Using Haptics to Simulate Medical Diagnoses

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Introduction

- Growing Industry for Medical Simulations
- WHY?
  - Cost-Effective Training
  - Increasingly Realistic Environments
    - ➢ Graphical Interface/Virtual Reality
    - ➢ Force-Feedback
  - Avoid Use of Limited Resources
  - Repetition

Project Summary

- Model medical applications based on touch.
- Provide proper force-feedback.
- Phantom Omni Haptic Device

Review of Previous Work

Image Generator to Support the Application of a Haptic Device for the Simulation of Arthroscopic Surgery

Renata Zabawa
Advisor: Dr. Stewart

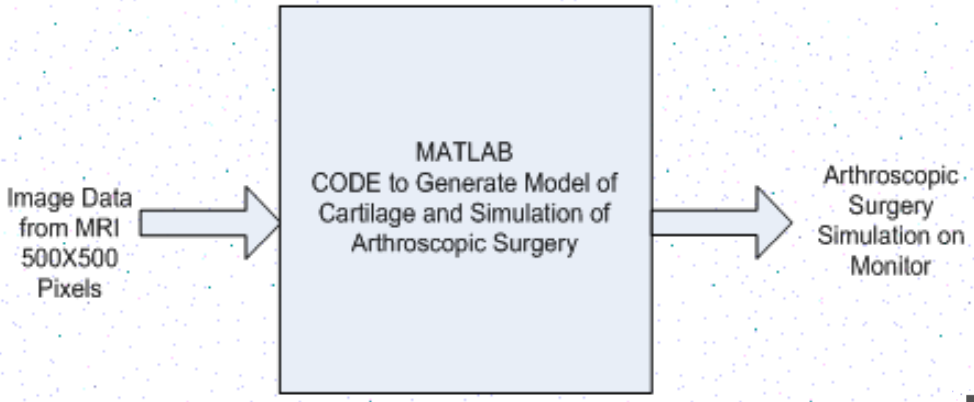
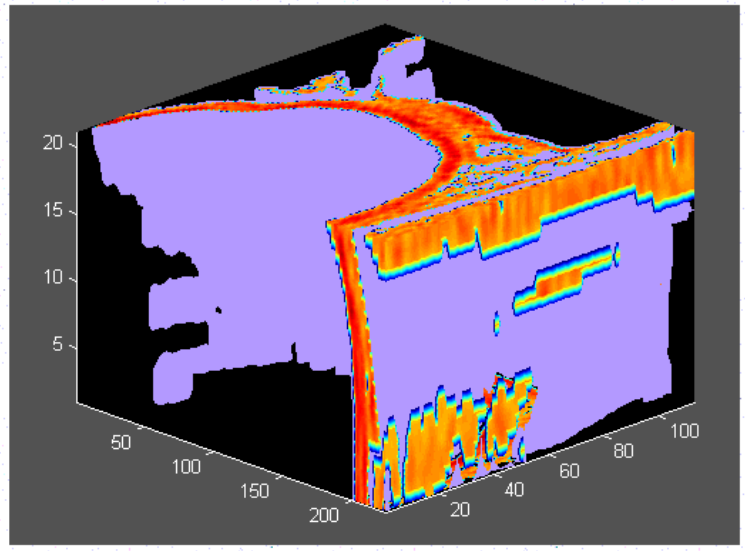


