Lectures on Motion Planning and Control for Underactuated Mechanical Systems

Lecture 1: Introduction

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Outline

1. Conceptual examples

2. Topics Covered in the Course

Conceptual examples

Example

Dynamics of a simplified model of a ship is given by

$$m\ddot{x} = F\cos\theta, \quad m\ddot{y} = F\sin\theta, \quad J\ddot{\theta} = T,$$

where

- x, y and θ define the Cartesian coordinates and the orientation of the ship;
- F and T are two control variables (the total force and the torque);
- m and J are the mass and the inertia of the ship.

Task:

Find behaviors of the ship along a straight line

$$y = k \cdot x, \quad \tan\theta = k$$

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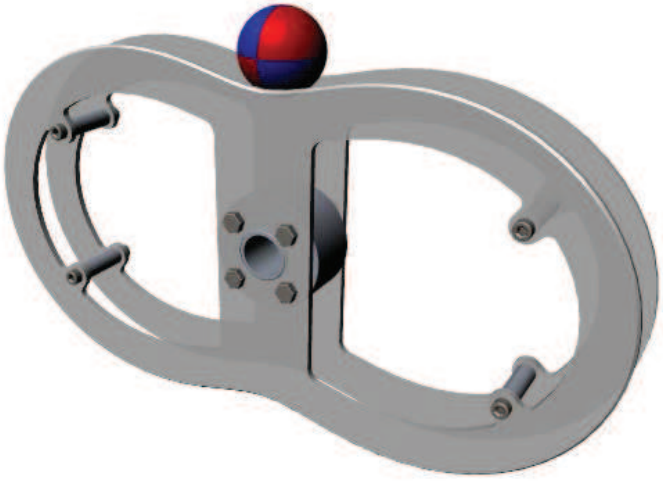
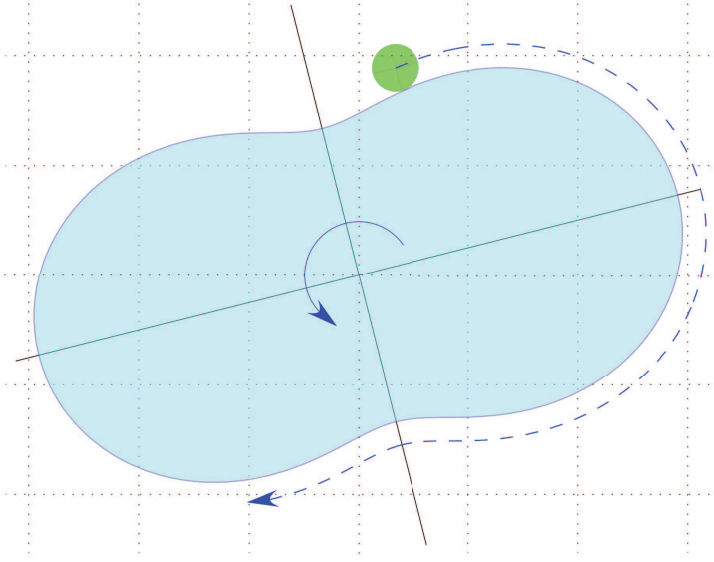
Task:

Find behaviors of the ship along a circle of radius r

$$x^2 + y^2 = r^2, \quad \tan\left(\theta - \tfrac{\pi}{2}\right) = \frac{y}{x}$$

Examples in Dynamic Manipulation





The tasks are

- to plan a rolling of a sphere on a frame
- to design a feedback controller to stabilize a motion

Topics Covered in the Course

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- **Perspectives, challenges and open problems**