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Visual Feedback for Skill Acquisition in Cataract Surgery

Advanced Computer Integrated Surgery

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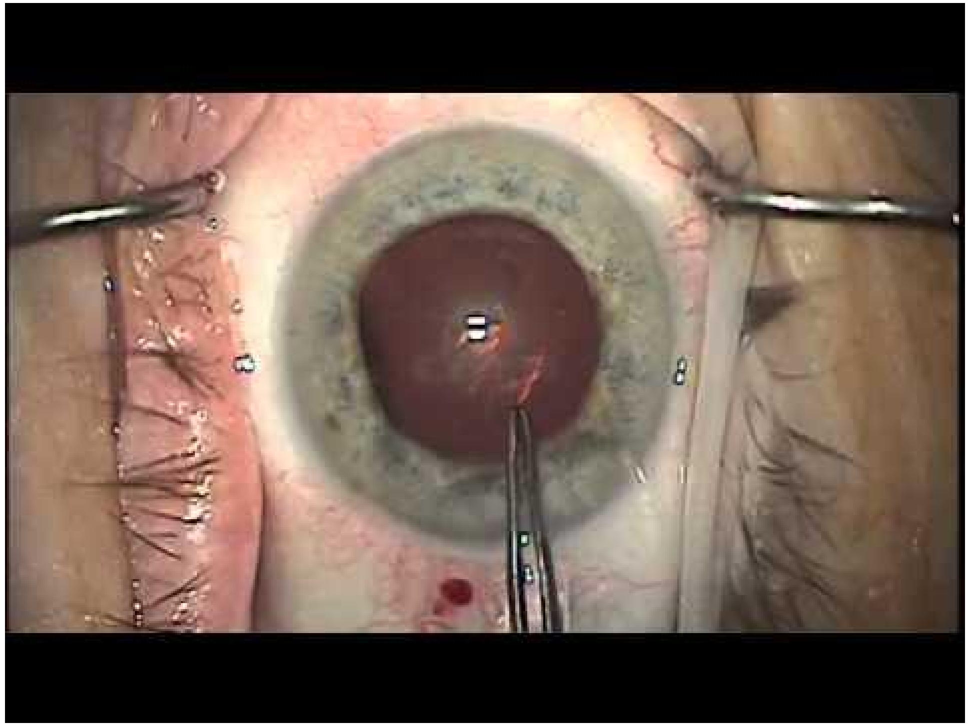
Project Summary

- Cataract Surgery Procedure
- Current feedback procedures
- Use visual overlays to aid skill learning