Figure 1: Overall System Block Diagram



Review of Applicable Patents and Standards

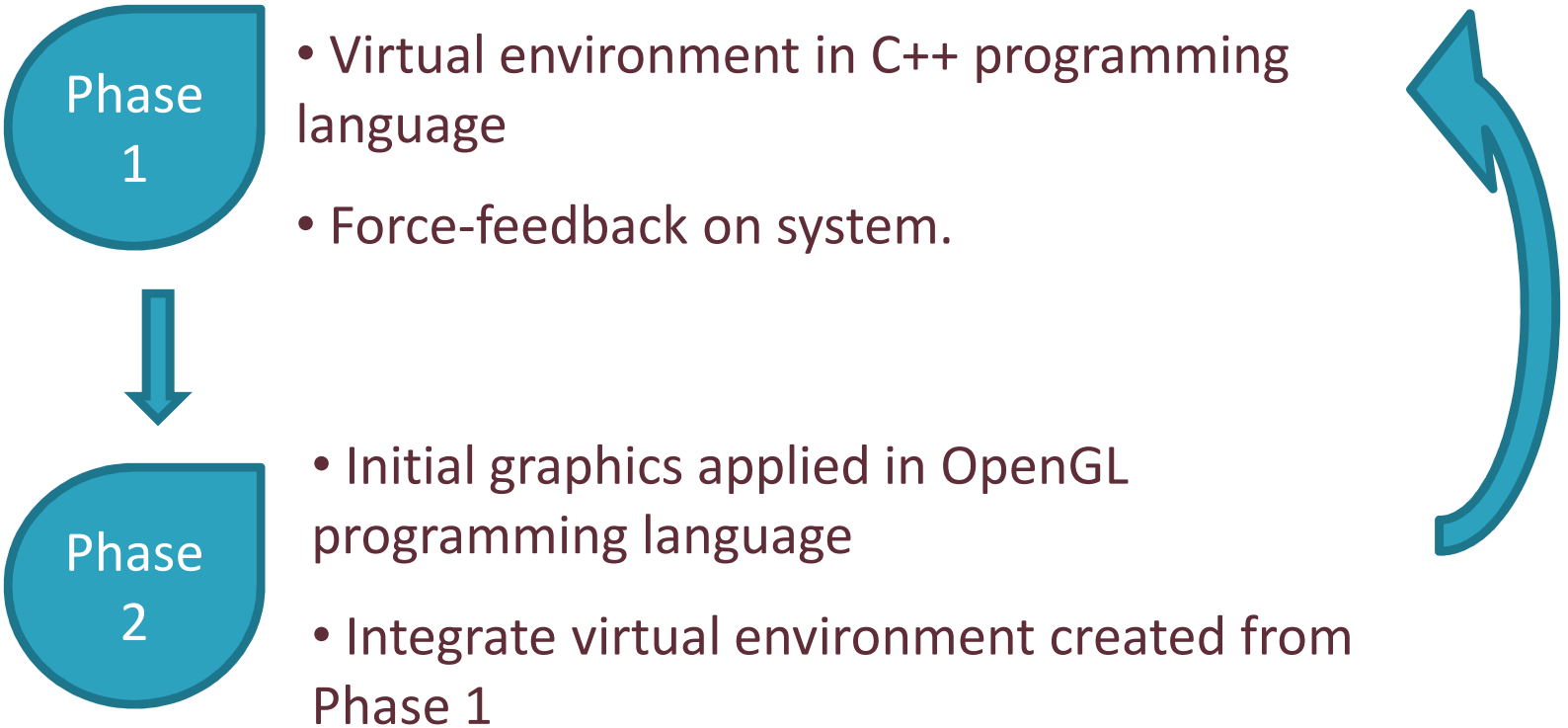
Patents

- 7,206,627: System and method for intra-operative haptic planning of a medical procedure.
- 7,206,627: System and method for haptic sculpting of physical objects.
- 6,113,395: Selectable instruments with homing devices for haptic virtual reality medical simulation.

Standards

- ISO/DIS 9241-920: Ergonomics of human-system interaction – Guidance on tactile and haptic interactions.

