

# DH2670 VT18-1

## Haptics, Tactile and Tangible Interaction 7.5 credits

Feedback from the touch modality is often taken for granted in real life but it is still not so common when interacting with computers. If you interact with an object by using a haptic device that is available today you can feel the qualities of the material of the graphical object, like softness, texture, weight, or viscosity. Magnetism and pulling forces can also be represented and felt physically. Haptic feedback thus makes it possible to feel graphical objects as if they were real physical objects and that makes the objects easier to manipulate. In this course the theoretical framework for haptic perception and cognition is presented. Methods for design and evaluation of different haptic interfaces as well as other tactile interaction methods are described. Application areas that are relevant for haptic technology are reviewed, like for example computer games, computer support for collaboration, scientific visualization, and medical simulation. Students will learn how to design and program their own applications in laboratory assignments and a larger project, with haptic devices.

Level: C

Grade scale: A, B, C, D, E, FX, F

### Goals

After the course students will be able to:

- describe the functionality of the sense of touch both perceptually and cognitively.
- explain how haptic feedback can be used in different application areas.
- use specific guidelines for haptic interface design.
- program haptic applications.
- apply HCI-methods for evaluation of haptic applications.

### Content

This is an advanced course in human-computer interaction about methods for design, development and evaluation of haptic and tactile interfaces in different application areas such as computer games, computer supported collaboration, scientific visualization, medical simulation, and assistive technology.

The frontline research results regarding human touch perception is presented as well as how the human brain processes these perceptual events cognitively. An interesting question is how humans can use more of the brain capacity when interacting with computers if more modalities than vision can be utilized?

Guidelines for how haptic interfaces should be designed are presented in the course and students practise to use these in the project and during laboratory sessions. In

the projects, HCI-methodologies are applied in innovative ways in order to evaluate haptic interfaces.

### **Eligibility**

Single course students: 90 university credits including 45 university credits in Mathematics or Information Technology. Swedish B or equivalent and English B or equivalent.

### **Prerequisites**

Knowledge in human-computer interaction from the Human-Computer Interaction, Introductory Course (DH2620) or a similar course.

### **Literature**

The literature used in the course is a collection of articles describing theory, research and application areas in the area of 3D haptics. The articles are available on Canvas, under "Course literature".

### **Examination**

- INL1 - Assignment, 1.5 credits, grade scale: A, B, C, D, E, FX, F
- LAB1 - Laboratory Assignments, 2.5 credits, grade scale: P, F
- PRO1 - Project, 3.0 credits, grade scale: A, B, C, D, E, FX, F

### **Requirements for examination**

The course is examined by a Project (PRO1, 3 hp) with an oral presentation, and a project report for each group, an assignment (INL1, 1,5 hp) that is an individually written literature report, and laboratory assignments (LAB1, 2,5 hp). Note that some compulsory deliverables are made individually and some are made by entire project groups.

The following sessions are compulsory to attend. The dates are shown in the schedule:

- Lecture: haptic programming 1-2
- Laboratory 1
- Laboratory 2
- Laboratory 3
  
- Seminar, discussing the progress report and demonstrations of the project application (PRO1)
  
- Oral presentation of the project (PRO1). You have 15 minutes for your PPT presentation and all group members should present some part. Demonstration of the application will be made after the presentation in the computer room Karmosin so prepare that in advance.

The following deliverables are compulsory. The dates are shown in the schedule:

1. *Project idea* 1/2 A4-sida (group task, PRO1 – Project)
2. *Individual literature review* max 5 A4 pages (individual task, INL1 - Assignment)
3. *Project plan* 1 A4- page (group task, PRO1 – Project)
4. *Progress report* 2 A4- pages (group task, PRO1 – Project)
5. *Project presentation* Oral presentation of the project (group task, PRO1 – Project)
6. *Project report* max 10 A4 pages (Times, font size 10) ACM style pages (group task, PRO1 – Project)

## **Labs**

The descriptions of the Laboratory assignment 1 (introduction to Chai3D and force effects), Laboratory assignment 2 (experimenting with haptic properties and grasp functions) and Laboratory assignment 3 (introduction to tactile interface programming), are found under “Lab assignments” in Canvas.

The programming will be in C++ and Chai3D. Information about haptic programming can be found at the course wiki: [dev.forsslundsystems.se/dh2660](http://dev.forsslundsystems.se/dh2660)

## **Individual literature report**

Many studies investigating different aspects of haptic perception and feedback can be found today. Many researchers have conducted/conduct basic research on e.g. illusions or how we process information conveyed through the touch modality. Others focus on algorithms for maximum realism in the force feedback and many researchers implements and evaluate haptic/multimodal environments for specific purposes and target groups. During recent years the interest has also grown with regard to haptic feedback in collaborative interfaces. The aim of the individual literature assignment is that you should focus on a specific area, related to the course content. Some examples of areas are given above, but you are free to choose something else as long as there is a clear connection to haptics/the sense of touch. The resulting report should be 5 A4 pages long excluding the reference list.

