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STUDY OF HUMAN COMPUTER INTERACTION (HCI) WITH ITS APPLICATION

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Abstract

The intension of this paper is to provide an overview on the subject of Human-Computer Interaction. The overview on HCI includes the basic definitions & terminology, a survey of existing technologies & recent advances in the field, common architectures used in the design of HCI systems which includes unimodal & multimodal configurations & finally the applications of HCI. This paper also offers a comprehensive number of references for each concept, method, & application in the HCI etc. Human Computer Interaction or Human Factors are concerned with the ways humans interact with information, technologies, & tasks, especially in business, managerial, organizational & cultural contexts. It is hoped that HCI studies can provide the evolution of the human centered technology development that enhances our work, our various needs, our organizations, our societies, & ourselves.

Introduction

The methods by which human has been interacting with computers with computers has travelled a long way. The journey still continues & new designs of technologies & systems appear more & more every day & the research in this area has been growing very fast in the last few decades. The growth in Human-Computer Interaction (HCI) field has not only being in quality of interaction, it has also experienced different branching in its history.

Instead of designing regular interfaces, the different research branches have had different focus on the concepts of multimodality rather than unimodality, intelligent adaptive interfaces rather than command action based ones, & finally active rather than passive interfaces.

History

For most of the computing era, interaction involved 80-column punch cards, paper tape, line editors, 1920-character displays, 1-megabye diskettes, & other extinct species. Are the interaction issues of those times relevant today? No.

The aspects of the human side of human-computer interaction change more slowly, if at all. Much of what was learned about out perceptual, cognitive, social, emotional processes when we interacted with other technologies applies to our interaction with emerging technologies as well. Aspects of how to recognize & retrieve information persist, even as the specific technologies that we use change.

Nevertheless, there are reasons to understand the field's history. The rapid pace of change could even strengthen them.

1. Several disciplines are engaged in HCI research & application, but few people are exposed to more than one. By seeing how each evolved, we can identify possible benefits of expanding our focus & obstacles to doing so.
2. Celebrating the accomplishments of past visionaries & innovators is part of building a community & inspiring future contributors, even when some past achievements are difficult to appreciate today.
3. Some visions & prototypes were quickly converted to widespread applications, others took decades, & some remain unrealized. By understanding the reasons for different outcome, we can assess today's visions more realistically.
4. Crystal ball are notoriously unreliable, but anyone planning or managing a career in a rapidly-changing field must consider the future. Our best chance to anticipate change is to find trajectories that extend from the past to the present. One thing is certain: The future will not resemble the present.

A historical account is a perspective. It emphasizes some things while de-emphasizing or omitting others. A history can be wrong in details, but is never right in any final sense.

A blueprint for intellectual histories of HCI was established by Ron Baecker in the opening chapters of the 1987 & 1995 editions of Readings in Human-Computer Interaction. It was followed in Richard Pew's chapter in the 2003 version. HCI research within management information systems is covered by Banker & Kaufmann (2004) & Zhang et al (2009). Rayward (1983; 1998) & Burke (1994; 2007) review the pre-digital history of information science; Burke (1998) provides a focused study of an early digital effort in this field.

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Definition, terminology of HCI

HCI sometimes called as Man-Machine interaction or interfacing, concept of Human-Computer Interaction/Interfacing (HCI) was automatically represented with the emerging of computer, or more generally machine itself.

The reason, in fact, is clear: most sophisticated machines are worthless unless they can be used properly by men. Functionality of a system is defined by the set of actions or services that it provides to its users. However, the value of functionality is visible only when it becomes possible to be efficiently utilized by the user.

The terms, computer, machine & system are often used interchangeably in this context, HCI is a design that should provide a fit between the user, the machine & the required services.

Overview of HCI

The advances made in last decade in HCI have almost made it impossible to realize which concept is fiction & which is & can be real. However, not all existing technologies are accessible &/or affordable by public.

Existing HCI technologies

HCI design should consider many aspects of human behaviors & needs to useful. The complexity of the degree of the involvement of a human in interaction with a machine is sometimes invisible compared to the simplicity of the interaction method itself. For example, an electrical kettle need not to be sophisticated in interface since its only functionality is to heat the water & it would not be cost-effective. On the other hand, a simple website that may be limited in functionality should be complex enough in usability to attract & keep customers.

Recent advances in HCI

The recent advances of research in HCI, namely intelligent & adaptive interfaces & ubiquitous computing, are presented.

