A Constrained Iterative LQR Solver for the Trajectory Optimization Framework Horizon

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The eILQR problem

$$\min_{x_{0:N},\, u_{0:N-1}} \quad \sum_{k=0}^{N-1} \ell_k(x_k, u_k) \; + \ell_N(x_N)$$

$$\text{s.t.} \quad x_{k+1} = F(x_k, u_k)$$

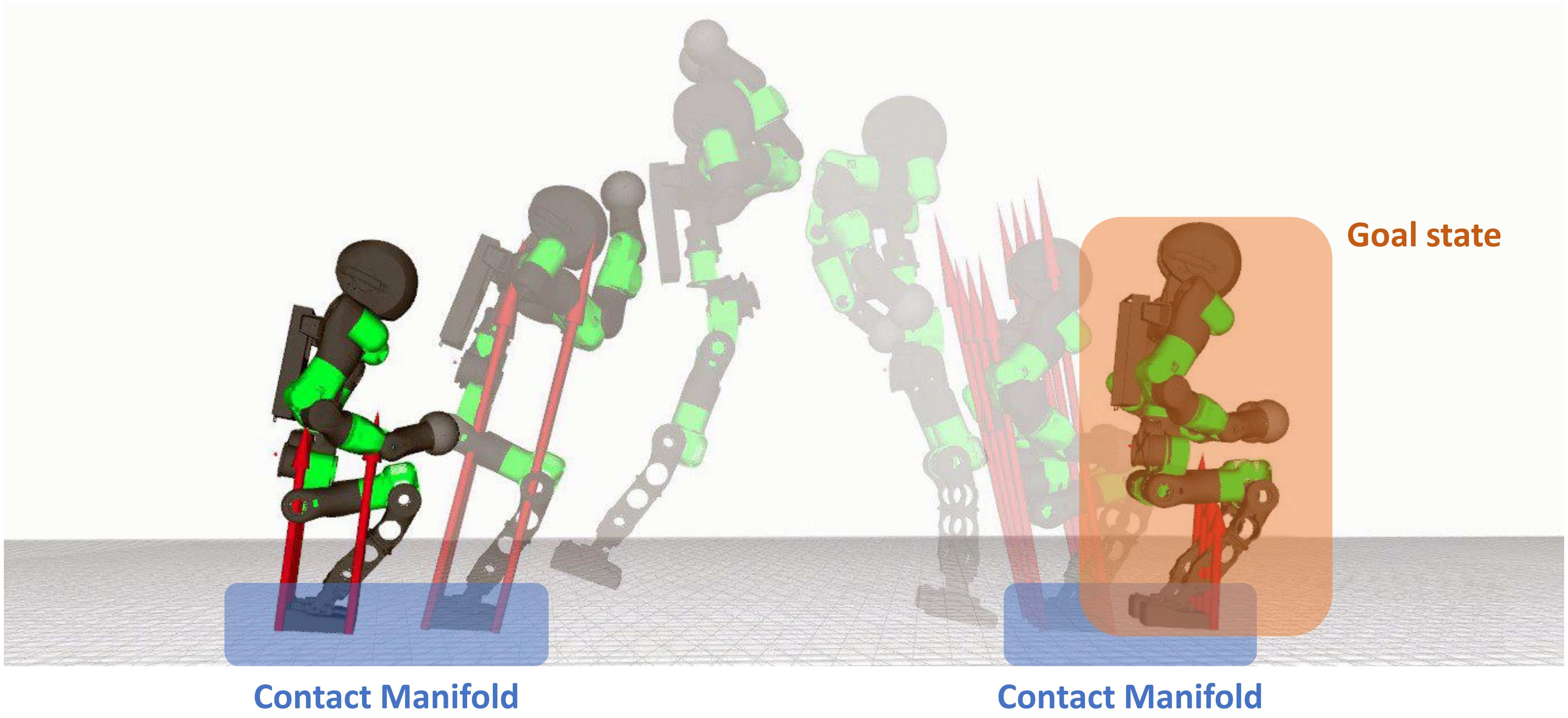
$$h_k(x_k, u_k) = 0, \qquad h_N(x_N) = 0,$$

Path vs waypoint constraints

- **Path constraints** keep the system state-input on a manifold
  - Constraint dimension smaller than input dimension
  - Easily dealt with via **projection** (null-space) methods
  - Example: the contact manifold

