Cognitive Cooperative Mobile Multi-Robot Manipulation


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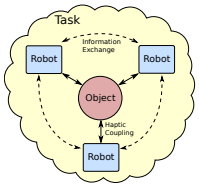
Motivation

- Team of robots and humans for efficient task execution
- Complex manipulation tasks in unstructured environments
- Increase of dexterity by multiple mobile robot manipulators
- Exploitation of heterogenous team member capabilities

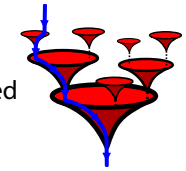
Research challenges

- Joint mobile manipulation with haptic coupling
- Recognition and correction of non-desired actions
- Handling intrinsic/extrinsic disturbances and uncertainties
- Coordinated task execution by a team of agents

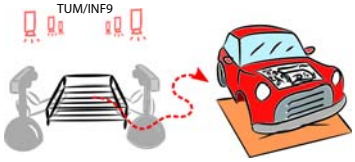


Plan representation

- Global and local sensorimotor primitives
- Plan given by a sequence of primitives
- Goal represented by global object-centered primitives, e.g. global visual servoing task
- Funnel based task execution

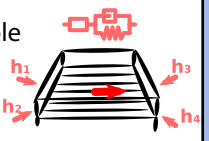


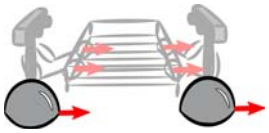
$$\mathcal{G}(\Phi_i) \subset \mathcal{D}(\Phi_k)$$



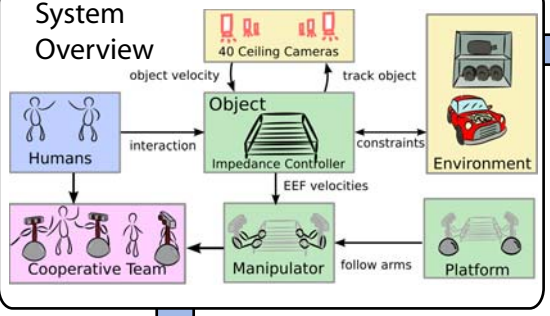
Compliant mobile manipulation

- Differential kinematics derived from tunable object impedance dynamics
- Manipulability-optimized mobile platform configuration
- Recognition and interpretation of environmental interaction

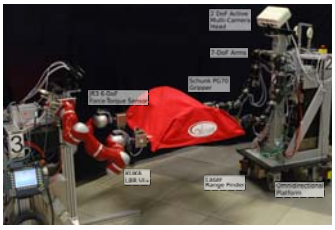




System Overview



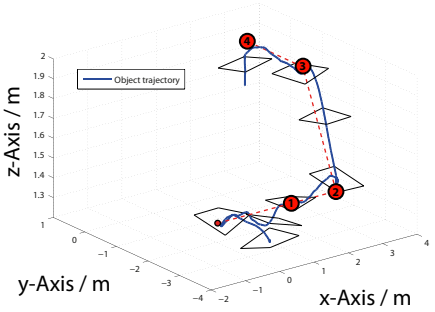
Experimental setup



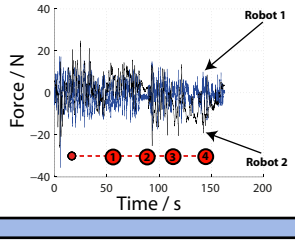
- Multiple robots pick up a large, rigid object
- Transport of the object from an arbitrary initial position to a desired mounting pose
- Human-guided final positioning

Experimental results

- Accurate waypoint tracking by global visual servo control loop



- Bounded internal forces



Selected publications

- Rambow et al., "A Framework for Information Distribution, Task Execution and Decision Making in Multi-Robot Systems", *IEICE Transactions on Information and Systems*, 2010
- Althoff et al., "An Architecture for Real-time Control in Multi-robot Systems", *Human Centered Robot Systems*, 2009
- Lee et al., "Human-robot cooperation control for installing heavy construction materials", *Autonomous Robots*, 2007
- Khatib et al., "Force Strategies for Cooperative Tasks in Multiple Mobile Manipulation Systems", 1996

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