1 Materials and Methods

1.1 Equipment

This reaserch has been conducted on a first-generation *daVinci*® surgical system decommissioned in 2016 and equipped with the *dVRK* (*daVinci*® Research Kit) framework. The *dVRK* [1] is an open-source mechatronics system, consisting of electronics, firmware, and software, that is being used to controlr esearch systems based on the first-generation *daVinci*® systems. Based on a ROS [2] framework, the *dVRK* implements a high-level accessibility to the sensors, actuators and control algorithms of the *daVinci*® robot, making it more easily interfaceable with advanced strategies and algorithms developed in the most diverse software environments.

The simulated environment developed for this project renders necessary only the surgion console, as the ROS messages are sent solely to the virtual surgical scene and not to the physical robot.

1.2 Surgical Simulator

1.3 Virtual Fixtures

1.4 Clinical Validation

1.5 Experimental Protocol

1.6 Performance Metrics

References

[1] Peter Kazanzidesf, Zihan Chen, Anton Deguet, Gregory S. Fischer, Russell H. Taylor, and Simon P. Dimaio. An open-source research kit for the da vinci® surgical system. pages 6434–6439. Institute of Electrical and Electronics Engineers Inc., 9 2014.

[2] Morgan Quigley, Ken Conley, Brian Gerkey, Josh Faust, Tully Foote, Jeremy Leibs, Rob Wheeler, Andrew Y Ng, et al. Ros: an open-source robot operating system. In *ICRA workshop on open source software*, volume 3, page 5. Kobe, Japan, 2009.