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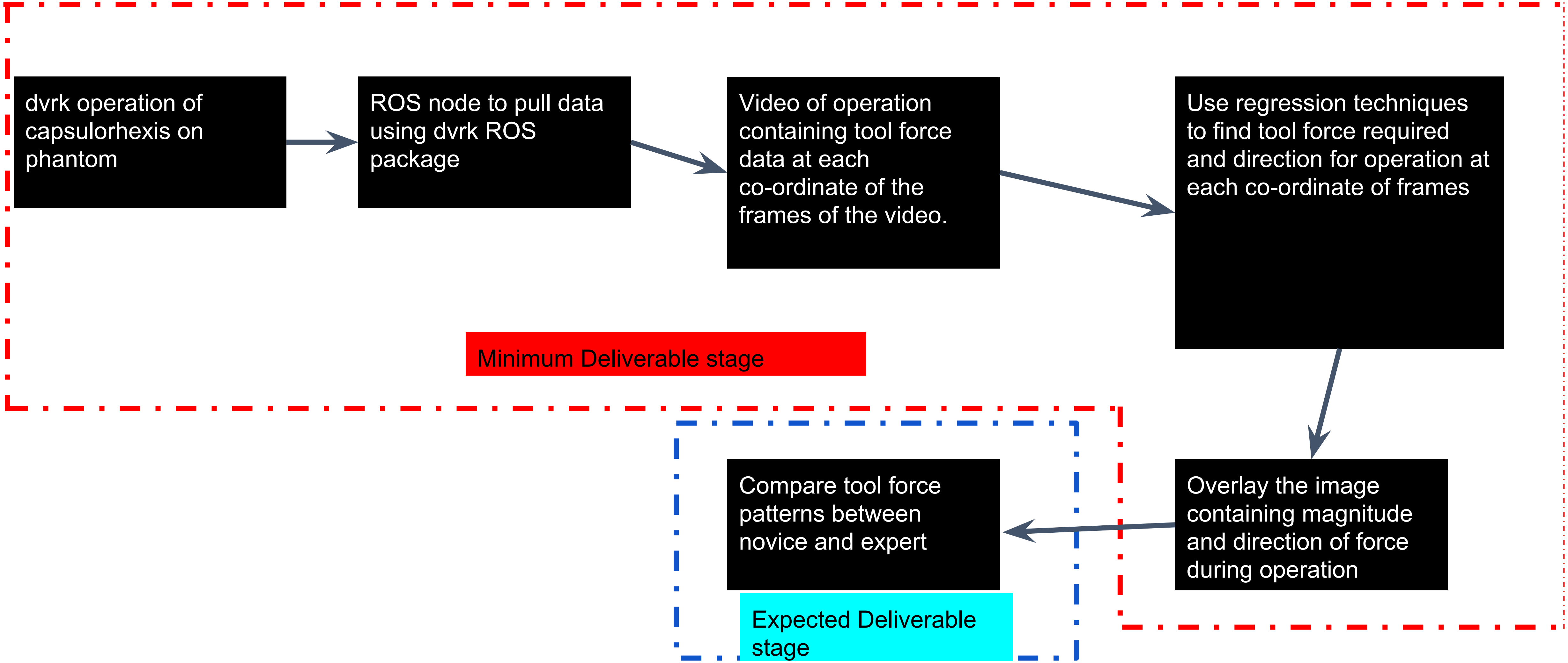
Overflow



Deliverables

Minimum:
- Simple phantom to simulate the task
- Video of tool motion with da vinci research kit
- Visual overlay of tool forces

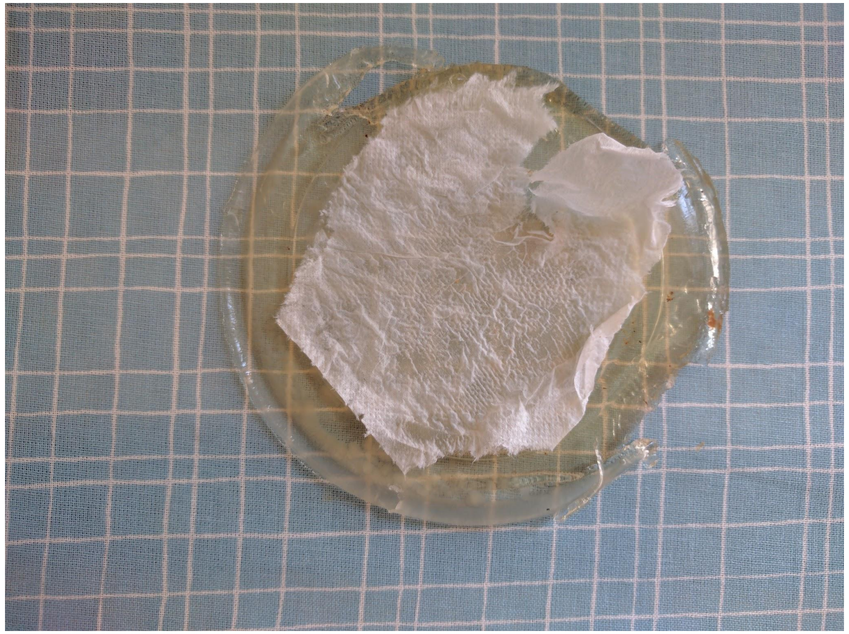
Expected:
- Compare tool force pattern between experts and novices

Maximum:
- Data of errors in this estimation

Deciding Phantom

Phantom for task simulation:

Need to scale the task equivalently. Should simulate the feel of peeling.



Deciding Phantom

Phantom for task simulation:

Need to scale the task equivalently. Should simulate the feel of peeling.

Deciding Phantom

Phantom for task simulation:

Need to scale the task equivalently. Should simulate the feel of peeling.

