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F O R S C H U N G S P R A X I S
for
xxx
Student ID xx, Degree xx

Robotic Planar Pushing with a Switched System Approach - An Extension to Allow for Sliding Motion

Problem description:

It is of great interest to provide robots with decision making capabilities to enable reactive manipulation in uncertain environments. For planar manipulation tasks, Euler-Lagrange dynamics and the Coulomb friction model [3, 2] can be used to model the physical interactions between the robot, the object and the environment. Given a finite set of discrete admissible inputs, the model can be represented as a mixed switched affine system [1]. The aim of this work is to extend a switching law (among the discrete admissible inputs) for the planar pushing task to allow the robot to push the object to a predefined desired position and orientation. The main focus is on the extension of the approach that so far only considers the sticking of the pusher to the object, which is very restrictive in terms of possible inputs. The aim is to allow certain inputs that cause the slider to move up or down. To do this, boundary conditions and constraints must be taken into account. The methodology must be adapted accordingly.

Work schedule:

- Literature research on mixed switched affine systems and methods for robotic pushing tasks
- Adapt the existing model of the planar pushing as a mixed switched affine system (include sliding up and down)
- Extension of the switching law for the planar pushing task given known friction coefficients
- Evaluating the robustness of the switching law against uncertainties in the friction coefficients
- Validating the proposed approach with Python or Matlab simulation
- Evaluating the simulation results and writing the report

Bibliography:

[1] Mohammad Hajiahmadi, Bart De Schutter, and Hans Hellendoorn. Design of stabilizing switching laws for mixed switched affine systems. *IEEE Transactions on Automatic Control*, 61(6):1676–1681, 2015.

[2] Francois R Hogan and Alberto Rodriguez. Reactive planar non-prehensile manipulation with hybrid model predictive control. *The International Journal of Robotics Research*, 39(7):755–773, 2020.

[3] Francois Robert Hogan, Eudald Romo Grau, and Alberto Rodriguez. Reactive planar manipulation with convex hybrid mpc. In *2018 IEEE International Conference on Robotics and Automation (ICRA)*, pages 247–253. IEEE, 2018.

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