubation - Global Need
- Intubation Procedural Background
- Current Training Methods
- PDS Summary
- Development platforms
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  - Blender
  - Unity
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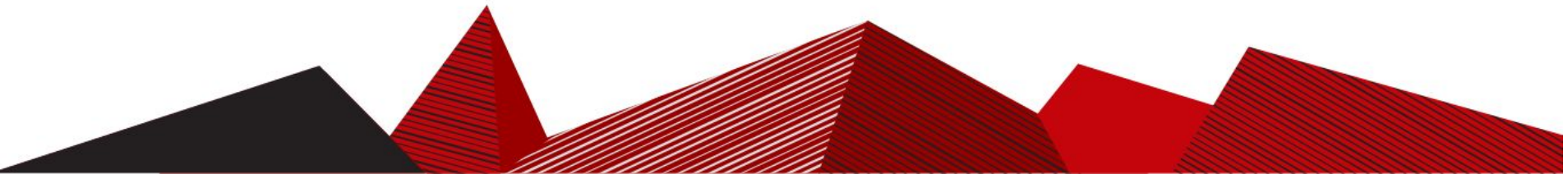
Neonatal Intubation - Global Need

- 7% of term-newborns undergo respiratory distress[1]
  - Increases substantially in premature infants
- In 2005, nearly 10% of births were premature[2]
  - Highest rates in North America and third world countries
  - Estimated that prevalence increased since 2005
- Anywhere from 30-70% of intubation attempts are successful[3-5]

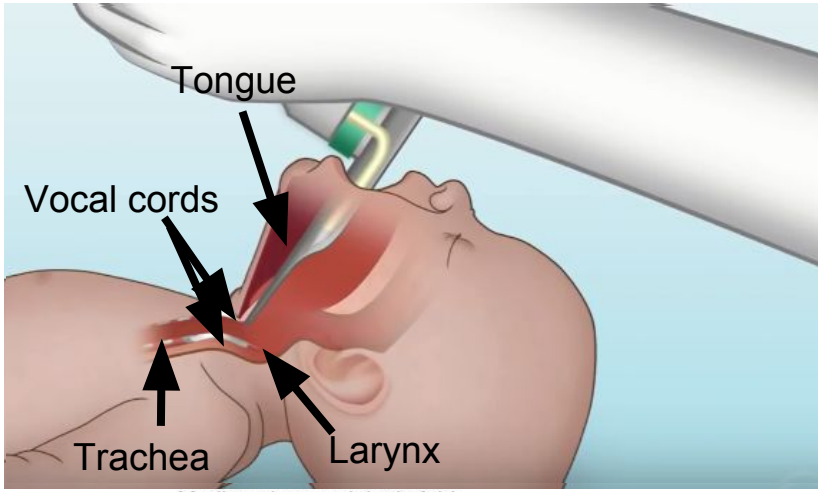


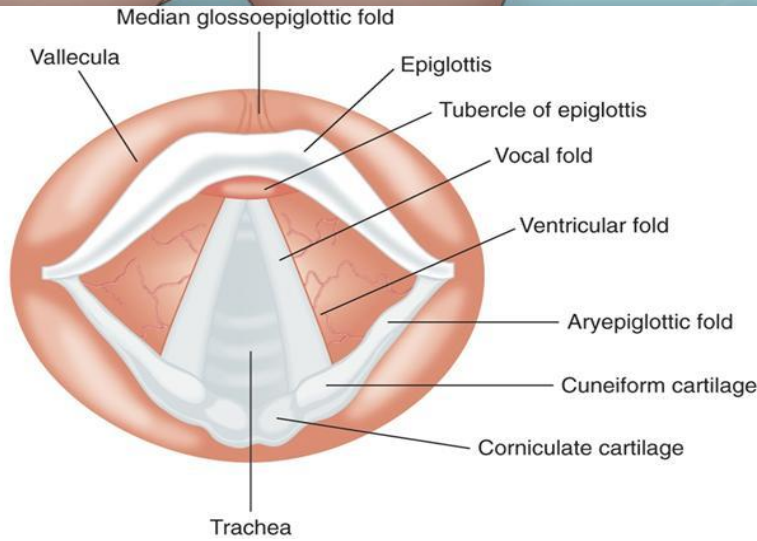
Intubation Procedural Background

- Intubation may be necessary if the neonate is under respiratory distress

- Procedural steps:
  - Insert endotracheal blade
  - Scoop and lift tongue to visualize vocal cords
  - Insert endotracheal tube through vocal cords
  - Once successful, secure tube