Choosing Phantom

Trade-off:

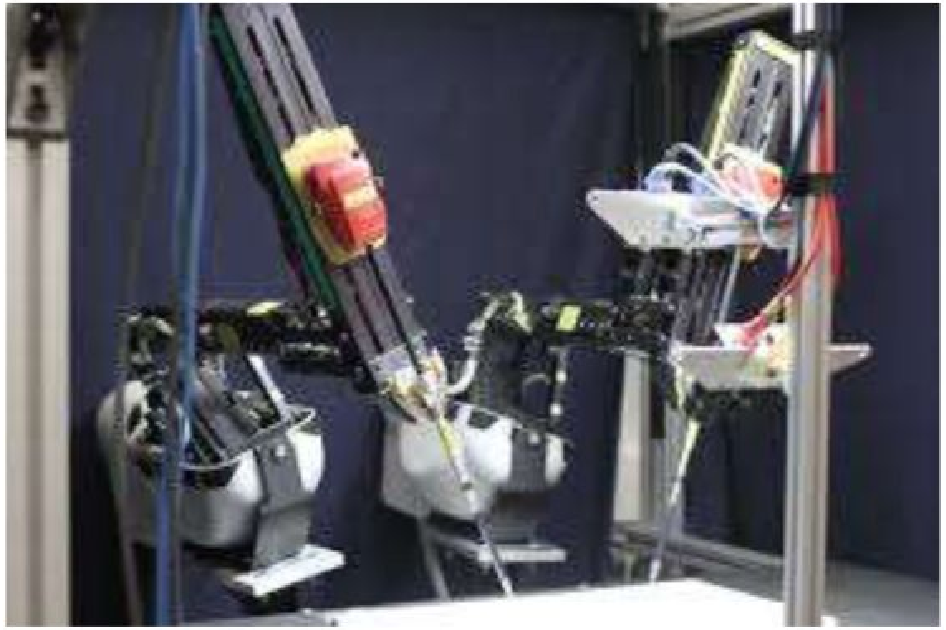
- Feel of the actual procedure
- Strong enough forces
- Ease of reproducability

Have to simulate the task and determine.

DVRK

DVRK = Da Vinci Research Kit

The robot (data source):
***da Vinci* Research Kit**



http://cal-mr.berkeley.edu/images/media/DVRK-2-high-res.jpg

Finding tool tip position

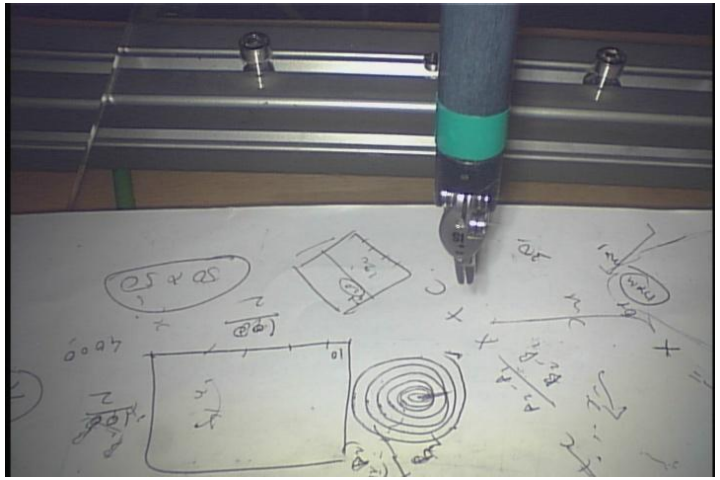
1. Use forward kinematics to compute the tool-tip position in the robot’s base frame. Find tool tip position in camera’s frame.

