Project: Haptic System and Study

The purpose of this project is for you to develop the design, control, and dynamic system analysis of a haptic device. The project must result in a system with bidirectional haptic interaction between a person and a robot/intelligent agent or a augmented, remote, or virtual environment, as well as a study that shows something about the control and/or system dynamics. The device must also have a purpose, such as understanding about human perception, answering a question about haptic device design, or demonstrating a useful application. Beyond that, the options are quite open. Your project must:

- be clear in its objectives: know how you define success!
- be informed by a thorough literature search
- be easily used and understood by a haptics novice on demonstration day
- have high “production values” (haptic especially, and also visual and aural where applicable)
- include a controls/dynamic systems study

Teams

The project is to be completed in teams of three. (Teams of three are desired for a reasonable overall number of teams, to allow the teaching staff to devote sufficient time and resources to each project. Two teams of four are allowed/necessary due to the number of students in the class.) All team members will receive the same grade for the project. We encourage project teams consisting of people with diverse backgrounds and skills.

Initial Ideas and Review with Teaching Staff

By Wednesday, May 8, identify your team here: https://tinyurl.com/ME327-Spring2019-ProjectTeams

Have a 1-hour brainstorming session with your team, and develop a list of at least 5 different haptic devices you could build for this project. For each haptic device, identify different concepts pertaining to the dynamic behavior and control schemes that may be involved, and identify a study you could perform that would give insight into either the haptic device performance or an aspect of the application.

By Monday, May 13, at 5 pm: Create a team in Gradescope and submit to the “Project Team and Initial Ideas” assignment. Submit (as a single pdf file) a document with writing/sketches to describe the outcome of your brainstorming session electronically. Be prepared to discuss your ideas with the teaching team.

We will schedule a meeting with your team during class time on May 14 & 16 to discuss your project plans. Together with the teaching staff, you will devise a set of checkpoints, i.e. milestones you need to have accomplished on each of the checkpoint dates listed below. The checkpoints will be included in your project proposal (see next section).
- Proposal due on Gradescope: Friday, May 17 at 5 pm
- Checkpoint 1 wiki report due: Friday, May 24 at 5 pm
- Checkpoint 2 wiki report due: Friday, May 31 at 5 pm
- Demonstration: Tuesday, June 4 (during class time)
- Final wiki report: Wednesday, June 5 at 5 pm

The checkpoints and final report will be posted on the project wiki pages at http://charm.stanford.edu/ME327 (we have posted examples from a previous class)
Project Proposal

Your project proposal is due on Friday, May 17 at 5 pm on Gradescope. Your proposal must be typed and easy to understand. The proposal should address the following questions and requirements, in this order:

❑ **Team Members and Skills:** Who is on your proposed team? What specific skills and knowledge can each person contribute to the team in the context of this project?

❑ **Topic and Motivation:** What haptic device design/implementation and controls/dynamic systems study will you perform? Why have you chosen this?

❑ **Previous Work:** Do a search for publications (conference papers, journal articles, and book chapters) and media reports that are relevant to your proposed project. Pick five or more of the most relevant, recent sources. For each chosen source, provide the following information:

  **The formal citation and a URL link to the publication.** At a minimum, this should include author names, title, source (proceedings, journal, or book), page numbers, and year. See the style used to list readings on [http://me327.stanford.edu](http://me327.stanford.edu). Also provide a direct link (URL) to the online resources.

  **A summary of what the previous work reports.** This must be in your own words, not copied from the paper, and it should be thorough. You will need to read the paper entirely to understand what it deals with. Talk with your teammates and the teaching staff to figure out confusing aspects. You may wish to divide up the papers between your team members to distribute the workload, but you should all read and discuss the summaries you write. Be sure to state of what implications this paper has for your project.

❑ **Identify a relevant paper for presentation in class.** You will select this paper from the set of papers presented at the 2018 IEEE Haptics Symposium Conference. This can be one of your 5 papers above, or you can add a 6th paper if necessary. Note that your presentation (10% of total grade) will be evaluated on organization, subject knowledge, slides, presentation skills, and interactivity. The teaching staff will review your proposed paper for presentation and assign you a presentation date.

❑ **Plan (1 page):** Describe what your team proposes to do. What do you seek to design and discover over the course of your project? This should be carefully thought out and clear. It should be a rational, clever, plan that has a very high likelihood of success. Include a description of what materials and resources you think you will need. Sketches will be helpful. Also include the checkpoints worked out in advance with the teaching staff.

**Materials and Fabrication Resources**

You are for the most part expected to access minimal materials needed for your project on your own, e.g. parts from your Hapkit and using the 3D printer available for this class. During the initial project meeting we will review what materials you would need. You can work on your project in the Product Realization Lab ([https://productrealization.stanford.edu](https://productrealization.stanford.edu)) and 520-145. You can store your project materials in 520-145 if desired; keep them in a box that is clearly labeled on a shelf in the alcove.