INL1 consists of one assignment (Assignment 2 in Canvas).

### **Assignment 2. Individual literature review, 5 A4 pages (individual task, INL1)**

You should start the review process as soon as possible, since the review task will take quite a while to perform. The first thing you need to do is to decide the topic for the review and decide on the specific research question you want to answer. This step is important, since the research question you choose will guide your literature search and the discussion topics. In an early stage you should also decide what limitations you want to use – what parts, relevant to the research question, will you not focus on? When you have defined your focus you should start searching for

relevant literature, summarize it in a theoretical background and then discuss the material in relation to your research focus.

The final report (including an introduction with a clearly stated research question and delimitations, theoretical background and deep discussion) shall be uploaded in Canvas, under "Assignment 2". Within the scope of this assignment you have the chance to deepen your understanding about several aspects of haptic feedback as well as get suggestions on interesting references to use in your project reports.

The following grading criteria will be used:

**Coverage** - it is important that you cover all important aspects of your research questions (or state in your limitations that some are intentionally left out).

**Scientific quality** - you should reference correctly when referring to other sources, you should clearly relate your own discussion to the theory and you need to be clear about the purpose and focus in your introduction (among other things).

**Depth of discussion** - we want you to draw your own conclusions from the theory and ideally look at it from a broader perspective. Connect your discussion to the theory and talk about

what the results from your review really means. You can also compare different aspects and propose future research based on your findings, among other things.

**Clarity** - it is of utmost importance that you are clear about the focus in the introduction and that the structure of your report makes it easy to follow and understand. Also try to avoid vague terms and clearly define terms that the average reader is probably not familiar with.

**Reflection/understanding** - the report should be written in such a way that is shows that you have gained an understanding of the particular aspect. The emphasis in the discussion should also be on reflection and reasoning (compare depth of discussion above).

**Focus** - the report should be focused around your research question(s), don't deviate from them. Thus, you should present a deep investigation of a narrow area.

**References** - your references should be of good quality, meaning emphasis on articles and proceedings highly relevant for your particular focus.

**Language** - make sure the language is as clear and free from errors as possible, that you use terms relevant for your focus and that you stay objective.

During the grading of the individual reports most emphasis will be placed on your use of relevant terms related to the topic of choice, the quality of the discussion about the gathered material and your understanding of the topic. The grading scale is A-F.

## **Project task**

In this course you will work in groups of three students in projects in which you will design, develop and evaluate a haptic application. You can also choose to develop

an existing haptic application further and add functionality and then evaluate the resulting design. Another alternative could be to evaluate an existing haptic system and redesign it based on the results from the evaluation. You should have a specific target group in mind when developing the system. It is preferable if the group members have different profiles ranging from programming to design and HCI-evaluation background. Project ideas will be found at Canvas.

The work process is the following:

**Assignment 1. Project idea, 1/2 A4-page (group task, PRO1 – Project)**

Form groups of three students in each and decide what haptic application to design/redesign/evaluate. It is compulsory to review your project idea critically before you start the project. What problems with the feasibility of the project do you anticipate? What basic user needs will the application fulfil? What is the target user group you have in mind that will use the application? How will you evaluate the application in order to verify its validity, what methods will you use? Describe a user scenario. Upload a description of the project idea, give it a title, write the group number, and include the names of the project members, at Canvas (1/2 A4). This project idea has to be approved by Eva-Lotta before you continue the work, and you will get feedback on it as well via Canvas.

**Assignment 3. Project plan, 1 A4-page (group task, PRO1 – Project)**

Describe how you plan to conduct the project. The apparatus and other equipment that you need to do the project should be described. Write down the different steps in the work process that you can anticipate and what methods you will use in the project both regarding design, development and evaluation. Describe the main functionality that the application will have. How do you plan to design the haptic feedback that the functionality will have? Motivate the haptic qualities (surface friction, softness/hardness, magnetism, rubber band, weight, texture, shape etc) that you have chosen to represent the different parts of the interface with. You should also describe the methods you plan to use for the evaluation of the system. What tools will you use for the evaluation (comparative experiment, think aloud, interview guide...) and how will you record the test sessions? To get feedback on the design of interview questions and other test materials you will have to attach these at this point. Irrespective of what project idea you are working on, you have to review the literature in the area, find complementary literature from the library or digital library (<http://dl.acm.org/> , access at computers at KTH). You should refer to *at least two* other books or scientific articles other than the course literature. Upload your plan (1 A4 page) at Canvas. This project plan has to be approved on by Eva-Lotta before you continue the work, and you will get feedback on it as well via Canvas.

**Assignment 4. Progress report, 2 A4-sida (group task, PRO1 – Project)**

Write a progress report (2 A4) that will be discussed in a seminar with all students and teachers. The progress report should include everything you have done so far in the project. You should be able to demonstrate the application you focus on in the project in the computer room Karmosin. We will discuss problems and alternative solutions in order for you to get help to achieve the best results possible in the

respective project. It's also an opportunity to get feedback on what to improve before the final oral presentations of the projects. Upload your progress report (2 A4 pages) at Canvas.

