

Robotic surgical tool manipulator - Recognition, control and manipulation of laparoscopic tools

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Historical Overview of Surgical robotics

Surgical Robotics Procedure

Advantages & Disadvantages of Surgical robotics

Problem statement

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Robotic arm & DH parameters

Forward Kinematics

Inverse Kinematics - Decoupling Technique

7DoF numerical solutions

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Gripper & Forward Kinematics

Gripper Inverse Kinematics

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Laparoscopic tool detection

Stereoscopic vision

Calculation of tool position and orientation

Calculation of grasping points

Trocar detection & Estimation of fulcrum point

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Path Planning - Sampling methods

Pick and place algorithm

Task space analysis

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Tool pose & the Fulcrum Effect

Circular trajectory of tool tip

Circular arc trajectory of tool tip

Line segment trajectory of tool tip

Cubic Spline trajectory of tool tip

B-Spline trajectory of tool tip

Polynomials of 5th order

Planning with velocity profiles

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Firm grasping algorithm & Force control

Position based visual servoing

Image based visual servoing

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Introduction to the ROS framework

Gazebo simulation environment

Visualization with RViz

Motion Planning with Moveit

Tools, Packages and Libraries

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Robot Planner 1: Simple MoveIt planning

Robot Planner 2: Simulation layout and reachability experiments

Robot Planner 3a: Circular and Circular arc trajectories in task space

Robot Planner 3b: Line segment trajectories in task space

Robot Planner 3c: Cubic Spline trajectories in task spac

Robot Planner 3d: B-Spline trajectories in task space

Robot Planner 3e: Polynomial trajectories in joint space

Robot Planner 3f: Trajectories in joint space with trapezoidal velocity profile

Robot Planner 3g: Trajectories in joint space with s-curve velocity profile

Robot Planner 4: Simple cube pick-and-place experiment

Robot Planner 5: Visual servoing

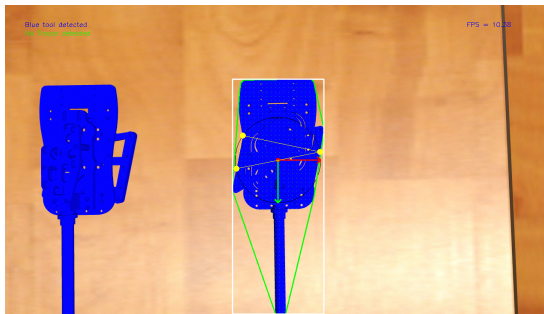


Figure: Image based visual servoing and calculation of grasp points. The yellow points are the grasp points and the thin black circumscribed circle is the growing circle that was used to calculate them.

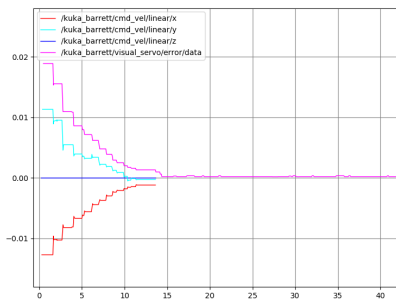
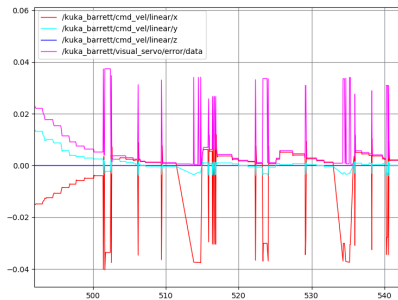


Figure: Visual servo controller error diagrams. On the left image in the error graphs appear some spikes. These spikes occur from the sudden temporary detection of a nearby surgical tool. On the right image, these spikes are filtered out, and only the error graphs of the visual servoing of one tool are shown. The controller parameters are $K_p = 0.9$, $K_d = 0.2$

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Conclusions & Comparison with similar projects

Future Work