Project Description – Functional Description



Project Description – System Block Diagram

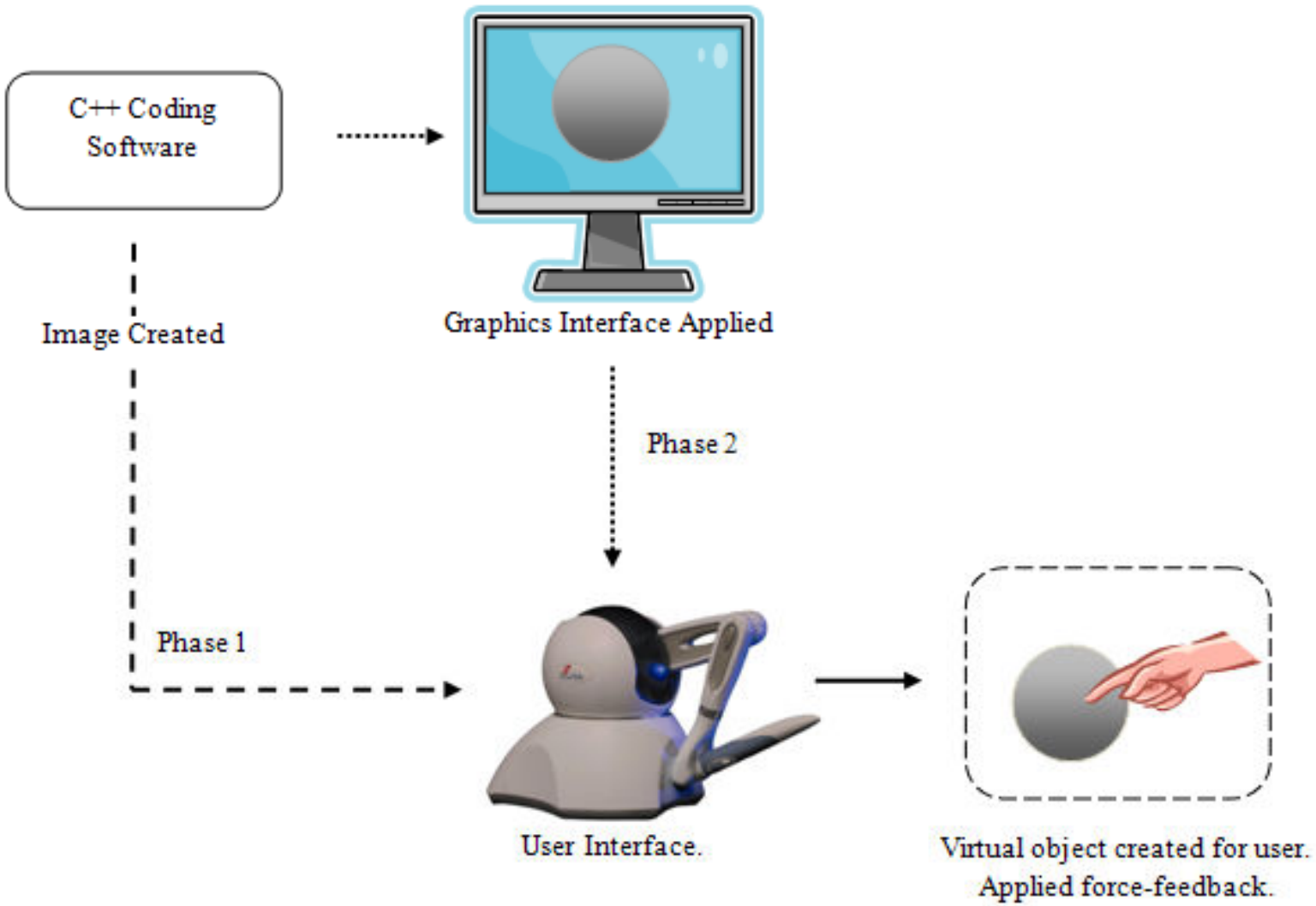


Figure 1: High Level Overall System Block Diagram

Project Description –Requirements and Performance Specifications

Subsystem	Requirements	Performance Specifications
C++ Programming	Shape definition	Successful user interaction.
Graphics Interface	3D imaging structure applied to shapes	Visually recognize graphics.
User Interface	Hand-hold haptic device.	Maximum spatial limits of device.
Virtual Object Created.	User-applied pressure	User differentiates between soft/hard surfaces and hollow/solid surfaces.

