MPC-based occlusion avoidance for object monitoring

Abstract: MPC have been used in the context of so-called perception aware applications, where vision-based constraints and objectives are integrated into the underlying optimization problem and solved in a receding horizon fashion. These approaches rely on the existence of a line of sight. However, this assumption is not easily verified in realistic scenarios, in uncontrolled and often cluttered environments. Occlusion avoidance is often tackled with geometric ray-casting to simulate the line of sight. But its evaluation is often computationally heavy, in particular when several occlusion obstacles are considered, and rely on a good knowledge of the environment. Moreover, these approaches rarely consider uncertainties associated with sensor measurements.

On the other hand, chance-constrained MPC are stochastic optimal control technics which have been successfully employed to tackle collision avoidance in receding horizon schemes. This thesis aims to address the problem of real-time occlusion avoidance in object monitoring in cluttered environments, exploiting stochastic constraints.

Tasks:

- Survey existing literature on collision or occlusion avoidance in stochastic MPC schemes
- Investigate relevant mathematical formulation of the problem
- Familiarize with simulation environments and real-time MPC software
- Propose an implementation of the proposed methodology
- Focus on hardware experiments and testing the proposed method on a quadrotor

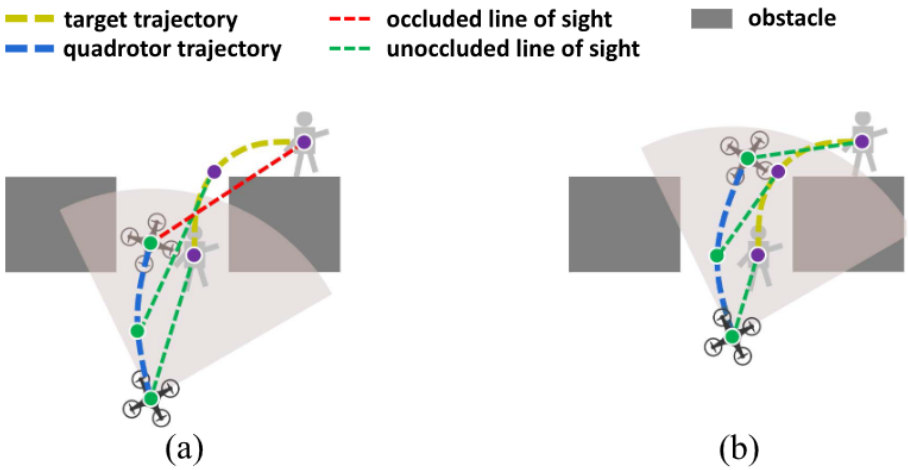

Figure: A quadrotor tracks a robot through a narrow opening, and plans to reduce observation distance to avoid possible occlusions. (from ref. [7])

Literature (indicative):

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[7] Hanzhang Wang, Xuetao Zhang, Yisha Liu, Xuebo Zhang, Yan Zhuang. "SVPTO: Safe Visibility-Guided Perception-Aware Trajectory Optimization for Aerial Tracking". In: IEEE Transactions on Industrial Electronics 71.3 (2024) https://doi.org/10.1109/TIE.2023.3270541

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