

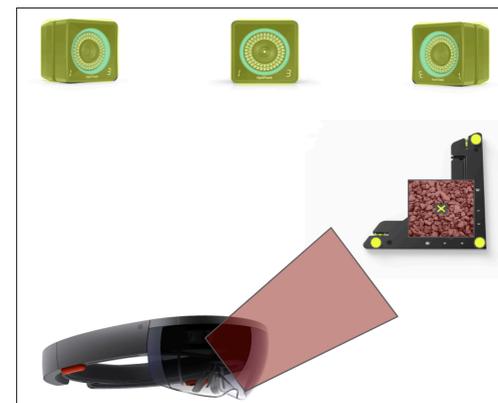
## INTRODUCTION

- Precision surgery demands precision tools and imaging.
- Current tracking capabilities of Microsoft HoloLens and Vuforia Image Targets have too much drift and latency to be used in a surgical setting.
- Many procedures require surgeons to view an external screen for camera views and tool positions, which requires surgeons to mentally map 2D screen positions to 3D locations in the patient's body.
- **GOAL: Create a precision holographic aid for surgeons. Optically track tools to allow for in-place image rendering and visualization of surgery progress via an updated 3D model.**

## METHODS

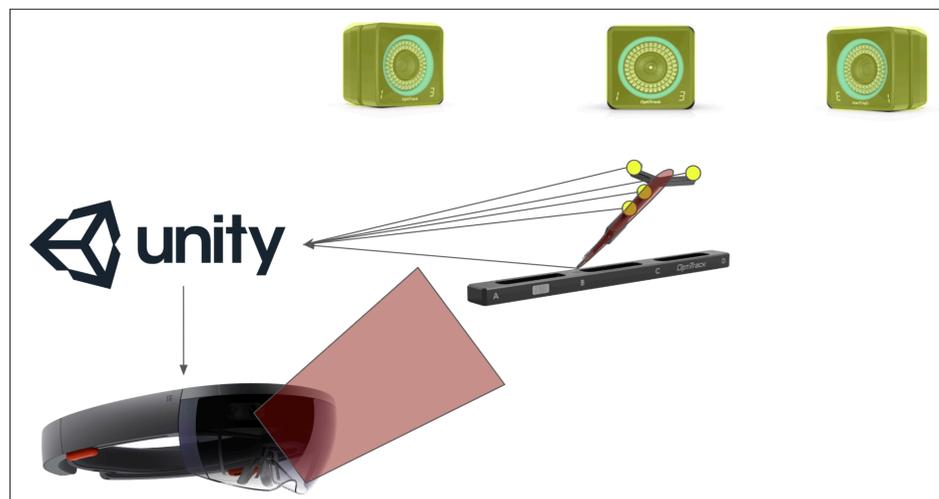
### CALIBRATION PROCESS

- The coordinate space of the optical cameras is different from that of the HoloLens.
- **GOAL: Relate the coordinates so that tracked tools can be viewed in HoloLens at the correct location.**



- 1) Optical cameras track the center of a calibration square (yellow) while the HoloLens tracks the center of the Vuforia Image Target on the square (red).
- 2) The different coordinates, which represent the same location, are used to calculate an OptiTrack-to-HoloLens transformation matrix  $O^{TH}$ .

### TRANSFORMATION PIPELINE



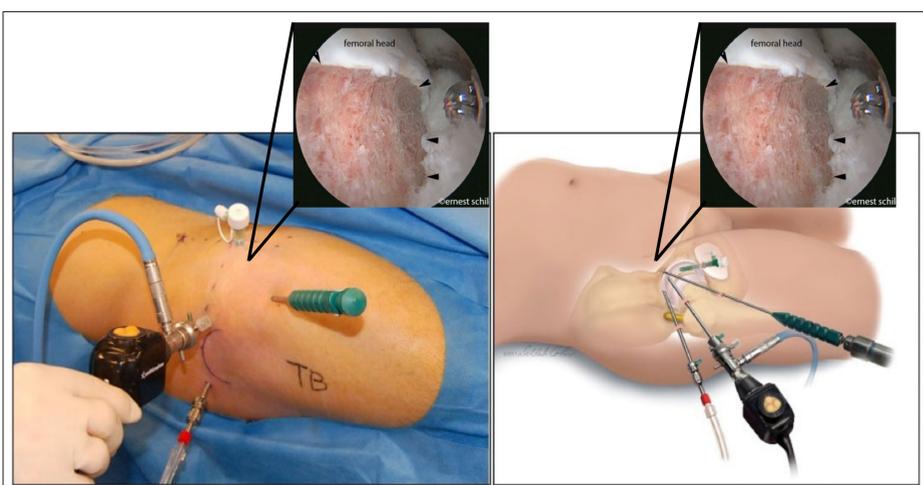
- 1) Optical cameras track the location of a tool and send the coordinates to the game engine Unity.
- 2) Unity applies the calculated transformation matrix  $O^{TH}$  to the streamed data and sends it to the HoloLens.
- 3) HoloLens renders the digital tool on the physical one.

## DISCUSSION

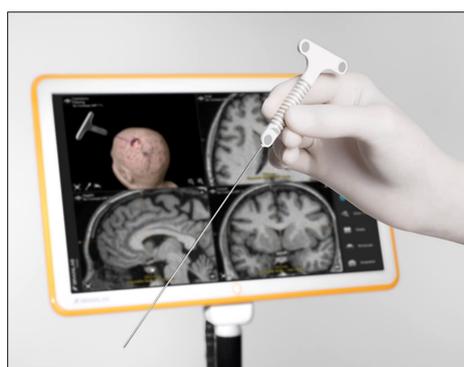
- Limitations:
  - 1) Need updated calibration whenever cameras move.
  - 2) Headset/hologram may obstruct surgeons view.
  - 3) Update rate of HoloLens potentially still too low.
- Next Steps:
  - 1) Finish rendering process to visualize tracked tool.
  - 2) Measure accuracy and latency; add bone model.
- Thank you to Marianne Black & Christoph Leuze.

## MOTIVATING APPLICATION

- Femoroacetabular Impingement (FAI) is a condition in which extra bone grows along one or both of the bones that form the hip joint. Surgery involves arthroscopic resection of the extra bone to restore joint mobility.
- The surgeon's limited field of view makes FAI surgery particularly challenging, and the leading cause of failure is in surgeon's control: **adequate resection.**
- **GOAL: Render 3D model of patient's anatomy in-place and update it as surgery progresses.**



**Image 1:** Left: Surgeon's current view. Right: Mock-up of view with the holographic aid and tracked tools. Source: Nashville Hip Institute



**Image 2:** Optically tracked tool from BrainLab that aids with cranial navigation surgeries. The same cameras used to track tools like this one in operating rooms can be leveraged to render them precisely in mixed reality.

Source: BrainLab