Using Haptics to Simulate Medical Diagnoses

Project Proposal

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Introduction

The market for medical simulators is growing drastically as an increase in technology is allowing these devices to come to life. Creating virtual environments for the medical industry can provide cost-effective training, a realistic surgery setting without live patients, and the ability for students to continually repeat and learn from these simulations.

Functional Description Abstract

Phase 1

Referring to Figure 1 below, the first phase of this project development will rely heavily on creating a virtual environment with C++ programming. A virtual environment shall include rendering the force-feedback on the system so that the user can differentiate between hard and soft surfaces. Phase one will not incorporate a graphics interface; instead the virtual environment will be felt, not seen, by the user.

Phase 2

The second phase will involve attaching graphics and images to the objects created. The software to create these images will be based on open source imaging software called OpenGL. Importing three-dimensional images to the system will also be considered at this stage.

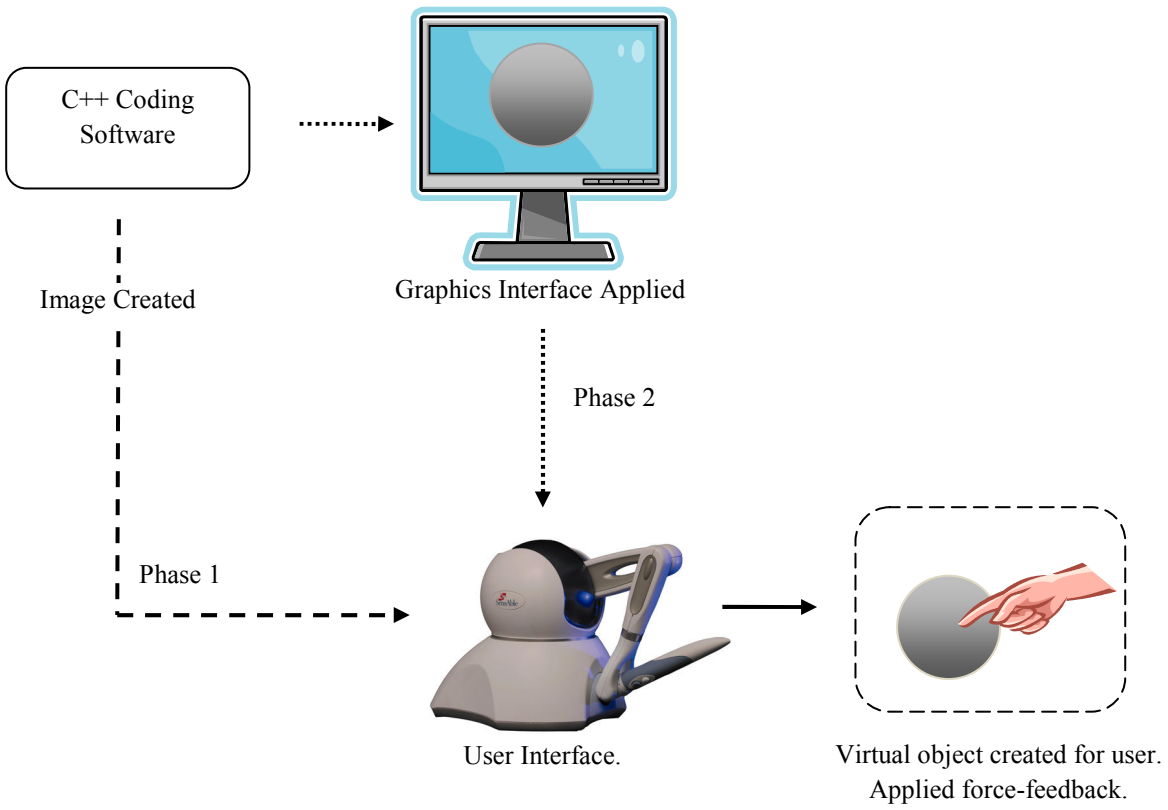


Figure 1: High Level Overall System Block Diagram

Functional Requirements for Each Subsystem

The system referenced in Figure 1 has been broken into each of its subsystems. Table 1 below describes each of the subsystem requirements and performance specifications.

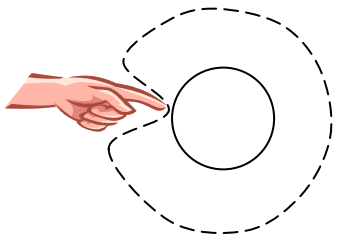
Subsystem	Requirements	Performance Specifications
C++ Programming	Shall define shapes and forces of virtual objects being created.	User shall be able to interact with and understand structure of virtual objects when using the Phantom Omni haptic device.
Graphics Interface	Three dimensional imaging structure applied to shapes created in previous subsystem. OpenGL software shall be utilized.	Graphics will represent visually the anatomical structures portrayed.
User Interface	Operator must hold the arm of the haptic device at all times.	Cannot exceed maximum spatial limits of haptic device.
Virtual Object Created.	Operator must apply slight pressure to the arm to experience any objects created.	Operator shall be able to differentiate between soft and hard surfaces as well as hollow and solid surfaces.

Table 1: Subsystem Requirements

Project Goals

Phase 1: Initial Design Specifications

Emergency doctors are able to diagnose based solely on touch. This phase will begin by modeling that known internal resistance. Two spheres will be used, one as the top outer layer representing the skin. The second sphere will be an inner layer representing the object for which the operator is locating. The malleability of the sphere will be determined by its stiffness programmed. Stiffness controls how hard the layer will appear to the user. Parameters must be chosen between 0 and 1, where 0 represents no surface felt and 1 is the hardest surface the device is capable of providing.

Layer	Matter Consistency	Programming Approach	Visual
Outer Sphere	Soft, expanding.	Sphere Stiffness $\leq 0.15^{*}$	
Inner Sphere	Hard, firm	Sphere Stiffness $\geq 0.25^{*}$	

*Stiffness numbers based on experimental analysis.

Table 2: Initial Design

Project Timeline

Lab Time	Project Goal
January 23 – January 25	Re-establish virtual environment created in December
January 28 – February 8	Complete graphics for sphere layers. (2 weeks)
February 11 – February 22	Program plane layer over multiple surfaces. (2 weeks)
February 25 – March 7	Complete graphics for multiple surfaces system (Part A-2 weeks)
March 10 – March 14	Spring Break
March 17 – March 21	Complete graphics for multiple surfaces system (Part B-1 week)
March 24 – April 11	Integrate material properties into graphics model (3 weeks)
April 14 – April 25	Integrate al three systems. Test haptic realism. (2 weeks)
April 28 – May 2	Preparation for Oral Presentation and Final Project Report

References Consulted

3D Touch SDK OpenHaptics Toolkit: API Reference. SensAble Technologies, 2004.

3D Touch SDK OpenHaptics Toolkit: Programmer's Guide. SensAble Technologies, 2004.

"Articular Cartilage Repair." Orthopedic Specialists. 23 Aug. 2007. Bryn Mawr Cartilage Restoration Center. 30 Oct. 2007 <http://www.orthspec.com/articular_cartilage_repair.htm>.

Chen, E, and B Marcus. "Force Feedback for Surgical Simulation." Proceedings of the IEEE 86 (Mar 1998): 524-530. 30 Oct. 2007 <http://ieeexplore.ieee.org/Xplore/defdeny.jsp?url=/iel3/5/14509/00662877.pdf?tp=&arnumber=662877&isnumber=14509&code=2>.

Equipment List

Haptic Device: PHANTOM® Omni™ Haptic Device

Programming: Microsoft Visual C++