where the matrix operator parameters are calculated iteratively.

Corollary 1. *Let the Assumptions be satisfied. For sufficiently small* $\varepsilon_1, \varepsilon_2 > 0$*, the decoupled system (1) is* $O(\mu)$*-close to degenerate (reduced),* ε_2*- and* ε_1*-boundary-layer systems [1] for the TSPLTISD.*

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OPTIMAL MOTION PLANNING IN CLUTTERED ENVIRONMENT

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1. Introduction. In both control and robotics communities the interest in the navigation through multi-obstacle environments is constantly growing due to its vast domain of applications, e.g., [1]. From a mathematical point of view, the main difficulty arises from the non-convexity of the feasible regions in the motion space and consequently in the lack of connectivity in the solution space.

Our solution exploits the *convex lifting* notion, which has been previously employed in constrained control and PWA (piecewise affine) control implementations [2]. Our work establish a link between the convex lifting involving the obstacles, the polyhedral partitions and the path selection in the navigation space. The technique can be understood as a convexification procedure for the characterization of the non-convex motion space.

The effective motion planning strategy is divided into two stages. Basically, in a first stage we neglect the dynamical constraints and the physical limitations that may appear in the motion planning in order to generate a feasible geometric path. As stated, the resulting path ensures the avoidance of obstacles and has the potential to explicitly describe a feasible corridor. At a second stage, using the geometric path and the corridor as starting points, we find some appropriate trajectory respecting the agent's dynamics and constraints using a MPC strategy.

2. Contribution

Definition 1. *Given a collection of obstacles* $\mathbb{P} = \bigcup_{j=1}^{N_o} P_j$ *with* $P_i \cap P_j = \emptyset, \forall i \neq j$, *and a partition of the environment* $\mathbb{X} \supset \mathbb{P}$ *induced by* $\mathbb{P}$, *the function* $z : \mathbb{X} \to \Re$ *is called a* PWA (piecewise affine) lifting of the cluttered environment *if there exists* $z(x) = a_i^\top x + b_i$, $x \in X_i$ *with* X_i *satisfying* $int(X_i) \supset P_i, \forall i$, $a_i \in Red$ *and* $b_i \in \Re$.

Theorem 1. *A piecewise affine lifting for a collection of obstacles* $\mathbb{P} = \bigcup_{j=1}^{N_o} P_j$ *with* $int(P_i \cap P_j) = \emptyset, \forall i \neq j$ *is continuous and convex if* (a_i, b_i) *satisfy: The values* $\epsilon, M > 0$ *are suitably chosen and* $\mathcal{V}(P_i)$ *denotes the collection of extreme points of* P_i.

Using Theorem 1, we are able to obtain a polyhedral partition of the navigation space w.r.t. the obstacle setting. Further, we define a graph, considering the vertices of the partition cells as nodes in that graph and the facets as edges. Applying a graph search algorithm, we can derive the shortest geometric path between any two points in the space. This path is a foundation for a corridor-constrained MPC strategy, as depicted in Figure 1.

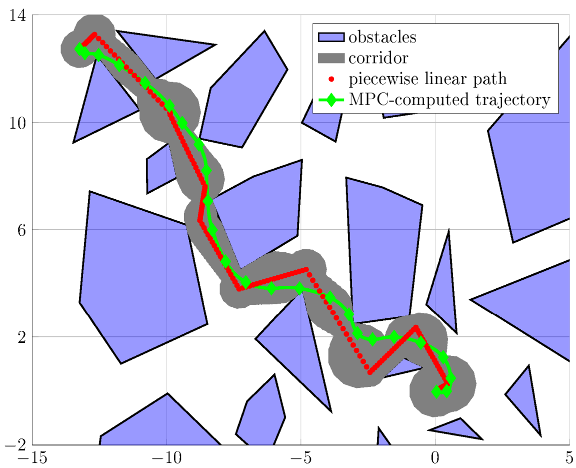

Figure 1 — The shortest path $\text{Path}(x_i, x_f)$ and a feasible trajectory within the corridor.

3. Conclusions We propose a constructive solution for the generation of collision-free trajectories between two points in an environment containing multiple obstacles in a d-dimensional space. This builds on the geometry of the obstacles and the convex lifting procedure describing a graph around the obstacles. This graph represents a key element in order to generate collision-free trajectories employing MPC controllers with recursive feasibility guarantees and convergence in between an initial and a final position.

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ADAPTIVE SENSORLESS INDUCTION MOTOR CONTROL SYNTHESIS WITH QUADRATIC COST CRITERIA

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The sensorless (without speed sensor) induction motor vector control synthesis is an actual problem [1] for industrial applications. This paper proposes a modified cost criterion which improve the speed computation, based on model reference adaptive control (MRAC).

In the stationary frame (a, b) the induction motor with the state vector $x = (\Psi_a, \Psi_b, i_a, i_b)^T$ and the control vector (u_a, u_b) is described by the equations

$$\begin{aligned} \dot{\Psi}_a &= -\alpha\Psi_a - \bar{\omega}\Psi_b + \alpha L_1 2 i_a, \\ \dot{\Psi}_b &= -\alpha\Psi_b + \bar{\omega}\Psi_a + \alpha L_1 2 i_b, \\ \frac{di_a}{dt} &= -R_1 K_4 i_a + K_4 u_a - k_2 K_4 \dot{\Psi}_a, \\ \frac{di_b}{dt} &= -R_1 K_4 i_b + K_4 u_b - k_2 K_4 \dot{\Psi}_b, \\ y &= i_{ab}. \end{aligned} \tag{1}$$