Elective in Robotics

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Final projects

DIPARTIMENTO DI INFORMATICA
E SISTEMISTICA ANTONIO RUBERTI

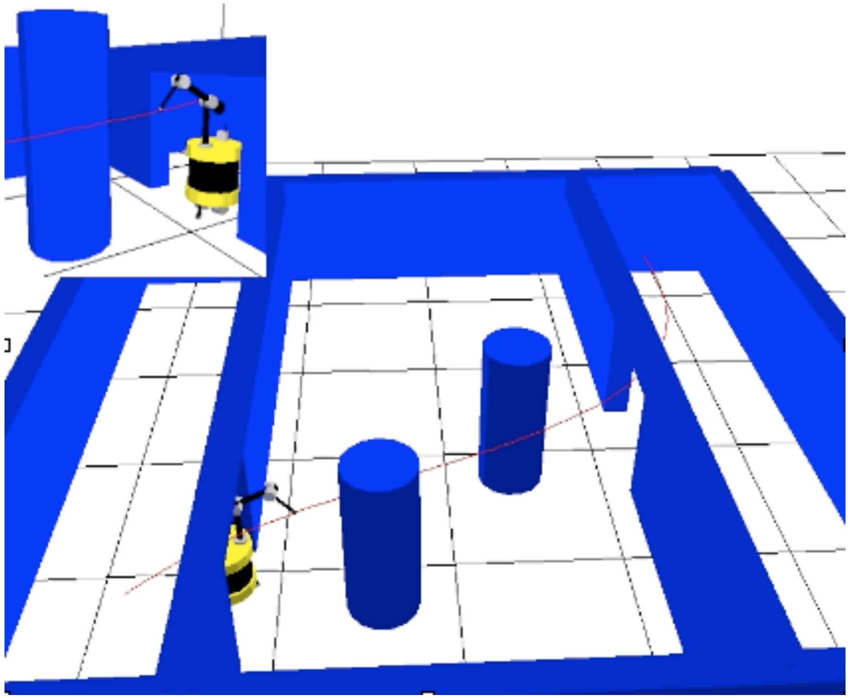
SAPIENZA
UNIVERSITÀ DI ROMA

- 7 projects covering the topics of modules 2, 3, 4
- work can be carried out in groups of 2-3 students
- all projects require programming in C/C++ using
  - the Computational Geometry Algorithms Library (CGAL) (http://www.cgal.org/)
  - Kite Lab: a software development platform dedicated to motion planning developed by Kineo CAM (http://www.kineocam.com/)
- projects must be completed by September 15 except for first-year MARR students who must finish by October 30

Project 1: task-constrained motion planning

(ref.: G. Oriolo, M.Vendittelli)

- task space constraints arise in many practical operations of robotic systems
- kinematic redundancy is purposely introduced in order to pursue additional objectives during the execution of the task



- obstacle avoidance is among the most important objectives $\Rightarrow$ it is necessary to generate robot motions satisfying task space constraints while avoiding collisions between the robot bodies and the obstacles

$\Downarrow$

- Probabilistic Roadmap Methods (PRM) for planning collision free motion
- appropriate motion generation scheme taking into account constraints
- planning space: task-constrained configuration space

$$\mathcal{C}_{\text{task}} = \{\mathbf{q} \in \mathcal{C} : \mathbf{f}(\mathbf{q}) = \mathbf{t}_d(\sigma), \text{for some } \sigma \in [0, 1]\}$$

- admissible solutions $\in \mathcal{C}_{\text{task}} \cap \mathcal{C}_{\text{free}}$

objective: to implement a RRT-based motion planner for a mobile manipulator subject to task constraints using Kite Lab