**Assignment 5. Project presentation, (group task, PRO1 – Project)**

Oral presentation of the Project (PRO1). You have 15 minutes and all group members should present some part.

**Assignment 6. Project report, max 10 A4 pages (Times, font size 10) (ACM style) excluding attachments (group task, PRO1 – Project)**

You should write a project report (see instructions below). You have one week after the oral presentation of the project to make improvements to the project report, use the feedback you get after the presentation. The project report should include all parts of the work you have done in the project. You should also reflect on your own ability to perform the project task – did you choose the right methods, what unexpected things happened, what problems occurred in developing the application or in the evaluation?

**Principal rules for the project report**

The project report together with your individual literature report will make up your final grade on this course. The following are the *principal rules*:

The project report should be max 10 A4 pages (Times, font size 10). The report should be in the CHI format.

Raw data, interview guides, protocols and so on can be attached. The birth date and names of project members should be present at each page as well as the title of the project and the group number. It is ok to write the report in Swedish. Upload the project report at Canvas no later than the date in the schedule at 24.00 o'clock (12.00 pm). This is a strict deadline.

- Oral presentation of the Project (PRO1). You have 15 minutes and all group members should present some part.
- Demonstration of the applications should be made in the computer room Karmosin.

**The project report should include the following information:**

IMPORTANT! The birth date and full name of project members and the title of the project as well as project number should be at each page.

*Abstract*

Sum up the work that has been done including a description of the application that has been designed. Describe the most important results.

*Introduction*

Present the domain of the application and motivate why it is interesting and relevant and what user needs the project addresses. A research question is always good

here. Describe the application that was developed and what features that was evaluated. What target group have you designed for and why would they be interested in using the system?

### *Background*

What earlier research has addressed the domain your project work is about. Reference to some books and articles. Here you can, if relevant, use some of the material you have from the respective individual reports.

### *Method*

Present the design concepts you have worked with and motivate the haptic features and functionality that you have chosen. Describe the methods you have used when developing the system. What design decisions did you have to make in the different parts of the process of the project and what facts or kinds of feedback were they based on? Give an account of what criteria for usability you have used, what methodology you have used, the procedure of testing/evaluation, the tested interface, the apparatus used, the tasks that users did and ethical aspects (attach interview guides etc.).

### *Results*

Describe in a detailed manner the application you developed. Take extra care when explaining the haptic features, their functionality and the haptic qualities chosen and how you designed those. What alternative design solutions did you consider and why did you decide on the ones you implemented? Describe the method of analysis regarding the user evaluation of the system. Report on the results from the evaluation in a clear and complete way in diagrams and tables. The qualitative results should be in accordance with general principles of qualitative analysis (See eg. Annika Lantz: Intervjumetodik ISBN: 91-44-38131-X).

### *Discussion*

Reflect over the strengths and weaknesses in your project work, what could have been improved. Discuss your results in relation to your initial goals and research questions and in relation to previous research that you have referenced in the background. Sum up the most important conclusions and give recommendations for changes that would improve your design.

*Reference* in accordance with established formats. Web pages will not be considered as proper references.

## **Examination criteria for the project report**

- How well the students have covered the whole project work, introduction, background including relevant literature references, research/design question, development including design decisions, method including evaluation, results and discussion with conclusions and reflections.

- If relevant course literature and other scientific literature has been referenced and used in the project work. If the group has based their work on what is known in science and current technology and has been able to further advance the field regarding the technology or /and methodology.
- How well students have understood the meaning of and can discuss core concepts in the area of haptics, human computer-interaction and interaction design.
- How well the method, design decisions and work process has been described both for development of applications and for the evaluation.
- How well the results are reported. For the application development part the system should be clearly described in terms of functionality, programming and what the user experience when using the system. For the evaluation, the results should be clearly reported with tables and diagrams and textual descriptions such that it is possible to judge if the analysis has been made correctly.
- How advanced the evaluation performed was methodologically and regarding the way in which it has been executed.
- How advanced the system development was regarding the design methodology and programming.
- If the students have been able to discuss their work regarding the applicability of the work, whether the needs of the target group have been met. Also, if the relevant research/work reported in the background has been related and compared to the results of the project work. Finally, how the system developed in the project could be improved based on the results from the evaluation.
- How well students can reflect on strengths and weaknesses in the project work performed.
- If ethical principles have been followed correctly in the project, as for example informing the participants in evaluations of their right to not participate in evaluations and obtaining consent from participants or their guardians when needed (e.g. under aged).
- How well the report is written regarding the language used and the structure of the report.

**Offered by**

CSC/Human-Computer Interaction

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In this course all the regulations of the code of honor at the School of Computer science and Communication apply, see:  
[http://www.kth.se/csc/student/hederskodex/1.17237?l=en\\_UK](http://www.kth.se/csc/student/hederskodex/1.17237?l=en_UK).