3D Scanning Application for Cranioplasty Procedure

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Topics

- Developing 3D Scanning methods and applications for Cranioplasty Procedures
- Segmentation of a 3D image
Team Members

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Mentors

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Cranioplasty Procedures

Pre-operative Condition:

- Bifrontal cranial defect from previous craniectomy

Cranioplasty

A. The previous bicoronal incision is reopened.

- Scout Film

B. The patient’s own bone is fitted on to his head and fixed using titanium plates and screws.

- Titanium plates
- Screwdriver
- Bone flap

C. Two 1/8” Hemovac drains are placed beneath the scalp and the skin closed.
Cranioplasty Procedures
Polaris System
Polaris System

- complicated
- requires large fiducial
- constant attention from surgical technician
- very expensive
CIS II Project

- Develop an inexpensive system to replace Polaris
  - 3D depth-sensing and imaging “Structure Sensor”
Goals

● Reduce the costs and complexity of cranioplasty implant creation
● Attempt to use 3D scanning solutions to replace use of the Polaris system for defect identification
Relevance

- Surgical time is very expensive
- Polaris system
  - complicated
  - requires large fiducial
  - constant attention from surgical technician
  - very expensive
- 3D scanning has recently become more popular due to the dropping costs of 3D Printing
Structure Sensor

- $350 iPad accessory
- USB interface
- Open Source code
- Comes with SDK
- Supported by Occipital
Structure Sensor Accuracy

**Structure Sensor Depth Precision**

Precision [mm] vs. Observed Depth [mm]

- 0.12%
- 0.3%
- 0.6%
- 1%
- 1.1%
Segmentation Approach

- **Color**
  - General location of the defect
  - Relies on high contrast between ink and skull

- **Depth**
  - Used to obtain an accurate 3D point cloud
  - Will be sensitive to large changes in surface angle
Development: Planar Surface

- Start with a flat panel that has a surface defect
- Simple, made of white plastic
- Defect should have depth similar to skull thickness
Development: Phantom Skull

- Attempt defect identification with model skull
- Use realistic ink and surface colors with lower contrast
Development: Mock OR

- Test in actual scenario
- Compare with current Polaris system
## Deliverables

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Expected</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>Paper regarding color and depth based segmentation for defect detection</td>
<td>Integration into the cranioplasty surgical procedure</td>
<td>Tablet application with integrated 3D scanning</td>
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<td>Analysis would use processed.stl file renders from sensor programs</td>
<td>Ability to use the scanner in an uplink mode</td>
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Dependencies

- **Structure Sensor**
  - purchased by Dr. Armand
- **Mock Operations**
  - once a month with Dr. Gordon
- **Test Objects**
  - printed at the DMC or Walter Reed
Timeline

CIS II Project

- RGBD Segmentation (11 weeks)
- Algorithm Development (7 weeks)
- Procedure Integration (2 weeks)
- Application Development (2+ weeks)

Minimum Deliverable
- 3D Segmentation Algorithm Paper

Expected Deliverable
- Surgical Integration

Maximum Deliverable
- Independent Mobile Application
Management Plan

Josh - Scanner integration, application development

Alex - Segmentation algorithm