2. Use markers near tooltip.

3. Use mouse clicks from images.

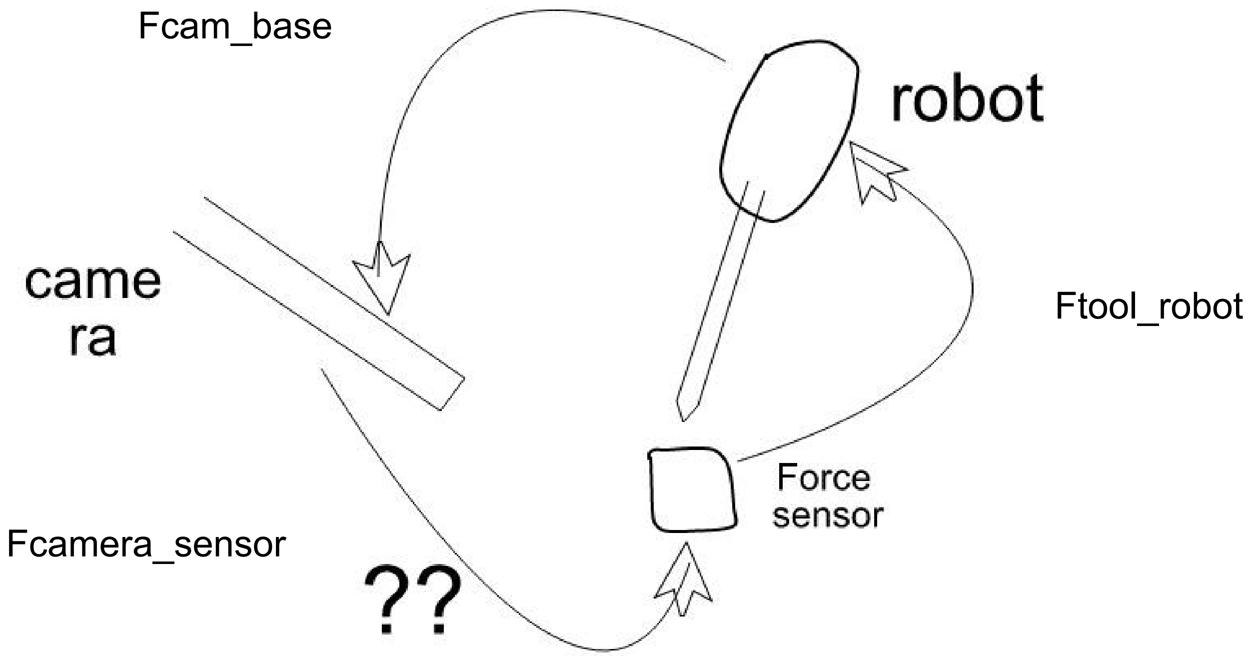
Finding tool tip position

1. Use markers/ known feature for estimating tool tip.



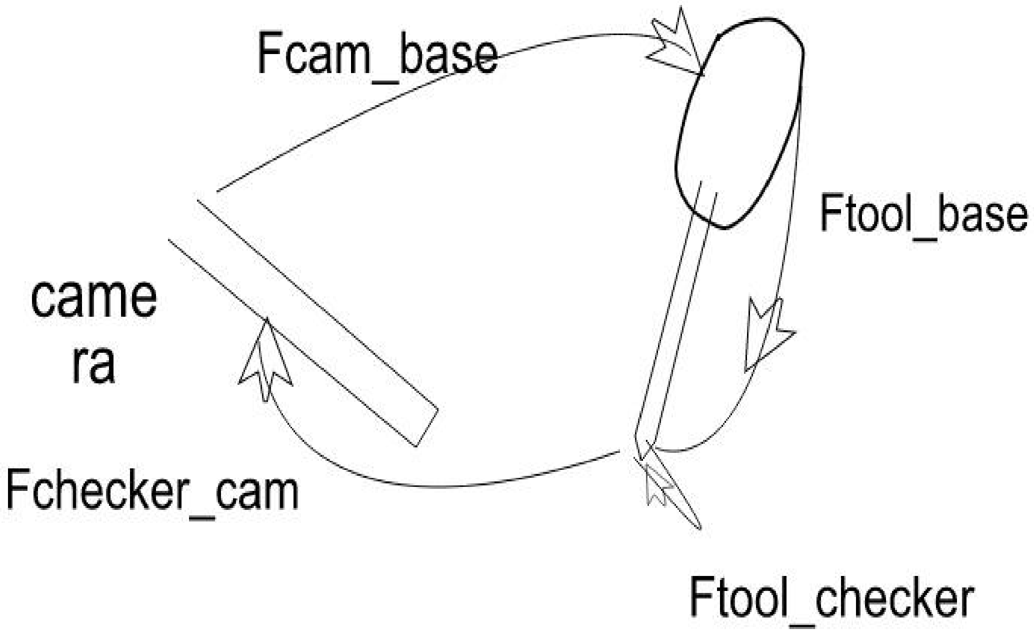
Wrench measurement in camera’s frame

Estimate the transformation between the Force-sensor’s frame and camera’s frame



Calibration

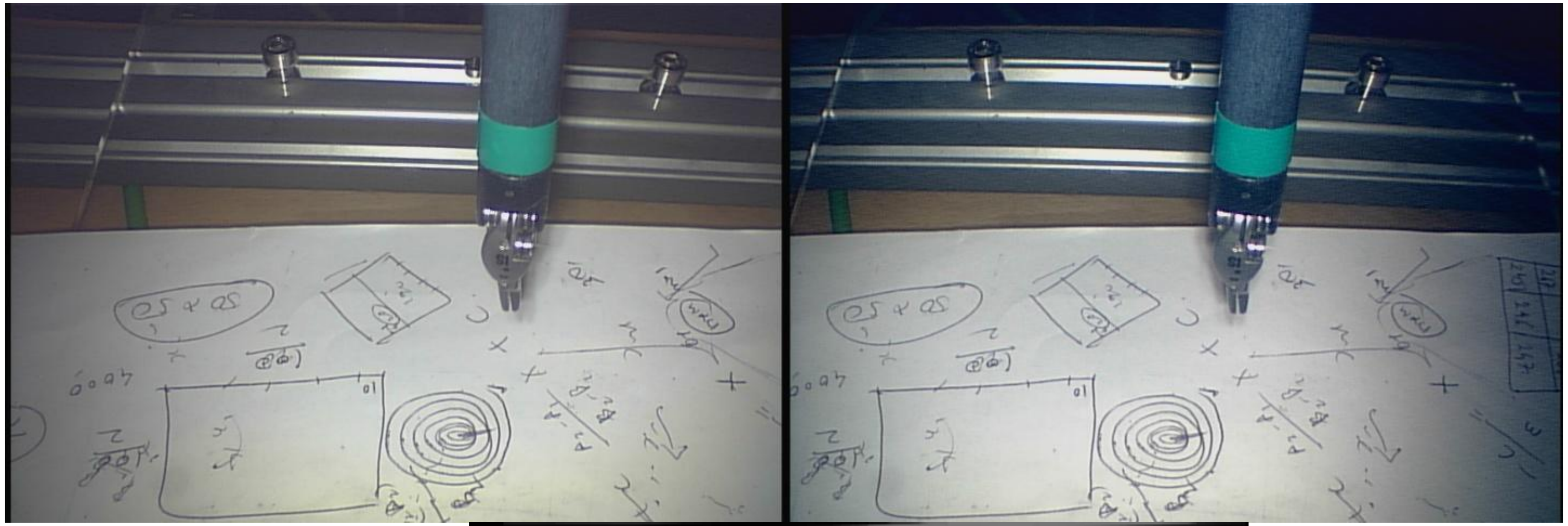
Estimate Fcam_base:



Fcam_base * Ftool_base* Ftool_checker *Fchecker_cam = I

Fcam_base found by AX=XB Calibration

Finding Depth



D = B*f/Disparity

Disparity map

Challenges for Visual Overlay

- Synchronising data from force sensor and video frames
- Estimating tool tip position
- Give perception of depth on the marked force/torque
- Estimating window size, max disparity for estimating depth (currently trial and error). Probably use a noise filter
- The force sensor values are very noisy, not very sensitive

