Social Robotics

PDEEC PhD course on Social Robotics

João Silva Sequeira[1]

[1]Instituto Superior Técnico
Institute for Systems and Robotics

Spring 2021

TÉCNICO LISBOA

Human memory – Teaser

- Given the audience models, is it a good strategy to have a social robot repeating key ideas ?
- If the answer is affirmative, is there a probability distribution that can be used to model the repeating behavior ?

Human-Computer Interaction – Loose ends

- Interfaces are designed with a focus point; often assuming a specific mental model
- Humans have “ways” of executing tasks; often relying on their mental models
- The relation between human and computer is observable and measurable
  - There are time intervals involved (duration, set up, close down, ...)
  - The amount of movement can be measured (spatial displacement, ...)

Usability of Interfaces in HCI I

- Aims at measuring the quality of an interface
- Oriented to the implementation
- Defined in ISO 9241-11 (see [Bevan,Macleod,1994])

  “The effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments”

  See for instance [Seffah et al,2006] for an additional discussion on several ISO standards related to usability

Usability of Interfaces in HCI II

- Usability can be defined by a set of attributes such as (see [Seffah et al,2006] for additional attributes)
  - **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design ?
  - **Efficiency**: Once users have learned the design, how quickly can they perform tasks ?
  - **Memorability**: When users return to the design after a period of not using it, how easily can they reestablish proficiency ?
  - **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors ?
  - **Satisfaction**: How pleasant is it to use the design ?

Usability of Interfaces in HCI III

- A typical recommendation is to include usability goals already at design time, [Bevan,Macleod,1994]

  In addition, usability measures can also be fed back at runtime, e.g., to change the focus of the interface

Utility of Interfaces in HCI

- Oriented to the results – high utility means that it does the job
- Utility and usability should be considered equally important

  What's preferable
  - To have a high usability interface that does not help achieving the mission?
  - To have a low usability interface that, nonetheless, manages to drive the user successfully to the goal?
- Some authors include utility as an attribute of usability

Evaluation of Motor Behaviors in HCI I

- Motor behaviors = Movement done while using the interface
- Objective: To develop performance metrics for motor behaviors such that the quality of interaction can be assessed during the execution of a task, [Carroll,2003]
- Hick-Hyman model for the time to make a decision

$$RT = a + b \log_2 (n + 1)$$

with a, b constants empirically determined and n the number of stimulae

Evaluation of Motor Behaviors in HCI II

- Keyboard model (1980) or Keystroke-Level Model (KLM); developed to predict the time it takes to a human to complete a task using a computer keyboard

$$RT = t_K + t_P + t_H + t_D + t_M + t_R$$

where

t_K	time to hit 1 key
t_P	time to localize 1 key
t_H	time to remove the finger from the key (homing)
t_D	time for planning
t_M	time for mental work
t_R	time for the system to respond

Common values: $0.08s \leq t_K \leq 1.2s$

Evaluation of Motor Behaviors in HCI III

- Fitt's model for a task difficulty index (1954) (see [Dix et al, 2004])

$$ID = \log_2(2A/W)$$

with A is the amplitude of the movement necessary for the execution of the task and W is the target size

This model is strongly similar to Shannon's model for the capacity of a communication channel

$$C = B \log_2(S/N + 1),$$

where S, N stand, respectively for the signal and noise power (an interface is a communication channel)

From HCI to HRI I

- Human factors in HCI controlling robots (see [Gertman,Bruemmer,2008])

  Sensation, attention, cognition, effort, utility, physiological and psychological factors

  - Response consistency in terms of task demand

    Different tasks have preferable interfaces; the response of an operator must be consistent with the task at hand

    Example: Wall painting has different positioning accuracy requirements than catching a glass of water

  - Use of different modalities

    The use of different sensory capabilities may help multi-tasking

    Example: auditory and visual sensing are processed in different regions of the brain which may indicate that interfaces making simultaneous use of these two channels may improve efficiency

From HCI to HRI II

- Stimulus response considerations

  The Hick-Hyman and Fitt's models need to be accounted for

- Visualization factors
  - Provide abstraction to support cognition

    Abstraction tends to reduce the number of stimulae and hence (Hyck-Hyman model) improves reaction time

  - Promote task based perception in 3D world

    Perception is improved if perceptual cues are provided in a 3D environment, e.g., the sense of depth in an image

  - Supply navigation metaphors

    Analyzing a scene for perceptual cues that can be used to take navigation decisions tends to be much more efficient than the hard processing of sensory raw data

From HCI to HRI III

- Link metaphors to affordances

  Affordances indicate the preferable actions associated with a metaphor

- Design computer-generated maps to be compatible with human cognitive maps

  The goal is to make the understanding of the sensory data easy; too much data tends to decrease good perception

- Select representations that reflect operator attention, expectancy, and value

  Adapt the interface/interaction to the knowledge level of the operator

Local biblio

Nigel Bevan, Miles Macleod

Usability measurement in context
Journal of Behaviour and Information Technology, 13:132-145, 1994

Ahmed Seffah, Mohammad Donyaee, Rex B. Kline, Harkirat K. Padda

Usability measurement and metrics: A consolidated model
Software Quality Journal 14:159-178, 2006

John M. Carroll (ed)

HCI Models, Theories, and Frameworks
Morgan Kaufmann, 2003

David Gertman, David Bruemmer

Human Factors Principles in Design of Computer Mediated Visualization for Robot Missions
Procs. of the ISSNIP 2008

Alan Dix and Janet Finlay and Gregory D. Abowd and Russel Beale

“Human-Computer Interaction”
Third edition, Pearson, Prentice-Hal, 2004.