Human-Computer Interaction (CE - HCI)

CE-HCI0. History and overview of human-computer interaction [core]
CE-HCI1. HCI in computer engineering [core]
CE-HCI2. Foundations of human-computer interaction [core]
CE-HCI3. Building a simple graphical user interface [core]
CE-HCI4. Human-centered software evaluation [elective]
CE-HCI5. Human-centered software development [elective]
CE-HCI6. Interactive graphical user-interface design [elective]
CE-HCI7. Graphical user-interface programming [elective]
CE-HCI8. Graphics and visualisation [elective]
CE-HCI9. HCI aspects of multimedia systems [elective]

The design and development of displays, alarms and interfaces for small or large screens (some of which may involve interaction) is an activity captured in the study of the human computer interface and in a study of human computer interaction. This discipline is increasingly software based and design needs to be guided by insights from psychology and informed by an appreciation of human diversity including matters such as coloured blindness and deafness; in these circumstances multimedia approaches often have a role to play. It is important to note that in certain applications there are crucial requirements for reliability and other kinds of performance which have implications for such matters as safety, security, etc.

The list of topics below is intended as an introduction to human-computer interaction for computer engineering students. Emphasis is placed on understanding human reactions to displays of various kinds and on human behaviour in the context of interactive objects. Based on these, students need to understand the principles associated with the evaluation of interfaces including those that embody interaction.

The creation of interfaces is an important specialist topic with its own life cycle, its own techniques and its own methodologies. Students need to know the principles and guidelines that reflect best practice in the design, development and maintenance of interfaces for multiple types of systems.

CE-HCI0. History and overview of human-computer interaction [core]

*Suggested time: 1 hour*

*Topics:*
- Indicate some reasons for studying human-computer interaction.
- Highlight some people that influenced or contributed to the area of human-computer interaction.
- Indicate some important HCI considerations such as foundational elements, ergonomic designs, and graphical interfaces.
- Contrast ways in which engineering design should reflect human interaction.
- Mention some advantages of small-screen designs versus large-screen designs.
- Describe how one would evaluate an engineering design vis-à-vis HCI compatibility.
- Explore some additional resources associated with human-computer interaction.
- Explain the purpose and role of human-computer interaction in computer engineering.
Learning objectives:

- Identify some contributors to human-computer interaction and relate their achievements to the knowledge area.
- Define HCI.
- Explain the reasons for proper HCI designs in engineering.
- Provide a good reason for having a small-screen graphical user interface.
- Provide a good reason for having a large-screen graphical user interface.
- Give an example on how one might evaluate an engineering design using some principles of HCI.
- Describe how computer engineering uses or benefits from human-computer interaction.

**CE-HCI1. HCI in computer engineering [core]**

*Minimum core coverage time: 2 hours*

**Topics:**

- Illustrations of the use and relevance of HCI in a computer engineering context: to include textual displays, displays that reflect change or motion, displays in a mobile context, multimedia possibilities.
- The influence of large scale and small scale display screens and other aspects of the context in which information has to be displayed.
- Interactive systems and the special challenges these provide.
- Computing concerns associated with the different kinds of human computer interaction taking into account human diversity.
- The consequences of multimedia development for software and systems.

**Learning outcomes:**

1. List the desirable characteristics of a range of interfaces including displays of various kinds, as well as systems that exhibit interaction.
2. Identify the impact of a range of interface considerations on the software used in the implementation of interfaces.

**CE-HCI2. Foundations of human-computer interaction [core]**

*Minimum core coverage time: 3 hours*

**Topics:**

- Motivation: the importance of the human interface in computer engineering; issues of small screens and larger screens.
- The range of possibilities: text-based systems, use of graphics, sound, animation, video; the possibilities of multimedia. Strengths and weaknesses of individual approaches.
- The web as an example of an interface.
- Human-centered development and evaluation.
- Human performance models: perception, movement, and cognition; culture, communication, and organizations.
- Accommodating human diversity; the role of multimedia.
• Principles of good human computer interaction design in the context of computer engineering; engineering tradeoffs
• Introduction to usability testing
• The role of and use of a range of tools

Learning outcomes:

1. Develop a conceptual vocabulary for analysing human interaction with software: to include terms such as affordance, conceptual model, feedback.
2. Summarize the basic science of psychological and social interaction relevant to the development of human computer interfaces.
3. Differentiate between the role of hypotheses and experimental results recognising the role of correlations.
4. Distinguish between the different interpretations that a given icon, symbol, word, or colour can have in (a) different human cultures and (b) in the context of human diversity.
5. Create and conduct a simple usability test for an existing software application, taking into account human diversity.