- Procedure must be done gently, quickly and precisely[6]





Current Training Methods

- Video instruction:
  - While useful, without practicing an intubation first-hand, one cannot hope to perform the procedure correctly under stress[7]

- Neonatal Mannequins:
  - The primary neonatal intubation training method is via the use of expensive mannequins
  - Mannequins fail to accurately mimic neonate anatomy and other physical properties
    - Unnatural texture and movements
    - Easily identifiable vocal cords[8]

PDS Summary

Function:

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

Performance Requirements:

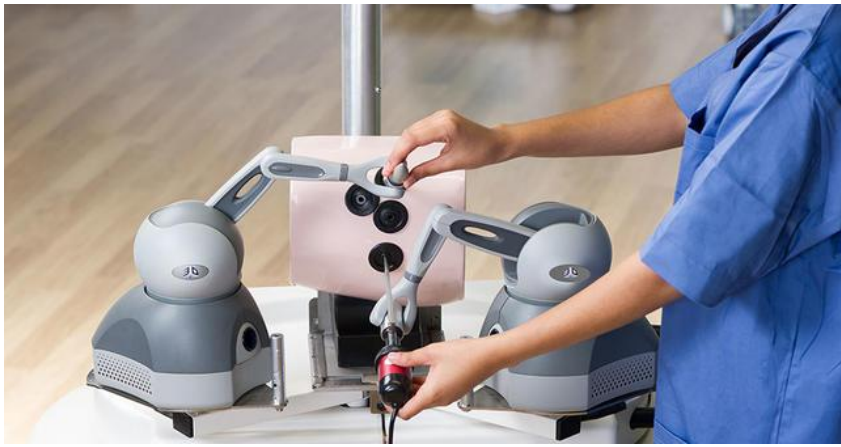
- Must be accurate to 0.02mm to compete with current haptic feedback systems
- Virtual environment must be detailed and load in real time without buffering

Ergonomics:

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

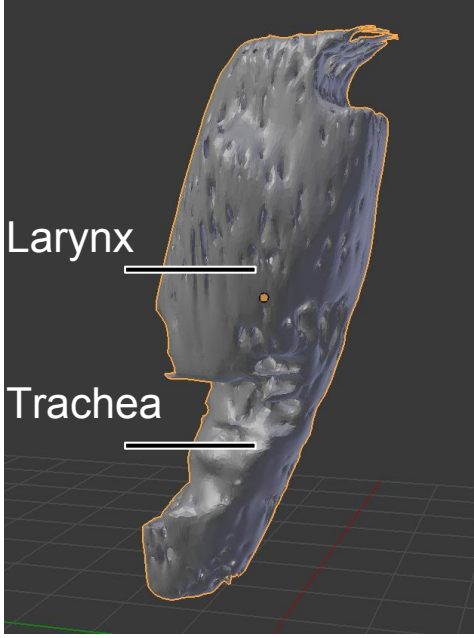
Cost:

