Tool Tracking for Periacetabular Osteotomy using CamC

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Mentors
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Clinical Collaborator
Prof. John Tis
Background

- Periacetabular Osteotomy (PAO) is for patients suffering from developmental dysplasia of the hip (DDH)
- Caused by reduced coverage of the femoral head
- PAO surgery improves poor femoral coverage by reorienting the acetabulum and stabilizing the hip joint

PAO Movement

(video taken from https://www.youtube.com/watch?v=aWofkU-td08)
Previous works

- 3D/2D registration algorithm of CT to intra-op. [1]
- An intra-operative mixed reality visualisation of 3D medical data and a marker-less tracking algorithm to track surgical tool. [2]
- Pose-aware C-arm for automatic re-initialization of interventional 2D/3D image registration. [3]


Objectives

- Track the osteotom tool with respect to the pelvis in PAO using RGBD and X-ray images
- Update the preplanned osteotomy fracture lines via 3D tracking of the osteotom within the pelvis
Technical approach

What we need to find out!

What if pelvis moves?
(Fiducials...)

\[ V_T^O = X_T^V \cdot RGBD_T^X \cdot RGBD_T^O \]
Workflow

- Transformation Chain
  - Visualize point cloud of osteotom in real time
  - Background subtraction
  - Improved segmentation

- Segmentation

- Pose Estimation
  - ICP
  - Globally Optimized ICP

- Achieving Plan Approach

- Collect & Lable Data

If time permits

Using our prototype for future use
Deliverables

Documentations:
- C++ source code
- Code documentation
- Report describing the methods and achievements

Minimum deliverables:
Working segmentation (e.g. background subtraction), pose estimation (ICP) and visualization

Expected deliverables:
Improved segmentation (graph cut/ML/etc.), better pose estimation (globally optimal ICP), visualize the cut plane

Maximum deliverables:
Start collect data base upon the prototype; start investigating the planning approach
## Dependencies

<table>
<thead>
<tr>
<th>Dependencies</th>
<th>Solution</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Access to previous code (2D/3D registration, etc.)</td>
<td>Email Dr. Unberath</td>
<td>Feb 23</td>
</tr>
<tr>
<td>Access to Intel RealSense SDK</td>
<td>Download it from website</td>
<td>Feb 20</td>
</tr>
<tr>
<td>Access to PCL (Point Cloud Library)</td>
<td>Download it from website</td>
<td>Feb 20</td>
</tr>
<tr>
<td>Access to the C-arm x-ray</td>
<td>Complete radiology certification</td>
<td>Mar 16</td>
</tr>
<tr>
<td>Access to RGBD camera, scanner</td>
<td>Email Javad</td>
<td>Feb 23</td>
</tr>
<tr>
<td>Access to the CAD model and the True model (Double confirm whether we can get that)</td>
<td>Email Dr. Armand.</td>
<td>Feb 23</td>
</tr>
<tr>
<td>Task</td>
<td>Feb 19</td>
<td>Feb 26</td>
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<tr>
<td>----------------------------------------------------------------------</td>
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<td>--------</td>
</tr>
<tr>
<td>Familiarize ourselves with existing works</td>
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<tr>
<td>Visualize point cloud in real time</td>
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<tr>
<td>Finish the background subtraction and basic pose estimation</td>
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<tr>
<td>Explore and implement better segmentation methods</td>
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<tr>
<td>Explore and implement better pose estimation methods</td>
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<tr>
<td>Visualize the cutting plane</td>
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<tr>
<td>Collect and label data base upon the prototype</td>
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<tr>
<td>Investigating plan approach</td>
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Include time for testing and documentation
Key dates and milestones

- Become familiar with preexisting works on the topic: **February 26th**
- Complete Minimum deliverable/ start expected/deliverables: **March 11th**
- Expand upon our previous segmentation and pose estimation methods: **April 2nd - April 16th**
- Complete expected deliverables/start maximum deliverables: **April 16th**

Be more concrete
When to settle down the documentations, design, procedure plans of the program so that it’s easier when implementing the code.
## Responsibility

Each member will contribute to each part

<table>
<thead>
<tr>
<th></th>
<th>Background subtraction</th>
<th>Pose estimation</th>
<th>Visualization</th>
<th>Collect data</th>
<th>Investigate plan approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum</strong></td>
<td>Nianhang</td>
<td>Wenhao</td>
<td>Billy</td>
<td>X</td>
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<tr>
<td><strong>Expected</strong></td>
<td>Nianhang</td>
<td>Wenhao</td>
<td>Billy</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>Nianhang</td>
<td>Wenhao</td>
<td>Billy</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
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Management Plan

- Code stored in a private git repository on BitBucket
- Weekly Meetings with Dr. Unberath and Javad to discuss the project
- Additional weekly meetings between the three of us to get together and work on the project (*settle that down*)
Reading list