Project 2: fast planning and replanning for a quadrotor

(ref.: J.P. Laumond, M.Vendittelli)

aerial vehicle with

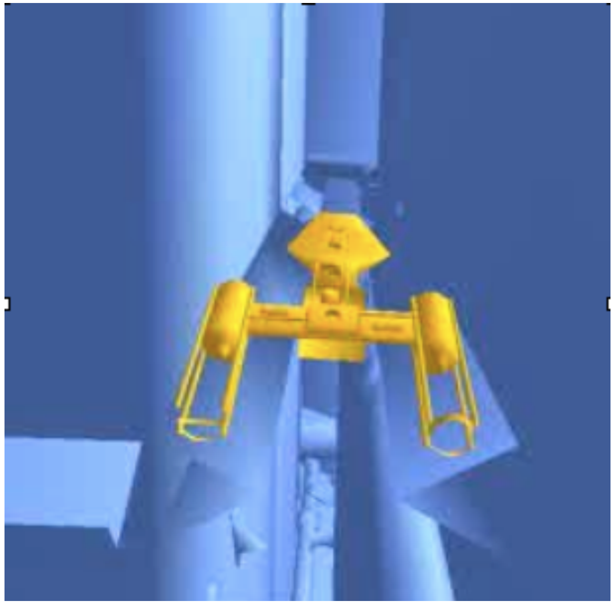
- vertical take-off and landing (VTOL)
- stationary
- slow

flight ability

↓

- appropriate for missions in indoor cluttered environments
  - monitoring of hostile environments
  - search and rescue operations
  - surveillance

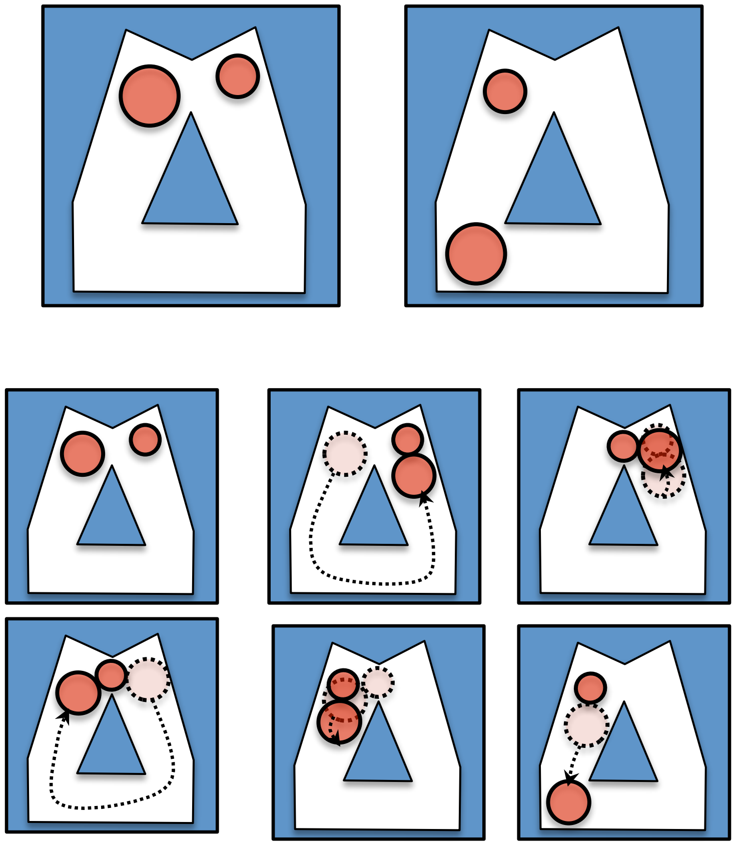
- $\mathcal{C} = SE(3)$ $\Rightarrow$ deterministic planners are not efficient
- $\Rightarrow$ PRM + flatness-based local planner
- fast replanning to allow on-line goal changing



objective: to implement a visibility-based motion planner for a quadrotor in a cluttered indoor environment using Kite Lab

Project 3: manipulation of two disks/polygons

(ref.: J.P. Laumond)



- 4D exact cell decomposition for coordinated motion
- 3D exact cell decomposition for motion in contact
- manipulation space structuring

objective: software development based on computational geometry for motion planning using CGAL library

Project 4: motion planning for video games

(ref.: J.P. Laumond, M.Vendittelli, G. Oriolo)