CE-HCI3. Building a simple graphical user interface [core]

Minimum core coverage time: 4 hours

Topics:

• Illustrations of developments of graphical user interfaces including: textual displays; interfaces that include alarms; displays that exhibit motion; displays that exhibit interaction.
• Principles of design using graphical user interfaces (GUIs); principles associated with interaction including fault tolerance
• GUI toolkits
• Principles associated with use of sound and multimedia in different contexts; use of relevant tools
• Principles of design for web interfaces; web interfaces for small screen and mobile devices
• Use of relevant tools

Learning outcomes:

1. Identify several fundamental principles for effective GUI design relevant for different applications in computer engineering.
2. Use a GUI toolkit to create a simple application that supports a graphical user interface.
3. Illustrate the effect of fundamental design principles on the structure of a graphical user interface.
4. Conduct a simple usability test for each instance and compare the results.
CE-HCI4. Human-centered software evaluation [elective]

Topics:
- Setting goals for evaluation
- The range of evaluation criteria including learning time, task time, completion time, acceptability; the strengths and weaknesses of the different criteria
- Evaluation without users: walkthroughs, Keystroke Level Model (KLM), guidelines, and standards
- Evaluation with users: usability testing, interview, survey, experiment

Learning outcomes:
1. Discuss the full range of evaluation criteria appropriate for one of a range of computer engineering applications
2. Conduct a walkthrough and a Keystroke Level Model analysis.
3. Summarize the features of the major guidelines and standards associated with human-centred software evaluation
4. Evaluate one of a range of existing interactive system with appropriate human-centered criteria and a usability, giving reasons for selection of techniques.

CE-HCI5. Human-centered software development [elective]

Topics:
- General guidelines associated with the structure of large systems that embody significant HCI code; separation of concerns, issues of maintenance; differing development life cycles.
- Approaches, characteristics, and overview of processes associated with human centered software; systems that offer interfaces in different natural languages
- Functionality and usability: task analysis, interviews, surveys
- Specifying presentation and interaction; techniques and approaches; software support
- Prototyping techniques and tools
  - Paper storyboards
  - Inheritance and dynamic dispatch
  - Prototyping languages and GUI builders
- Quality considerations
- Standards and guidelines

Learning outcomes:
1. Explain the basic types and features of human-centered software development.
2. State three functional requirements and three usability requirements.
3. Specify an interactive object using one of the common methods as well as appropriate standards or guidelines.
4. Demonstrate the application of guidelines and fundamental principles in developing one of a range of possible computer engineering applications that rely on a human computer interface.
CE-HCI6. Interactive graphical user-interface design [elective]

Topics:
- Choosing interaction styles and interaction techniques appropriate to applications
- HCI aspects of common widgets
- HCI aspects of screen design: layout, colour, fonts, labelling
- Handling human failure
- Beyond simple screen design: visualization, representation, metaphor
- Interfaces for computer engineering tools that utilise databases
- Multi-modal interaction: graphics, sound, and haptics
- 3D interaction and virtual reality

Learning outcomes:
1. Summarize common interaction styles.
2. Explain good design principles of each of the following: common widgets; sequenced screen presentations; simple error-trap dialog; a user manual.
3. Design, prototype, and evaluate a simple 2D GUI
4. Discuss the challenges that exist in moving from 2D to 3D interaction.

CE-HCI7. Graphical user-interface programming [elective]

Topics:
- User interface management systems: different approaches; responsibilities of the application and of the application.
- Kernel based and client server models for the user interface
- Dialogue independence and levels of analysis, Seeheim model
- Widget classes; aggregation of widgets
- Event management and user interaction
- Geometry management, constraint based approaches
- GUI builders and user interface programming environments; callbacks and their role in GUI builders
- Cross-platform design

Learning outcomes:
1. Compare the event-driven paradigm with more traditional procedural control for the user interface.
2. Identify common differences as well as similarities in cross-platform user interface design.
3. Demonstrate an ability to outline an approach to interface design for a computer engineering application that utilises an appropriately chosen selection of technologies from event management, widgets, geometry management and GUI builders.
CE-HCI8. Graphics and Visualisation [elective]

Topics:

- Computer graphics
  - design of models that represent information and support the creation and viewing of images
  - possibilities to include two dimensions, three dimensions, shading, animation
  - graphical display devices
  - packages that support graphical design
- Visualisation
  - the nature of computer visualisation
  - the role of visualisation in communicating information in a dataset to an interested party
  - use of tools to accomplish this
- Virtual reality
  - the nature of and benefit of virtual reality; its limitations
  - components of a typical virtual reality situation, e.g. graphics, sound
  - the nature of interaction with a user
  - virtual environments
- Computer vision
  - role in deducing properties and the structure of a three dimensional world from one or more two dimensional images
  - tools used for this and their role in computer engineering

Learning outcomes:

1. Understand the nature of graphical design and implement a simple graphical activity using a standard software package.
2. Appreciate the role of visualisation technologies and demonstrate them through the development of a simple application.
3. Appreciate the benefits of virtual reality and the nature of the advantages this offers.
4. Demonstrate a simple application of computer vision technology in a computer engineering context.

CE-HCI9. HCI aspects of multimedia systems [elective]

Topics:

- The use of multi-media in computer engineering applications; the benefit, especially in reinforcement and in a context of human diversity
- The implications of performance requirements associated with multi-media for the hardware, the software and communications aspects of computer based systems
- Considerations resulting from interaction of various kinds
- Design concerns associated with the development of multi-media interfaces
- Implementation issues; synchronisation aspects, tools
- Quality considerations
- Guidelines and standards
Learning outcomes:

1. Select system components which are suitable for the realisation of multi-media interfaces of high quality
2. Design and develop a multi-media interface for a simple computer engineering application.