Intelligent & adaptive HCI

The exact theoretical definition of the concept of intelligence is not known or at least not publicly agreeable. It is economically & technologically crucial to make HCI designs that provide easier, more pleasurable & satisfying experience for the users. To realize this goal, the interfaces are getting more natural to use every day.
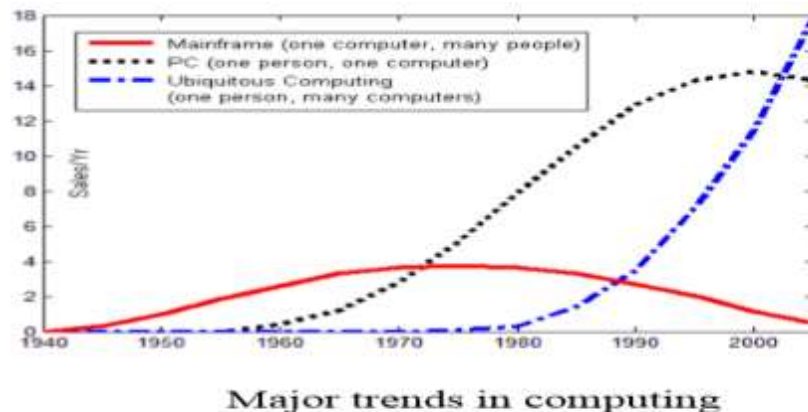
One important factor in new generation of interfaces is to differentiate between using intelligence in the making of the interface or in the way that the interface interacts with users. One example that uses both intelligent & adaptive interface is a tablet PC that has the handwriting recognition ability.

Another factor to be considered about intelligent interfaces is that most non-intelligent HCI design are passive in nature i.e. they only respond whenever invoked by user while ultimate intelligent & adaptive interfaces tend to be active interfaces. The example is advertisements that present themselves according to users' taste.

Ubiquitous computing & ambient intelligence

The latest research in HCI field is unmistakably ubiquitous computing (Ubicomp.). The term which often used interchangeably by ambient intelligence, refers to the ultimate methods of human-computer interaction that is the deletion of a desktop & embedding of the computer in the environment so that it becomes invisible to humans while surrounding them everywhere hence the term ambient.

The idea of ubiquitous computing was first introduced by Mark Weiser in 1998, His idea was to embed computers everywhere in the environment & everyday objects so that people could interact with many computers at the same time while they are invisible to them & wirelessly communicating with each.

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Major trends in computing

HCI systems architecture

Architecture of a HCI system shows what the inputs & outputs are & how they work together. The most important factor of a HCI design in its configuration.

Unimodal HCI systems

Each of the different independent single channel is called modality. A system that is based on only one modality is called unimodal. Based on the nature of different modalities, they can be divided into three categories:

a)   Visual-Based
b)   Audio-Based
c)   Sensor-Based

Visual-based HCI

The visual based human computer interact\ion is probably the most widespread area in HCI research. Some of the main research areas in this section are as follows:

i.   Body Movement Tracking
ii.   Facial Expression Analysis
iii. Eye movement Tracking
iv.   Gesture Recognition

The goal of each area differs due to applications. Facial expression analysis generally deal with recognition of emotions visually. Body movement tracking & gesture recognition are usually the main focus of this area & can have different purposes but they are mostly used for direct interaction of human & computer in action scenario. Eye movement tracking is mostly an indirect form of interaction between user & machine. The exception is eye tracking systems for helping disabilities in which eye tracking plays a main role in action scenario.

Audio-based HCI

The audio based interaction between a computer & a human is another important area of HCI systems. Thai area deals with information acquired by different audio signals. In this section the research areas can be divided to the following parts:

i.   Speaker Recognition
ii.   Speech Recognition
iii. Musical Interaction
iv.   Human-Mode Noise

Sensor-based HCI

This sensor is the combination of variety of areas with a wide range of applications. These sensors can be very sophisticated.

i.   Joysticks
ii.   Mouse & keyboard
iii. Pen-Based Interaction

iv.   Pressure Sensors
v.   Haptic Sensors

Pen-Based sensors are specifically of interest in mobile devices & are related to pen   gesture & handwriting recognition areas. Haptic & pressure sensors are of special interest for application in robotics & virtual reality.

Multimodal HCI system
The term multimodal refers to combination of multiple modalities. A multimodal interface acts as a facilitator of human-computer interaction via two or more modes of input that go beyond the traditional keyword & mouse.
Although an ideal multimodal HCI system should contain a combination of single modalities that interact correlatively, the practical boundaries & open problems in each modality oppose limitations on the fusion of different modalities.

Eye tracking in human-computer interaction
This section considers the application of eye movements to user interfaces, both for analyzing interfaces & as an actual control medium within a human-computer dialogue. The two areas have generally been reported separately. For usability analysis, the user's eye movements while using the system are recorded & later analyzed retrospectively, but the eye movements do not affect the interface in real time. As a direct control medium, the eye movements are obtained & used in real time as an input to the user computer dialogue. They might be the sole input, typically for disabled users or hands-busy applications, or they might be used as one of several inputs, combining with mouse, keyboard, sensors or other devices.