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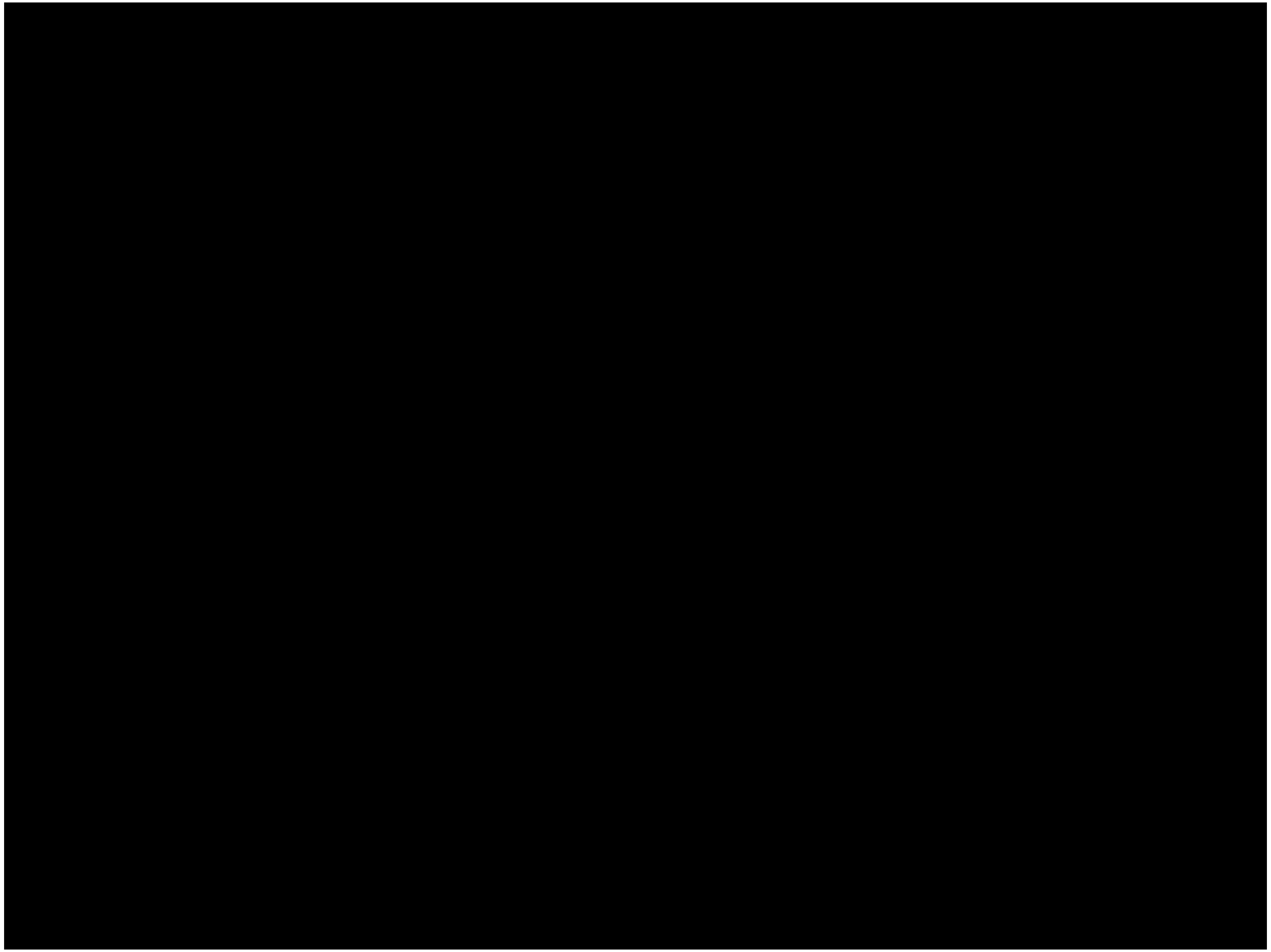
Visual overlay of measured forces



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Dependencies

Dependencies	**State (resolved/pending/in progress)**
Phantom for simulation of the task	In progress (have to make a choice)
Setup of Da Vinci research Kit ROS package	Resolved
Force sensor	Resolved
Experts for operation	Pending (have a few)
Regression Technique	Yet to be decided
IRB	Resolved (submitted)
Tool position detection algorithm	Yet to be resolved

