Report N°1 MSc Thesis: Active Constraints

Alberto Rota - *Supervisor: Prof. Elena De Momi*

Title: *To Be Defined*

General guidelines

Development of surgical training tasks implementing Active Constraints of different nature and with different levels of intervention, in order to evaluate their efficacy and role in Robot-Assisted Minimally Invasive Sugery.

- *Phase 1:* Software Development in a virtual environment (Unity)
- *Phase 2:* Implementing on the dVRK, followed by experimental tests with data gathering, analysis and validation

Progress

In these first weeks of work:

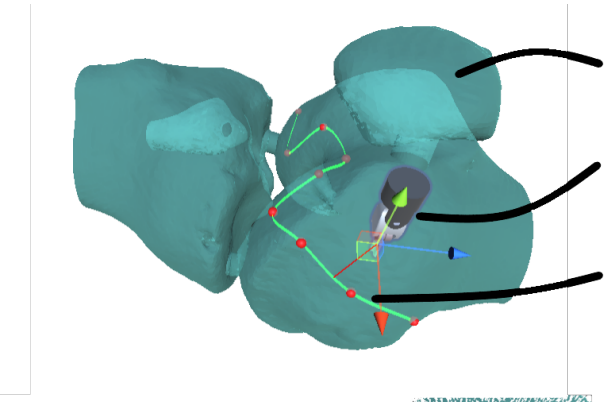
- I learned C# and familiarized better with the Unity Environment
- I selected "Active Constraints/Virtual Fixtures: A survey" (link here) as a discrete guide of workflow and as a point of reference on the different kinds of Active Constraints and for their implementation on the mathematical and software side.
- From here I creaded a virtual surgical scenario in Unity with the model of a Knee as a subject and with the end-effector of a PSM. Inside of this virtual scenario:
  - I implemented the *Trajectory Guidance Active Constraints* described in "A Dynamic Non-Energy-Storing Guidance Constraint with Motion Redirection for Robot-Assisted Surgery" (link here), which functions properly inside the virtual surgical scenario
  - For this same purpose, I also implemented the possibility of generating 3D *Hermite Trajectories* starting from any set of control points, which are set up in the pre-operatory stage: what is described int the previous point has been tested on this kind of trajectories
  - I implemented the *Surface Avoidance Active Constraint* described in "Dynamic 3-D Virtual Fixtures for Minimally Invasive Beating Heart Procedures" (link here), which functions properly in the virtual surgical scenario

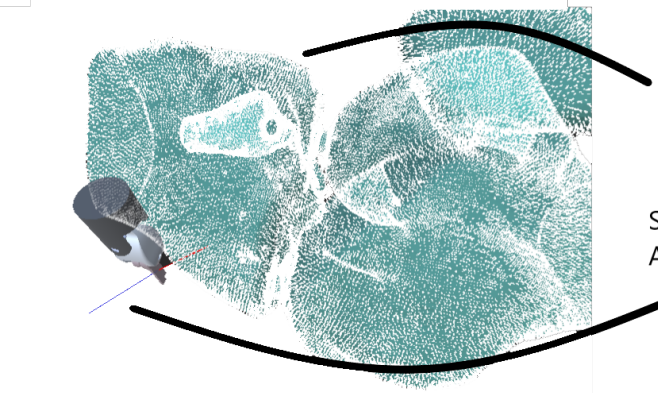
In the following page I'm showing a few screenshots (and I'm aware of their limited descriptiveness) of the virtual surgical scenario with some graphic visual aid of what ha been described above.

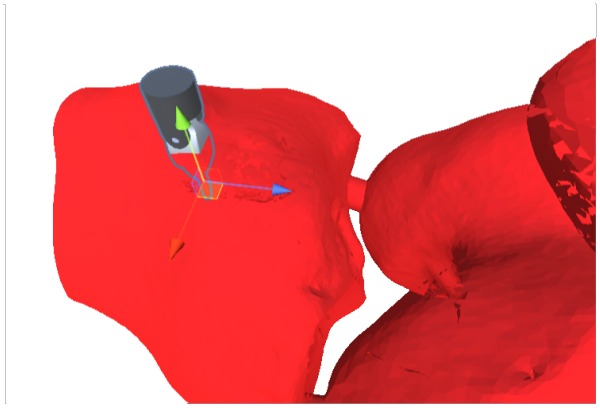
Next Steps

- Using "Active Constraints/Virtual Fixtures: A survey" again as a guide, implementing at least one of every kind of virtual fixture described in the paper and in the cited and referenced literature (guidance / avoidance / redirection, trajectory / surface / volume-based / force-field, static/dynamic, *etc.*).
- Literature research and first implementation (software-wise) of real surgical tasks (not limited to surgical training) where to apply the virtual fixtures implemented above.

Screenshots







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