Course Syllabus

Description

This course investigates recent work in the areas of nonlinear dynamics and control of robots that walk, run, fly and swim.

Instructor

Prof. Katie Byl (katiebyl@ece.ucsb.edu)
Room 5115, Harold Frank Hall

Time/Location

Monday, Wednesday 2:00-3:50pm, in 1437 Phelps

Prerequisites

An undergraduate-level background in both System Dynamics and Controls.

Office Hours

Tuesday 10am-noon (and/or by appointment), in 5115 HFH.

Required Text/Readings

There is no text for this course. Instead, we will read, analyze and discuss a variety of recent publications relating to robot locomotion. Please be respectful that such publications are protected by copyright law; any links to publications are for educational use by students within this course, only.

Grading

Class participation 30%  (Includes leading at least one class discussion.)
Homework 35%  (Lowest HW grade will not be included in average.)
Final Project 35%  (With conference-length research paper and talk.)

Participation

Each student will be assigned a particular reading for which (s)he will lead a class discussion. Students are strongly encouraged to meet with me beforehand (either in regular office hours or by appointment) to review their assigned readings. Your grade for class participation will also depend on your regular contributions to other class discussions throughout the class.

Homework

Homework is due at the start of class. While some collaboration is allowed, direct copying is not (and will be dealt with severely). The lowest homework grade a student receives will not be included in calculating the total homework grade contribution.

Projects

Details on potential topics for the term project will be discussed in class. Deliverables for the term project include both a conference-length paper (e.g., 6-8 pp.) and a short, in-class presentation (about 15 minutes).
# Tentative Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics (numbering matches HWs)</th>
<th>Required Readings</th>
<th>Optional Readings</th>
<th>Homework Out Due</th>
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<tbody>
<tr>
<td>1/4</td>
<td>1: Locomotion overview&lt;br&gt; 1.1 Underactuation and controllability.</td>
<td>[14]</td>
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<td>1/6</td>
<td>2: Passive dynamics in walking&lt;br&gt; 2.1 Impedance; robot examples.</td>
<td>[36]</td>
<td>[38]</td>
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<td>[41]</td>
<td>[42]; [12]</td>
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<tr>
<td>1/11</td>
<td>2.2 Stability analyses and modeling.</td>
<td>[10, 25]</td>
<td>[23, 47, 26]</td>
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<td>[49]</td>
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<td>1/18</td>
<td>** No class. (MLK’s Birthday.) **</td>
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<td>1/20</td>
<td>3.2 Stability margins.</td>
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<td>[22]</td>
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<td>3.3 Preview control for ZMP.</td>
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<td>[32]</td>
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<tr>
<td>1/25</td>
<td>3.4 Hybrid Zero Dynamics (HZD). 3.5 (Manifold control.)</td>
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<td>1/27</td>
<td>4: Running gaits&lt;br&gt; 4.1 Raibert hoppers; BigDog.</td>
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<td>[43]</td>
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<td>2/1</td>
<td>4.2 Spring-loaded inverted pendulum (SLIP). 4.3 RHex; CPGs.</td>
<td>[24]</td>
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<td>[2];[29]</td>
<td>[1];[18]</td>
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<td>2/3</td>
<td>5: Dynamics of (flapping) flight&lt;br&gt; 5.1 Blade element method.</td>
<td>[15]</td>
<td>[3, 13]</td>
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<td>[16]</td>
<td>[51, 19, 39]</td>
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<tr>
<td>2/8</td>
<td>5.2 Passive dynamics.</td>
<td>[56]</td>
<td>[4, 40]</td>
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<td>5.3 Controllability.</td>
<td>[46]</td>
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<td>2/15</td>
<td>** No class. (Presidents’ Day.) **</td>
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<td>2/17</td>
<td>6.2 Gradient-based methods.</td>
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<td>2/22</td>
<td>6.3 Genetic algorithms.</td>
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<td>2/24</td>
<td>7: Kinodynamic planning&lt;br&gt; 7.1 Motion planning for fully-actuated robots.</td>
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<td>3/1</td>
<td>7.2 Rapidly-exploring Randomized Trees (RRTs).</td>
<td>[33]</td>
<td>[52, 8, 34]</td>
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<td>3/3</td>
<td>Review; Future directions&lt;br&gt; TBA</td>
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<td>3/8</td>
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<td>3/10</td>
<td>Final project presentations.</td>
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† Use “References” (on pages ahead) as a key to the Readings.
References


(Last revised January 15, 2010)


