

## Lecture 3 - Simulation of Techniques and Tools

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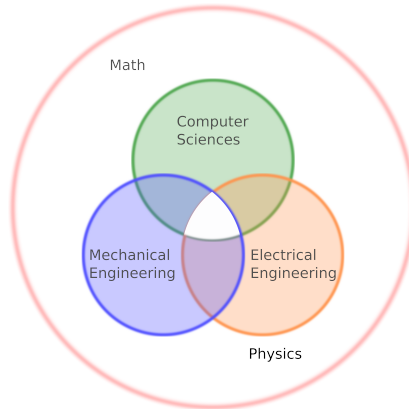
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# A holistic perspective



## Robotics - An Interdisciplinary Science



## Modeling Approaches

### Bottom Up

- ▶ A model consists of submodels
- ▶ Every parameter is considered
- ▶ High physical accuracy

### Top Down

- ▶ A model consists of an input-output behavior
- ▶ A subset of parameters are needed
- ▶ Efficient simulation

# A holistic perspective



## Bottom Up

- ▶ (Low Level) Controller Design
- ▶ Learning more than I/O relations
- ▶ More "realistic" behavior

## Top Down

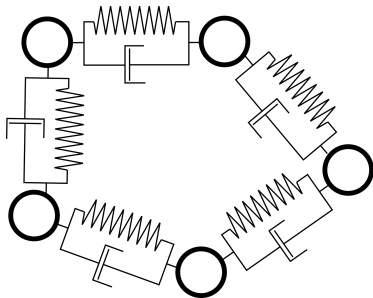
- ▶ (High level) controller design
- ▶ Learning basic I/O relations
- ▶ Visual behavior / Gaming

# Opportunities and Limitations



## Soft Body Dynamics

- ▶ Connect **each** node of a mesh with a spring damper system
- ▶ Huge effort from numerical point of view
- ▶ Examples

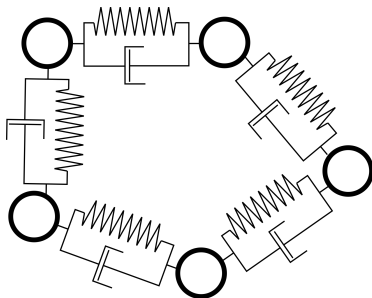


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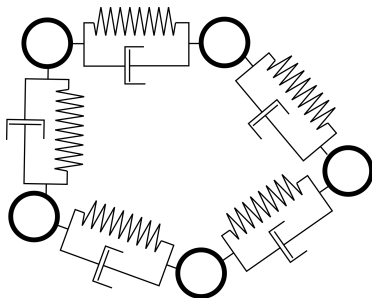


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## Good Questions

- ▶ How to model joint clearance?
- ▶ How to make objects grippable?
- ▶ Avoid self collision?
- ▶ Using CFM and ERP.
- ▶ Enable pairings of object and destroyable fixed links
- ▶ If needed, use collision layers.





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## Problem Abstraction

### Description

Model a factory worker which can step in the working cell of a robot. The robot is able to identify a worker via visual detection.

### Abstraction I

Model a visual of the factory worker that is able to "walk" in the simulation.

### Abstraction II

Model a visual of the factory worker that is able to change its position smoothly.



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Estimate the forces acting on each joint during a given walking gait.

### Abstraction

High accuracy simulation of a robots lower body.

### Suitability

Is a rigid body simulator sufficient for the task?



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### Description

Model a factory worker which walks around naturally.

### Abstraction

Give a model a walking like behavior.

### Requirements

Ray Tracing: Detects objects in front of it.

Target Generator: Creates a (reachable) target.



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Model a current for underwater simulations.

### Solution

Create a vectorfield of current forces and add some degree of randomness!



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## Live Coding

## Model of an IMU

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Measure the acceleration and rotational velocity at a given frame.

### Equations

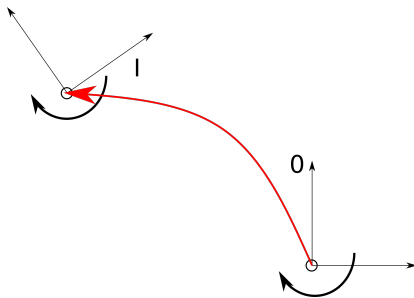
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## Gazebo

### Gazebo Overview



## V-Rep

### V-Rep Overview





OpenModelica

## Live Demonstration