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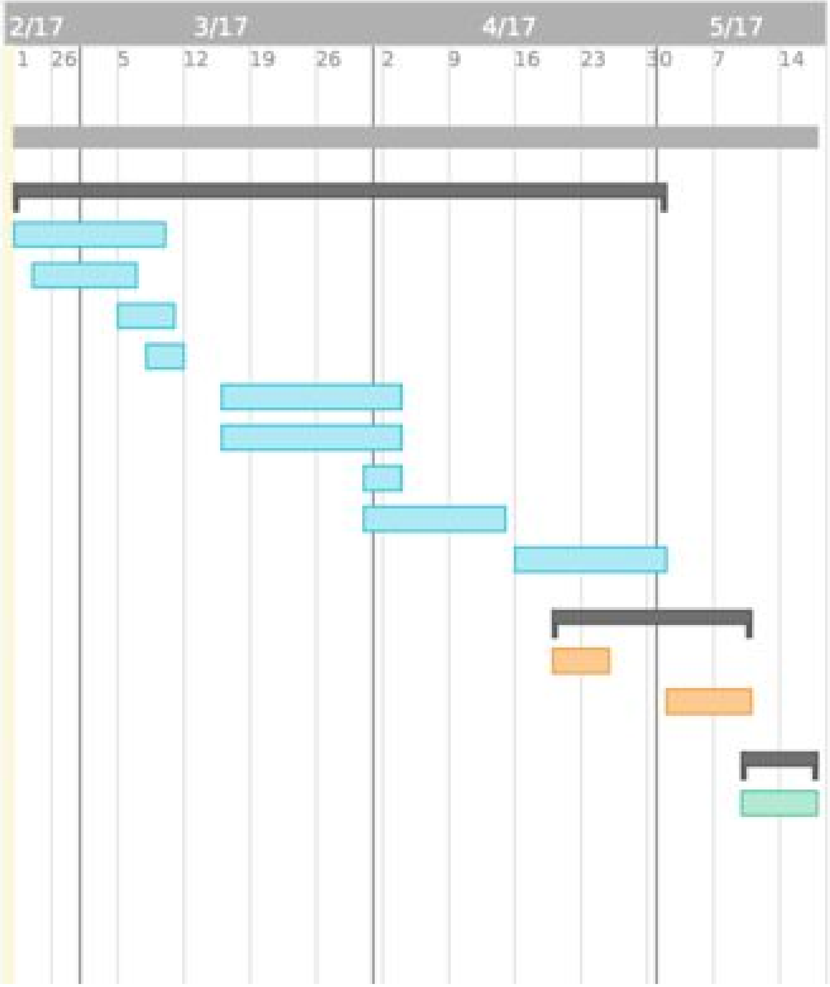
Original TImeline

CIS 2	start	end
Minimum deliverables	**02/22/17**	**05/01/17**
Simple phantom to simulate the task	02/22	03/09
Understand DVRK software	02/24	03/06
Understand how to use DVRK	03/05	03/10
Setup ROS node to pull data from dvrk	03/08	03/11
Operate on the phantom using the dvrk to collect data	03/16	04/03
Video of tool motion with dvrk	03/16	04/03
Extract Tool-force vector at each co-ordinate in each frame of video	03/31	04/03
Estimate tool-force vector for any point of the procedure	03/31	04/14
Visual overlay of tool force vectors	04/16	05/01
Expected Deliverables	**04/20/17**	**05/10/17**
Obtain video data of operation via experts and novices	04/20	04/25
Compare the tool-force patterns between experts and novices	05/02	05/10
Maximum Deliverable	**05/10/17**	**05/17/17**
Compute errors in tool-forces between estimated and actual	05/10	05/17



