Haptics is to touch, as optics is to sight.

Instructors: Prof. William Provancher, MEB 2136, 581-4119, wil@mech.utah.edu (I greatly prefer you contact me during office hours or by email)
Prof. Jake Abbott, Ken 138, 585-6672

Office Hours: TBD and by appointment (please email in advance)

Units: 3

Meeting Sessions: Tuesday and Thursday, 10:45am-11:35am, Room MEB 3147

Lab: MEB 2172 (Small Robotics Lab)

Reference Texts:
• Human Haptic Perception Basics and Applications. Grunwald, Martin (Ed.) 2008
• Haptic Rendering: Foundations, Algorithms, and Applications by Ming Lin (Editor), Miguel Otaduy (Editor) 2008.

Course Website: http://mech.utah.edu/haptics

Prerequisites: Robotics (ME5220/6220), Advanced Controls (ME5200/6200) (or concurrent with Intro to Robot Controls (ME5960/6960), C programming (CS1000 or better)
(or most of the above and permission of an instructor)

Course Summary
This course will give students a broad overview of the topic haptics, which is the study of touch: touch sensing, perception, cognition, and feedback. The course is organized into two halves where the first half of the course aims to rapidly bring students up to speed with the basics of haptics through lectures, homeworks/labs, readings on classical and current topics in haptics. Through homework lab exercises, students will learn to program basic feedback behaviors with a haptic device. The focus of the second half will be a term project; however, students will continue to meet during class to discuss readings (and perhaps for additional lectures). Through readings and conducting their own projects, students will learn to think critically about prior work presented in the haptics literature as well as their own work and begin to abstract ideas from prior work to form their own research hypotheses. See the course website for more details. (Note that “first half” of the course really means the first ~9 weeks of the course, before spring break)

Course Objectives (Course learning outcomes)
1. Provide a broad overview of haptics through readings and lectures
2. Provide students with a hands-on opportunity to program a haptic device
3. Read and discuss important papers relevant to current haptics research
   a. Begin to think critically about the haptics literature
   b. Begin to abstract ideas from prior work and other fields to formulate new research
4. Provide hands on experience with haptics research through a term-based research project.
   a. Propose and present a project to the class and peers

Acknowledgement
We would like to acknowledge the many colleagues whose course materials were borrowed and adapted in putting together this course, namely: Drs. Allison Okamura (JHU), Katherine Kuchenbecker (U Penn), Francois Conti, Federico Barbagli, and Kenneth Salisbury (Stanford), Ed Colgate (Northwestern), Hong Tan (Purdue), Blake Hannaford and G. Sankaranarayanan (U. Washington), and Karon MacLean (UBC).
Course Schedule & Topics
The following topics are intended to be covered. Each topic as listed below will cover roughly 1 class period. **Reading assignments** will be made in each lecture that **should be read before the next lecture.**

1. Overview of course and haptics,
2. Overview of human haptic sensing, neurophysiology and psychophysics
3. Physical Haptic Systems
4. Overview of dynamics/controls & terminology
5. Stability analysis (1)
6. Device design (1) - haptic devices and tactile devices
7. Fundamentals of teleoperation and control (1)
8. Fundamentals of teleoperation and control (2)
9. Device design (2) - haptic devices and tactile devices issues in device design for humans
10. Issues in device design for humans
11. Psychophysics (2) and experiment design
12. Haptic rendering (1)
13. Haptic rendering, (2) -- finish above topics, plus haptic shading
14. Catch up, plus 5-min student project presentations
15. Stability analysis (2)
16. Improvements in haptics
17. Modeling humans (limbs and system ID)
18. Event-based haptics
19. Haptic rendering (3)

Homework/Labs
There will be roughly 7-10 homework assignments distributed over the first half of the course. Some of these homeworks will be lab exercises performed with haptic devices that are available in the “Robotics Lab” in MEB 2172. These exercises will be completed in 2-person teams and will primarily involve programming a haptic device, such as a Falcon or Haptic Paddle using C/C++ and Microsoft Visual Studio 2008. Other homework assignments will be individually completed unless otherwise noted, and will involve applying knowledge gained from lectures and readings.

The instructors will establish a time for at least one of their office hours to be held in the Robotics lab, to facilitate answering lab related questions. Otherwise, students will complete labs independently on their own schedule with 24 hour access provided to the robotics lab by your student ID and card reader (please email Dr. Provancher your full name, UID # in the form u0xxxxxx, and card# in the form xxxx xxxx xxxx xxxx).

Class participation
Students will be expected to read articles that are assigned in each lecture for the next lecture and then be prepared to participate in discussions or state what kind of questions they have. This will facilitate the coverage of lecture material in the first half of the course. 1-3 articles will be assigned to read for each class meeting (assigned in the prior lecture) for the first half of the course.

Class meetings in the second half of the course will be used primarily to have more in-depth discussions of articles, rather than having formal lectures. 2-3 articles will be assigned to read for each class meeting for the second half of the course. In these weeks, students will be asked to present an overview of assigned articles and state points of interest from an article. Assignments of which student(s) will lead the discussion for a particular article will be assigned at least a week in advance of the class meeting in which an article will be discussed.
Course Project
The term project constitutes a major portion of each student's grade. Students can choose projects from a list of suggested projects provided by the instructors, or work with the instructors to work on some other haptic related project of interest. The project will require significant planning, starting the 2nd or 3rd week of class and will be the students' primary focus in the second half of class. The course project can be worked on individually, but is recommended to be worked on in teams of 2 or 3. Your team mates may be the same as who you worked with for the lab-based homework assignments. Further details concerning projects will be discussed in class and be posted on the course website.

Grading

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<tr>
<th>Course</th>
<th>35% Homework/Labs</th>
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<tr>
<td>15% Class Participation</td>
<td>(Readings and discussions)</td>
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<tr>
<td>35% Project</td>
<td>(33% of this for the final wiki report)</td>
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<tr>
<td>15% Presentation</td>
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This class will be graded on a straight scale where 95 = A, 90 = A-, 88 = B+, 85 = B... However, if scores are lower than expected (i.e., below a B or B+ average), grades may be curved up.

Late Policy

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<tr>
<th>1 day</th>
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<td>2 days</td>
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<td>&gt;5 days</td>
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Classroom conduct
Use of cellular phones and text messaging is strictly prohibited in class. Laptops may only be used to take notes. If you are playing games, browsing the web, emailing, etc., you will be asked to stop or to leave the classroom. This is not respectful towards your classmates or teaching team. Please also keep classroom conversation focused on topics specified in class.

Policy on collaboration (cheating)
Students are invited to discuss how to complete assignments, however, must complete work independently (or in pairs, as appropriate). If you turn in the same work as someone else, all parties will receive a zero for the assignment. A 2nd offense will mean a visit to the ME Dept. Academic Advisor and possible suspension.

Americans with Disabilities Act of 1990
The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.