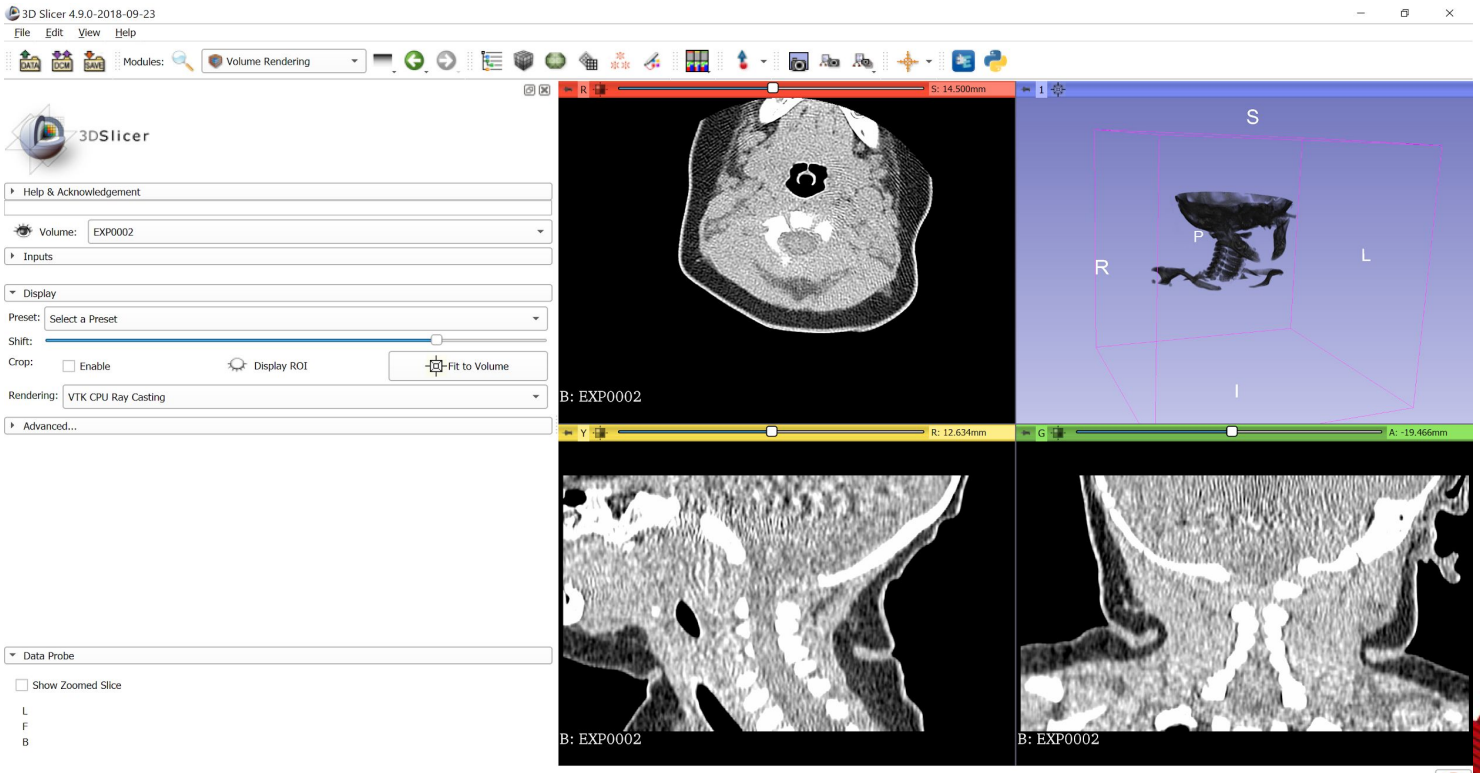
- Should cost under $6000

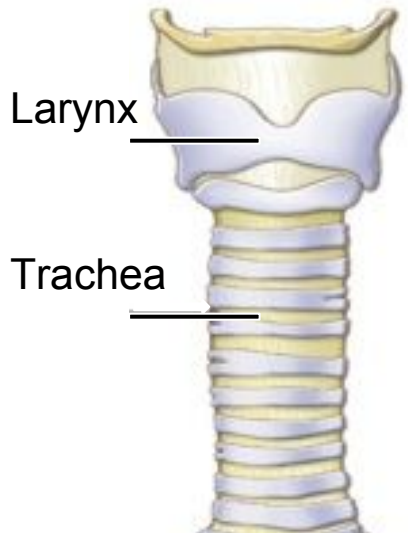


Development Platforms: 3DSlicer

- 3DSlicer is a free, open source image processing and visualization system[9]
- Reconstruct CT scans of a neonate to create an .STL file
- Once in 3DSlicer, segment regions of interest (ROIs)
- Refine ROIs to create more precise model

