Deutsches Zentrum
DLR für Luft- und Raumfahrt

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Student Internship or Master Thesis Topic

Investigation of Run-Time Fault Detection and Re-Planning Algorithms for Autonomous Spacecraft with Dynamic Motion Planning

Autonomous systems are typically constrained by their surroundings and their kinematics and dynamics. Dynamic motion planning is a key component of autonomous systems, namely it receives high level motion commands and provides the reference for lower-level controllers. To limit computational burden and run guidance, navigation and control at a high rate, most motion planning algorithms reduce the problem as much as is feasible. For example, using simple motion parameterizations such as fixed-order polynomials in Euclidean space and resolving actuator allocation at the controller level. Such problem reduction is advantageous for the aforementioned reasons, but will always be subject to in-feasibilities due to the model simplification.

We are currently researching nonlinear optimization-based motion planning techniques for application on free-flying systems, such as MIT Space Systems Laboratory's SPHEREs (http://ssl.mit.edu/spheres) onboard the ISS. Such techniques are useful in their ability to resolve complex constraints, for example: avoiding colliding into other objects, guaranteeing feasible actuator dynamics, and motions compatible with on-board sensor requirements (e.g. camera field of view). Careful formulation, such as representation of positions using basic splines which are sparse and linear with respect to their coefficients, can yield algorithms which are performant and efficient. We want to further develop existing dynamic motion planning software at the DLR to handle run-time faults, such as thruster loss or re-mapping of obstacles in the environment.

This student position may incorporate:

- Learning the theoretical foundations of path, kinematic and/or dynamic motion planning (books, papers)
- Implementing run-time fault detection and re-planning for autonomous spacecraft using an existing C++ motion planning library at DLR
- Testing various software configurations for feasibility and computation time
- Testing in simulation and, if schedule permitting, experiments with the SPHEREs or mobile platforms at the DLR such as the hexacopter Ardea (https://www.dlr.de/rm/en/desktopdefault.aspx/tabid-11715/#gallery/29283) or the Lightweight Rover Unit (https://www.dlr.de/rm/en/desktopdefault.aspx/tabid-11431/#gallery/27820)

Contact Samantha Stoneman by email or phone with questions or to apply for this position.