**Demonstrate your Project**

We will have a Haptics Open House on Tuesday, June 4 in 520-145 (the d’Arbeloff lab) during class time. Please reserve some time before the open house to set up, as well as afterward to clean up. At the demonstration, you will:
• Demonstrate and explain your project to the teaching staff for the functionality portion of the project grade.
• Create and hand out a flyer that gives the title of your project, your names, and an overview of the project.
• Allow visitors to try out your haptic device, while you explain your project and answer questions.

Analysis/Study

Your analysis/study should clearly explain a controls or dynamic systems aspect of your project. This analysis/study can be done at any point in the project, and if it involves data collection we anticipate that you will do this toward the end, after the haptic device is assembled and working. Be cognizant of the timeline, because the final report is due the day after the demonstration. The teaching staff will be available to provide guidance on experimental procedures, data analysis, and presentation of results on your wiki page.

Checkpoint Reports and Final Report

To properly document your project, you will create short checkpoint reports and a more detailed final report via your project wiki page at http://charm.stanford.edu/ME327. The wiki page will look like a single document with the checkpoints in an appendix at the end. See the sample page at http://charm.stanford.edu/ME327/Sample. (You will receive a login after you submit your project proposal. Note that the layout of the page will appear a little different when you are logged in versus when you are logged out. Don’t worry if the placement of the images/table of contents don’t look right when you are logged in – just make sure they look good when you are logged out.)

For each checkpoint (deadlines given above), you will update the title and summary (if needed) and add material to the “Appendix” of your team’s wiki page. For the final report (due May 5, 2019 at 5 pm), you will fill in the rest of the wiki page and leave the Appendix with the checkpoints as they were. We recommend that you do your major writing/edits in an external word processor to help you keep track of versions and do automatic spelling/grammar checking. It is easy to accidentally delete wiki text while you are editing, so make sure to keep backups!

The updates you need to make to your wiki page by the end of the project are as follows:
• Add a representative image of the overall project to the upper right corner of your wiki project page, with caption. The sample wiki page has the correct format for this – and it will be the first line in your wiki code. Note that the wiki command “[[<]]” will put a line break in your caption so you can adjust it to the width of your image.
• Make the project title larger using a single exclamation point “!” in front of it.
• Edit the title and summary to their final version, to reflect what was actually done in the project. The summary is your final short (<150 words) abstract of your project.
• Add a table of contents immediately after the abstract using the command “(\*toc\-float;)”.
• Next, place all the components of your final report. (Note that there is not a separate “final report” section, since the whole wiki page is now your final report.) Please use these specific sections:
  o Introduction: Explain the motivation for your project in terms of the educational objectives and why your haptic device is an appropriate approach.
  o Background: Explain the relevant prior work in the field of haptics and provide references. These will likely be different from the references in your project proposal. Make sure to do a thorough literature search on relevant haptic devices/application.
  o Methods: Provide a detailed description of your project, such that another student from the class could generally re-create your project/experiment from the report if necessary. (You don’t need to document every screw, but the design should be clear.) Add images and videos as needed to support the description. You can refer to downloadable drawings and code in
the “Files” section (later). You should divide this section into subsections, which can vary depending on your particular project.

- Results: Describe the results, which may include qualitative responses from users at the open house.
- Future Work: Describe how your system could be tested (e.g., through experiments if you have not already done so), how it can be improved, and how it might be applied.
- Acknowledgments: Here you can list any individuals or groups who helped you with your project. This is optional, so delete this section if you aren’t using it.
- Files: Code and drawings should be linked here. You should be able to upload these using the Attach command. If you aren’t willing to share these data on a public site, please discuss with the instructor. Also, in this section include a link to a file with a list of major components and their approximate costs.
- References: List the referenced literature, websites, etc. here.
  - Keep your Checkpoints as they are in the Appendix.

**Grading**

**General**
- Concept 15 pts.
  - Is the motivation good, and the general idea logical?
- Approach 15 pts.
  - Are the design and study approach appropriate?

**Demonstration and Study**
- Functionality 20 pts.
  - Did the system function compellingly throughout the demonstration?
- Completeness 20 pts.
  - Was the working system and study complete, compared to what proposed?

**Report**
- Technical strength 15 pts.
  - Is the report technically accurate?
- Presentation 15 pts.
  - Is it well written, with appropriate supporting images/videos?

**TOTAL** 100 pts.

These scores will take into account the difficulty of the project tackled. That said, we prefer that you aim to do a simple thing very well instead of trying to do a complicated thing and not succeed. Note that the project is 30% of your overall course grade.