Plan in 2-D, execute in 3-D: an augmented reality solution for cup placement in total hip arthroplasty

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Review of Project

Objective:
Track the osteotom tool with respect to the pelvis in PAO using RGBD and X-ray images
Paper selection


Reasons:
- Shows the overall picture of how the camera-augmented C-Arm (CAMC) system works
- Similar to our project (RGBD and X-ray data is also used)
Background

Total hip arthroplasty (THA)

• Replace the damaged bone with prosthetic component.
• Proper implant placement is critical but challenging
• Use intraoperative fluoroscopy to guide the surgeon
Method

- Dislocation of the femoral head
- Reaming the acetabulum and removing the articular cartilage
- Identifying the size of the acetabular cup

**Image acquisition**
Acquiring two X-ray images from different perspectives (e.g. anterior-posterior and 15° oblique)

**Intra-operative planning**
Placing the acetabular cup simultaneously on two stereo X-ray images

**AR visualization**
Overlay of the planned cup and impactor and real-time cloud of points observed by the camera

**Impactor alignment**
Aligning the cloud of points from the impactor with the planned 3D impactor

**Placing the acetabular component**
Method

\[ X' T_X = \text{RGBD'} T_{X'}^{-1} M^{-1} T_{\text{RGBD'}}^M T_{\text{RGBD}} \text{RGBD'} T_X \]
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Method
Results

• 10 different poses and 4 virtual perspectives of the surgical site for each pose
  o Translational error: 1.98 mm
  o Orientation error: 1.22 deg

→ Smaller than the navigation-based system (by Sato et al.)
  o Translational error: 2.98 mm
  o Orientation error: 4.25 deg
Assessment

• Pros:
  o Shows how the camera-augmented C-arm (CAMC) is used in a procedure
  o Reduced error compared with previous works

• Cons:
  o A visual marker needs be placed on the surgical site
  o Patient assumed to be static
  o Do not involve tracking of the cup