User acceptance
The integration of user acceptance of I.T. with new technological development should be studied. Human-Computer Interaction is considered a core element of computer science. People have interacted with computers from the start, but it took time for human computer interaction to become a recognized field of research.
In searching for better interfaces between users & their computers, an additional mode of communication between the two parties would be of great use.

Implications
The overall picture of eye movements for a user sitting in front of a computer is, then, a collection of steady fixations connected by sudden, rapid saccades.

Research contribution types in human computer interaction
Research in Human-Computer Interaction contains both technological & human-behavioral concerns. The research types concerned here are:

1. Empirical
2. Aircraft
3. Methodological
4. Theoretical
5. Dataset
6. Survey
7. Opinion

Examples of HCI in global development

- Industry: The Mobile Phone
- Methodological Innovations
- Research

Applications
In a noisy setting, one may provide input through handwriting rather than speech. Few other examples of applications of multimodal systems are:

- Intelligent Homes/Offices
- Driver Monitoring
- Smart Video Conferencing
- E-Commerce
- Intelligent Games

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Multimodal systems for disabled people

One good application of multimodal systems is to address disabled people which need other kinds of interfaces then ordinary people. In such systems, disabled users can perform work on the PC by interacting with the machine using voice& head movements. Figure is an actual example of such a system.

Gaze detection pointing system for people with disabilities (taken from

www.adamfulton.co.uk)

The head position indicates the coordinates of the cursor in current time moment on the screen. Speech, provides the needed information about the meaning of the action that must be performed with an object selected by the cursor. This is mainly due to the fact that during the process of pronouncing the complete sentence, the cursor location can be moved by moving the head, & then the cursor can be pointing to the graphical object.
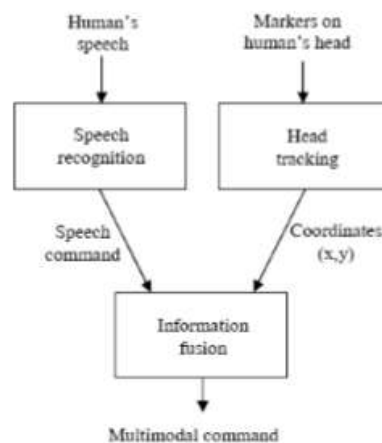

Diagram of a bimodal system [65]

Teaching human-computer interaction to blind students

In the more than twenty years of Computer Science & Informatics Engineering teaching in our Department, there was never a blind student until about sin year ago: a girl, & around the same time, a visually impaired boy. Both of them successfully completed some courses, a couple of them in Computer Science, but left before the HCI course. The girl already held a diploma in Education & she started working in special school for blind people, teaching them how to use computers. The boy decided to graduate in Statistics instead, which he already did successfully. The new blind students, another girl & boy, joined us there & a half or two & a half year ago, respectively. After teaching them three other courses ourselves, why would HCI be a different challenge? The first answer popping up was its traditional strong focus in visual aspects, & in particular the nature of the project

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students need to do. The second was the accessibility_ the problem we were facing _ is in fact one of the topics addressed in HCI.

In recent years, the Human-Computer Interaction community has shown significant interest in doing research that has inherent value to society.

Human-tool interaction & information processing at the dawn of computing

In the century prior to the advent of the first digital computers advances in technology gave rise to two fields of research that later contributed to human-computer interaction. One focused on making the human use of tools more efficient, the other on ways to represent & distribute information more effectively.

Origins of Human Factors

Frederick Taylor (1911) employed technologies & methods developed in the late 19th century – photography, moving pictures, & statistical analysis-to improve work practices by reducing performance time. Time-&-motion studies were applied to assembly-line manufacturing & other manual tasks.

World War 1st & World War 2nd accelerated efforts to match people to jobs, train them, & design equipment that would be more easily mastered. Engineering psychology was born during World War 2nd after simple flaws in the design of aircraft controls (Roscoe, 1997) & escape hatches (Dyson, 1979) led to aircraft losses & thousands of casualties. Two legacies of World War 2nd were respect for the potential of computing, based on its use in code-breaking, & an enduring interest in behavioral requirements for design.

Early tool use, whether by assembly-line workers or pilots, was not discretionary. If training was necessary, people were trained. One research goal was to reduce training time, but a more important goal was to increase the speed & reliability of skilled performance.

Conclusion

Human-Computer Interaction is an important part of systems design. Quality of system depends on how it is represented & used by users. Therefore, enormous amount of attention has been paid to better design of HCI. Virtual reality is also an advancing field of HCI which can be the common interface of the future.

The new direction of research is to replace common regular methods of interaction with intelligent, adaptive, multimodal, natural methods. Ambient intelligence or ubiquitous computing which is called the Third Wave is trying to embed the technology into the environment so to make it more natural & invisible at the same time.

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