ENG ME 740: Vision, Robotics, and Planning—Intelligent Machines

Course Outline: (Spring 2013)

1. Foundations of intelligent mechatronics
2. Geometry and robot coordinate systems
   (i) Rigid motions of $\mathbb{R}^3$
   (ii) Kinematic pairs and the lattice of subgroups of the special Euclidean group
   (iii) Free vectors and bound vectors
3. Euclidean group theory and kinematic equations
   (i) The Denavit-Hartenberg formalism
   (ii) The product of exponentials formula
   (iii) Screw theory
4. Differential relationships
   (i) The manipulator Jacobian for spatial mechanisms
   (ii) The propagation of joint volicities and forces
5. Specifying robot motions
   (i) The theory of motion interpolation
   (ii) Nonholonomic motion planning
6. Analytical dynamics of mechanical systems
   (i) Lagrangian mechanics
   (ii) Hamiltonian mechanics
7. Control: basic issues
   (i) Controllability
   (ii) Design and synthesis
   (iii) Stability of feedback control laws
8. Control: information-based control
   (i) Nyquist frequency and Shannon’s theorem
   (ii) The zero order hold and quantization alternatives
   (iii) The data-rate theorem and feedback control with communications constraints
9. Advanced topics: algebraic and geometric methods
   (i) Nonlinear/geometric control theory
   (ii) Motion control in living organisms: paradigms and puzzles
   (iii) Networked control systems
   (iv) Graph theoretic structures for distributed control and control motifs
10. Advanced topics: cooperative control
    (i) Control of multiple mobile agents
    (ii) Data-structures for distributed control of mobile agents
    (iii) Distributed sensing and sensor fusion
    (iv) The blind robot problem
11. Advanced topics: information-based control theory
   (i) Connecting control theory to information theory
   (ii) Information gradients
   (iii) Optimal reconnaissance strategies
   (iv) Control communication complexity

12. Advanced topics: kinematic redundancy
   (i) Survey of techniques for resolving kinematic redundancy
   (ii) The extended Jacobian technique and constrained motions
   (iii) Super-articulated mechanical systems

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**Suggested Reading**

**Text:**


**Other books:**


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**Grading**

Grades will be given for homework assignments (one every week or so), class participation, and most importantly, for a term project which will be assigned during the first few weeks of the class.

For up-to-date information about the class, visit: [http://people.bu.edu/johnb/ME740.html](http://people.bu.edu/johnb/ME740.html).

(1/11/13)