- **Waypoint constraints** (e.g. final constraints) are useful to specify a goal
  - Constraint dimension up to the state dimension
  - **Cannot be fulfilled with the choice of a single control input !**
  - Example: posture at the end of a jump motion
  - Example: space travelled after taking N steps

An example



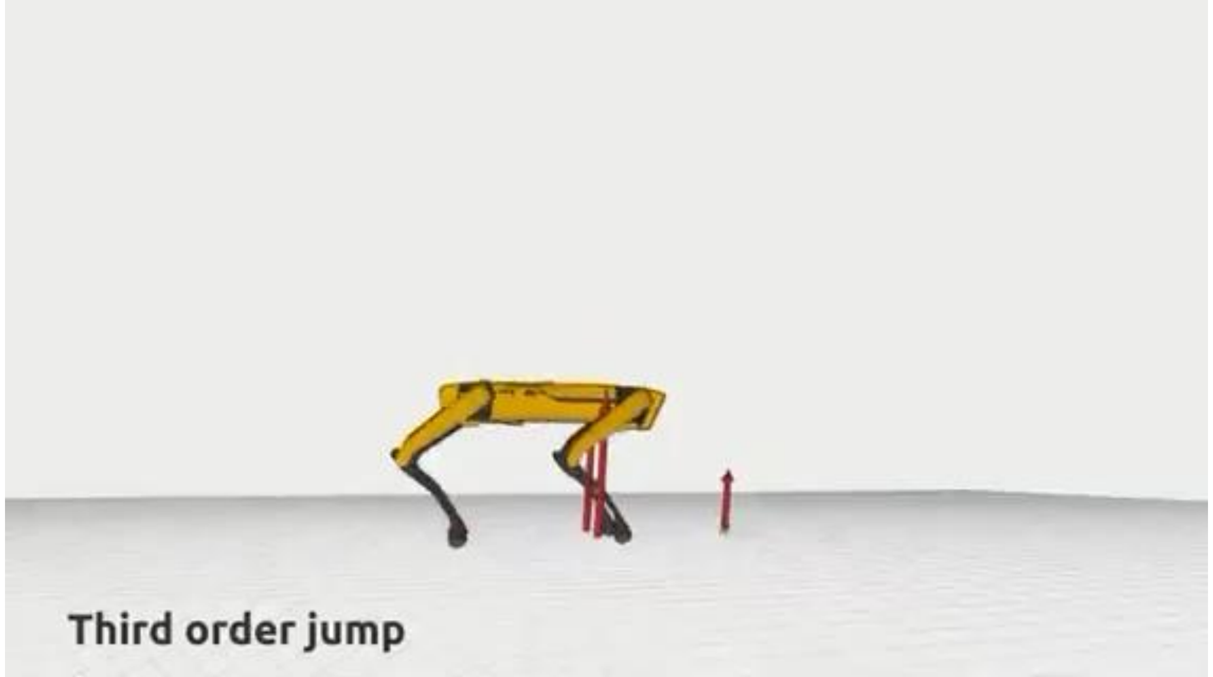
Our contribution

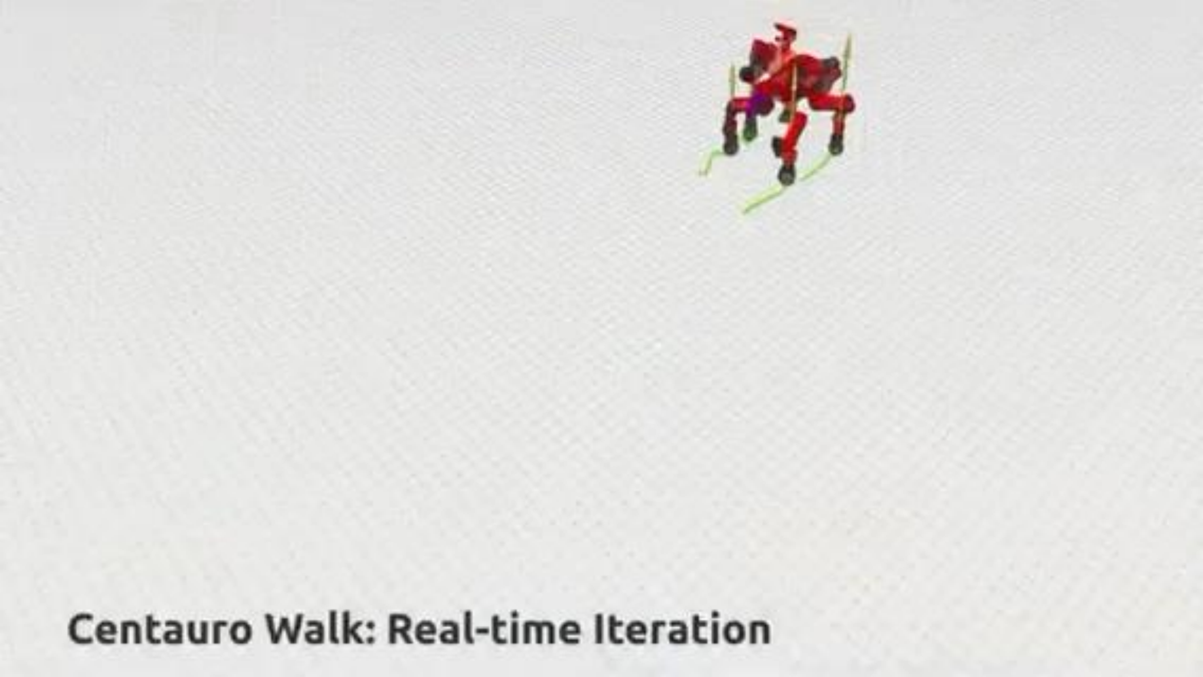
- A **Riccati**-like recursion to compute
  - The eILQR **optimal policy**
  - **Lagrange multiplier** estimates
- Lagrange multipliers are useful to **autotune** an L1 merit function