Project Description –Datasheet

Model	The PHANTOM Omni Device
Force feedback workspace	~6.4 W x 4.8 H x 2.8 D in > 160 W x 120 H x 70 D mm
Footprint Physical area the base of device occupies on the desk	6 5/8 W x 8 D in ~168 W x 203 D mm
Weight (device only)	3 lb 15 oz
Range of motion	Hand movement pivoting at wrist
Nominal position resolution	> 450 dpi ~ 0.055 mm
Backdrive friction	<1 oz (0.26 N)
Maximum exertable force at nominal (orthogonal arms) position	0.75 lbf. (3.3 N)
Continuous exertable force (24 hrs.)	> 0.2 lbf. (0.88 N)
Stiffness	X axis > 7.3 lb/in (1.26 N/mm) Y axis > 13.4 lb/in (2.31 N/mm) Z axis > 5.9 lb/in (1.02 N/mm)
Inertia (apparent mass at tip)	~0.101 lbm. (45 g)
Force feedback	x, y, z
Position sensing [Stylus gimbal]	x, y, z (digital encoders) [Pitch, roll, yaw (± 5% linearity potentiometers)]
Interface	IEEE-1394 FireWire® port
Supported platforms	Intel-based PCs
GHOST® SDK compatibility	No
3D Touch™ SDK compatibility	Yes
Applications	Selected Types of Haptic Research and The FreeForm® Concept™ system

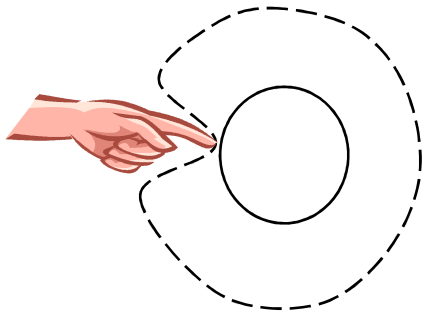
Preliminary Lab Work

Research:

- Specific device programming commands.
- Sample programs provided with device, understanding user interaction and device responses.

Initial Design Specifications:

- Medical Application – Two Layers

Layer	Matter Consistency	Programming Approach	Visual
Outer Sphere	Soft, expanding.	Sphere Stiffness ≤ 0.15	
Inner Sphere	Hard, firm	Sphere Stiffness ≥ 0.25	

Preliminary Lab Work

Completed:

- ✓ Programming of plane orientation.
- ✓ Programming of two physically distinguishable layers.

In Process:

- ○ Break down graphics programming.
- ○ Apply plane layers to virtual spheres.

Next Steps:

- ❑ Create multiple surfaced objects underneath even plane

Equipment Parts List

Haptic Device:

PHANTOM® Omni™

Software:

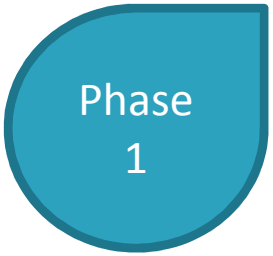
Microsoft Visual C++ Language

Schedule of Tasks

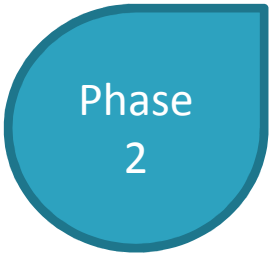
Lab Time	Project Goals
January 23 – January 25	Re-establish virtual environment created in December.
January 28 – February 8	Complete graphics for sphere layers. (2 weeks)
February 11 – February 22	Program plane layer over multiple surfaces. (2 weeks)
February 25 – March 7	Complete graphics for multiple 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 weeks)
March 24 – April 11	Integrate material properties into graphics model. (3 weeks)
April 14 – April 25	Integrate all three systems. Test haptic realism. (2 weeks)
April 28 – May 2	Preparation for Oral Presentation and Final Project Report
May 5 – May 9	Final Project Report

Questions?

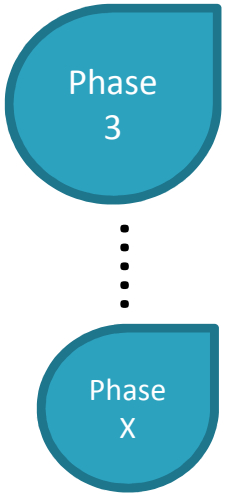
Project Description – Functional Description



- Virtual environment in C++ programming language
- Force-feedback on system.



- Initial graphics applied in OpenGL programming language
- Integrate virtual environment created from Phase 1



Phases added as each new milestone is met.