R&D defense Supriya Vadiraj

Date: Thursday, 16.05.2019
Time: 1:30
Room: C115

Title: Singularity detection in the Vereshchagin hybrid dynamics solver

Abstract:

In the field of robot manipulation, singularities can be defined as state in which robot is incapable to moving its end effector regardless of the movements of its joints. They can also be defined as a state in which the joints can consume arbitrary forces. The existence of singularities is a significant problem in the application of velocity based task controllers. However, in tasks where robots are in contact with objects and environment (eg: pushing heavy loads) the singular configurations can be utilized when evaluated on the level of forces. Thus, depending on the type of task performed by robot, the singular configurations can either be avoided or exploited.

This project extends the existing Popov Vereshchagin hybrid dynamics solver to detect singularities occurring at runtime. The solver only relies on considering the kinematic and dynamic state available in the existing solver to detect singularities. The naive traditional method to detect singularities does not apply. Hence, a detection mechanism has been formulated by analyzing the available dynamic primitives within the solver. The solver after extension is able to detect the satisfiable task constraints and also provides relate with the traditional singularities. The original solver has been extended to provide a singularity feedback as a separation of concern between detection mechanism and policy of exploiting the decision.

In this work, a detailed analysis and reasoning to the detection mechanism has been performed by backtracking the contributors to singularity within the solver. The evaluation has been performed using KUKA-LWR4 and PUMA560 manipulator models in simulation to validate the desired results in the case of singular configurations. The main results indicate the direction of satisfiable task constraints and relation with the traditional methodology. The future work aims at extending the solver to support the detection mechanism in different platforms such as mobile bases with tree structured kinematic chains.