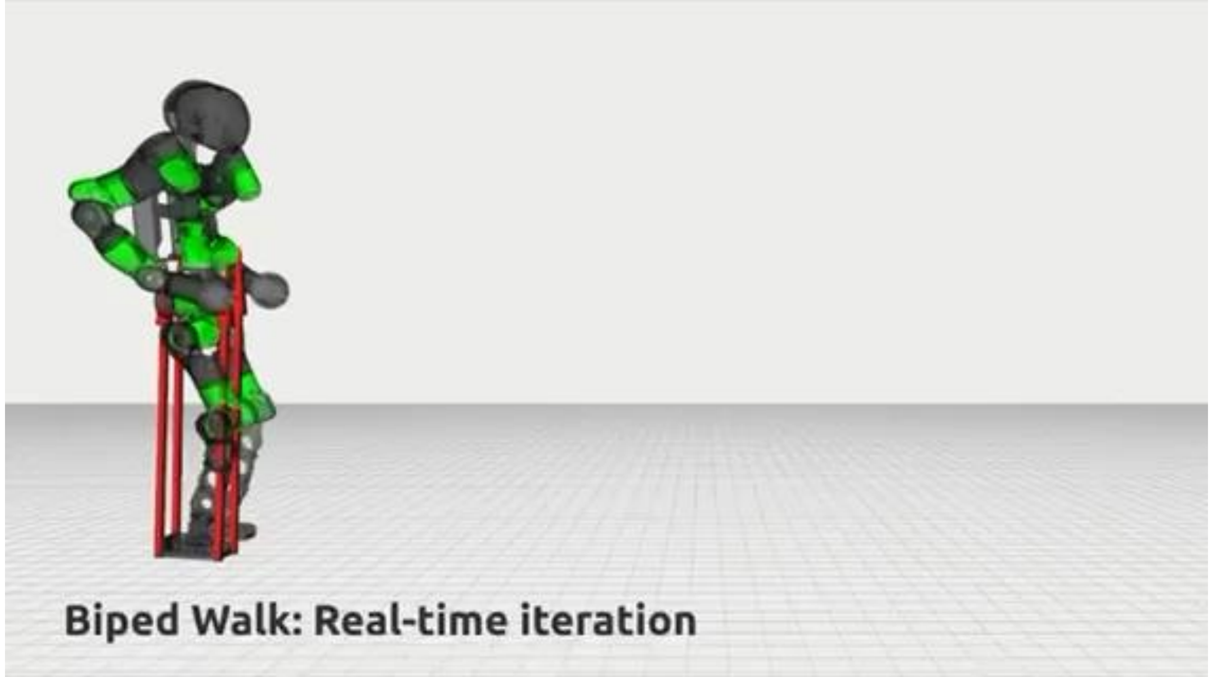
$$m(X) = L(X) + \gamma \|H(X)\|_1$$

- An open-source implementation
- Extensive validation campaign

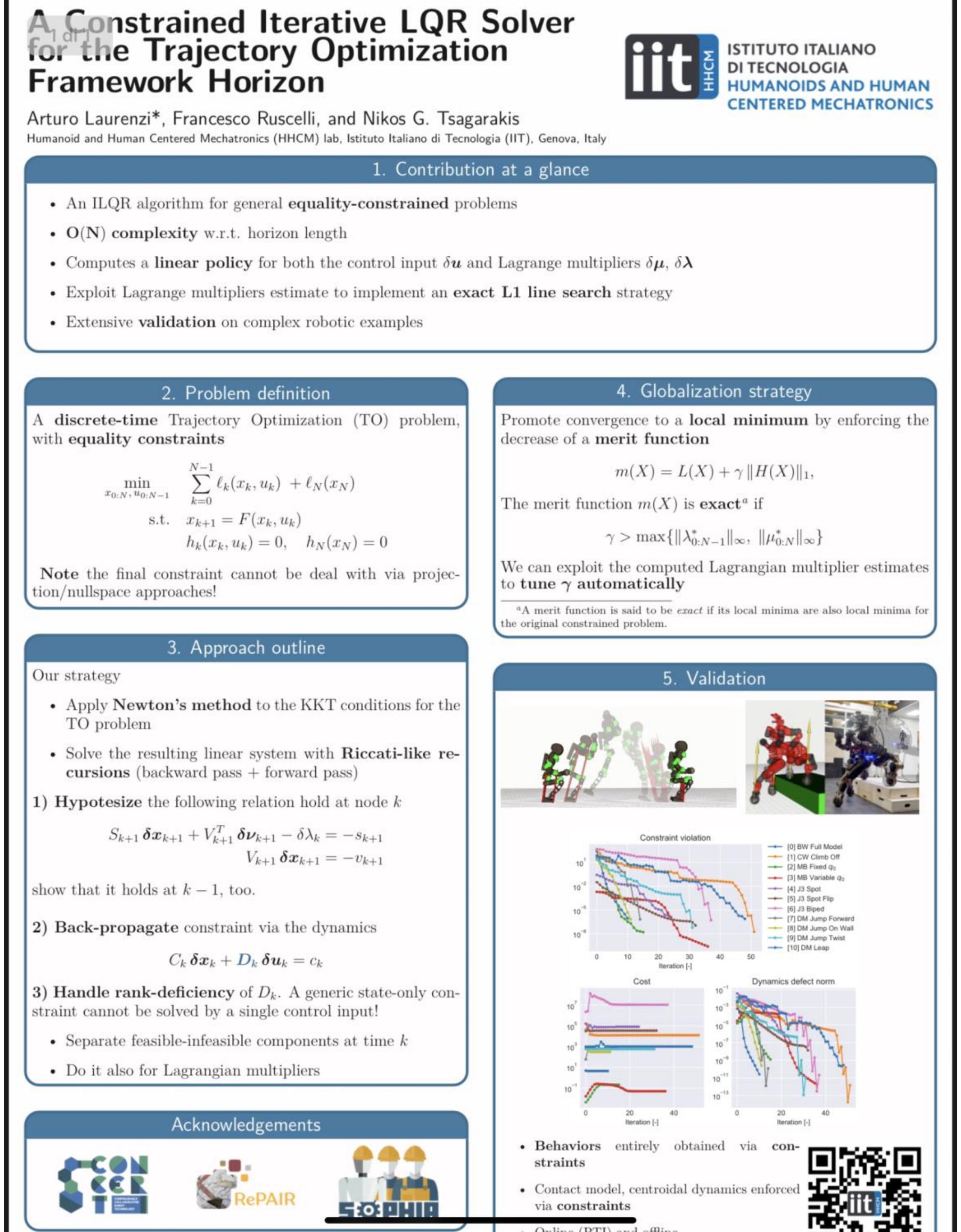

Centauro Walk: Climb Off


Third order jump


Centauro Walk: Real-time Iteration


Biped Walk: Real-time iteration

Meet me at the poster session !



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