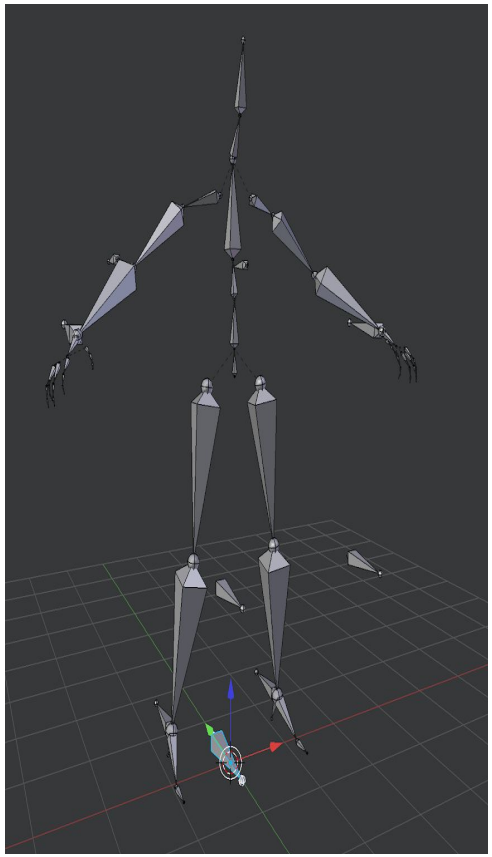


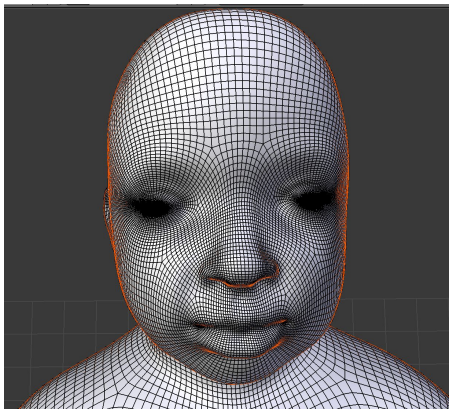




Development Platforms: Blender

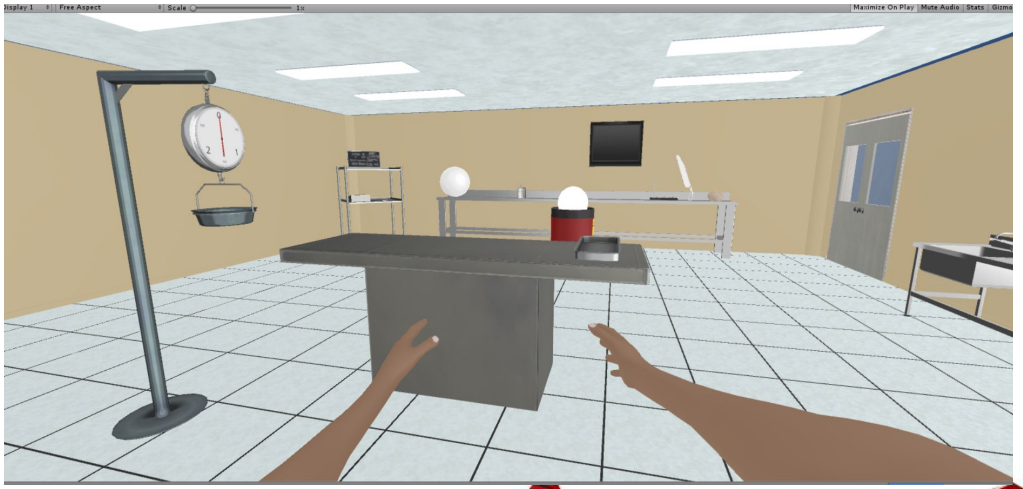
- **Meshing**
  - Turns 3D images into 3D objects
- **Rigging**
  - Create bones/joints for manipulating motion of objects
- **Texturing**
  - Giving the 3D objects realistic appearance