- precompute roadmap for real-time path planning
- interactive control of an artifact against another autonomous artifact
- appealing scenario

objective: realization of a video game (including scenario design) based on motion planning technology within Kite Lab

Project 5: motion planning for digital actor interaction

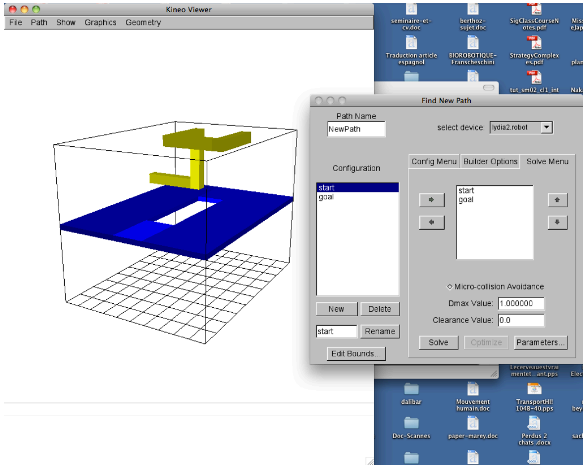
(ref.: J.P. Laumond)

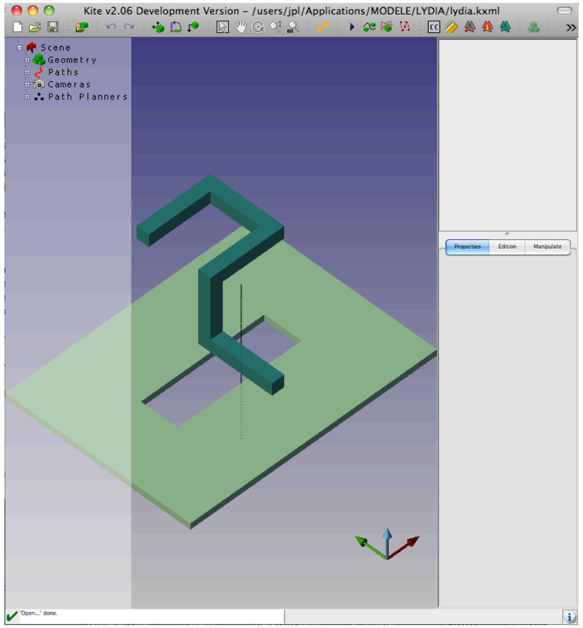
- definition in the interaction task space vs configuration space
- motion generation based on inverse kinematics
- geometric constraint satisfaction based on motion planning technology

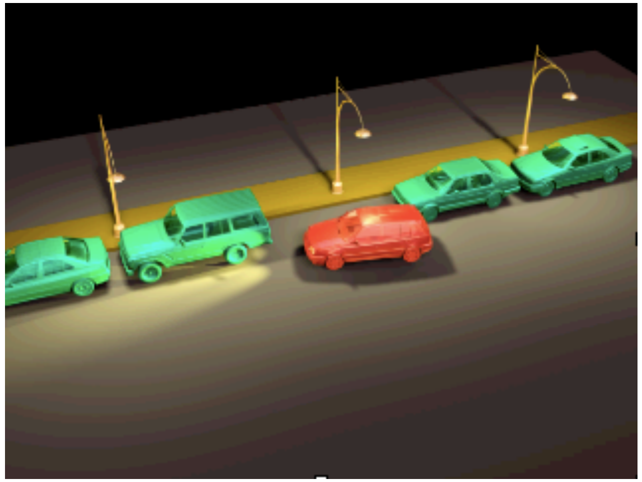
objective: to develop a motion planner for human character interaction within Kite Lab

Project 6: benchmarking

(ref.: J.P. Laumond, M.Vendittelli)







- motion planning for free-flying objects, car-like, car-trailer systems

objective: realization of benchmarks within Kite Lab

Project 7: motion planning for NAO

(ref.: M.Vendittelli)

- highly articulated system
- dynamic balance constraints
- PRM + ZMP-based gaits

objective: implementation of a footstep generator and a motion planner for NAO within Kite Lab