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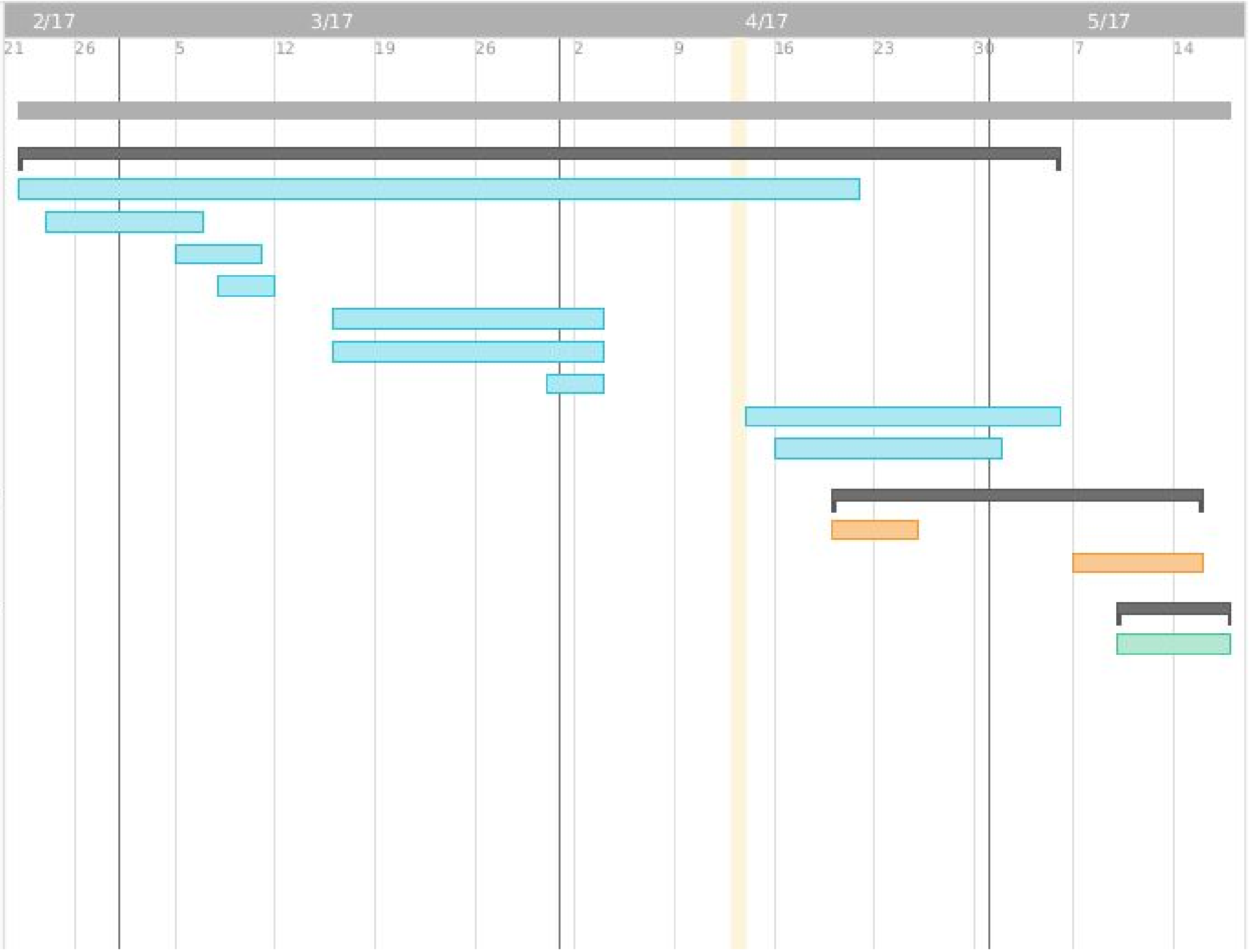
New TImeline

CIS 2	start	end
Minimum deliverables	**02/22/17**	**05/05/17**
Simple phantom to simulate the task	02/22	04/21
Understand DVRK software	02/24	03/06
Understand how to use DVRK	03/05	03/10
Setup ROS node to pull data from dvrk	03/08	03/11
Operate on the phantom using the dvrk to collect data	03/16	04/03
Video of tool motion with dvrk	03/16	04/03
Extract Tool-force vector at each co-ordinate in each frame of video	03/31	04/03
Estimate tool-force vector for any point of the procedure	04/14	05/05
Visual overlay of tool force vectors	04/16	05/01
Expected Deliverables	**04/20/17**	**05/15/17**
Obtain video data of operation via experts and novices	04/20	04/25
Compare the tool-force patterns between experts and novices	05/07	05/15
Maximum Deliverable	**05/10/17**	**05/17/17**
Compute errors in tool-forces between estimated and actual	05/10	05/17



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Challenges and next tasks

Challenges faced uptil now:

- Calibration of Dvrk - camera
- Synchronising topic publication from force sensor with camera frame rate
- Setting up ros node for subscribing ft sensor topics

Tasks to do(brief) :

- Collect data
- Estimate forces
- Compare tool force data to distinguish between novices and pros

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Questions?? Suggestions??