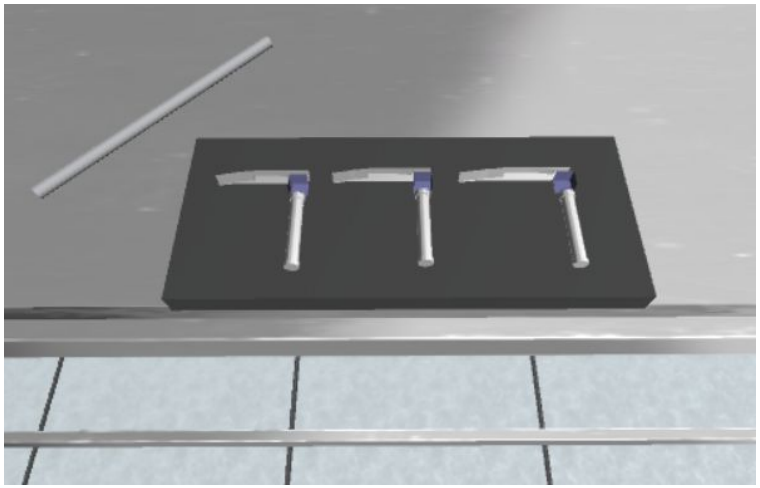




Development Platforms: Unity

- The world's leading real-time gaming/development engine[10]
- Used to create half of the world's games[10]
- We will use it to combine 3D models made in Blender with functionality of haptic devices



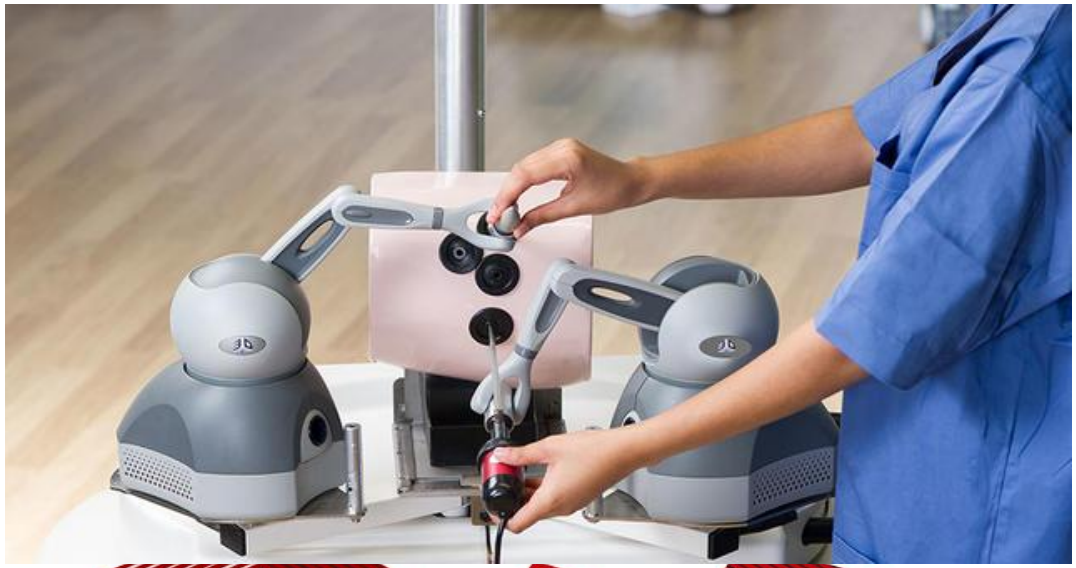


Existing Technology: Haptic Devices

- Produced by 3DSystems, the Phantom Touch provides force-feedback to physically emulate virtual objects[11]

- Used to represent surgical implement position in real time, by tracking translational and rotational movement

- Dual haptic devices used to emulate multiple surgical implements



Potential Problems

- Required processing power limits how detailed the environment can be
- Software/hardware compatibility
- Accurate emulation of tissue-like properties in virtual reality
  - Somatosensory properties
  - Destructive VR
- Unnatural movements of haptic device

Conclusion and Future Work

- Create 3D models for tools used during the procedure
- Improve the VR environment to resemble a neonatal operating room
- Integrate realistic models of newborn mouth and throat into Unity
- Incorporate VR headset into design
- Reach out to existing companies such as Arch Virtual

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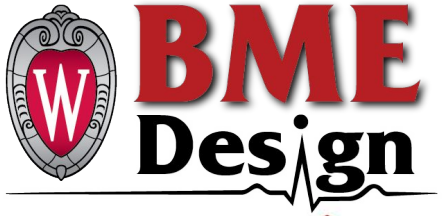

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Questions?