ISSN: 2321-7782 (Online)
Volume 3, Issue 11, November 2015
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

HCI- Ubiquitous Computing and Ambient Technologies in the Universe

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Abstract: Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. It is concerned with the joint performance of tasks by humans and machines; Cognition is the processing of information from the world around us. It includes perception, attention, pattern matching, memory, language processing, decision making, and problem solving. Cognitive load is the amount of mental resources needed to perform a given task.

Keywords: computing systems; Cognition; perception; pattern matching; Cognitive load

I. INTRODUCTION

The field of Human-Computer Interaction investigates how users can best interact with computers. Particular emphasis is put on software aspects and operation of the interface like Design and Engineering. A user interface should not reflect the structure of the underlying Program, but the structure of the task domain and/or the task Solution process. Users should not interact with the computer, but with their tasks.

II. DISCIPLINES OF HCI

Academic Disciplines: Computer Science, develop programming languages, system architectures etc. of the computing systems

Engineering: Provide faster and cheaper equipment, Linguistics, Artificial Intelligence, Speech synthesis and recognition, natural language processing, etc.

Psychology: Provide information about human mental capabilities (e.g., memory, decision making)

Ergonomics (Human Factors): Provide information about human physical capabilities.

Sociology: How people interact in groups

Design Practices: Graphic Design, Art of combining text and graphics and communicating an effective message in design of posters, brochures, signs, logos & other type of visual communications

Product Design: Process of planning the product's specification

Industrial Design: Applied Hart H whereby aesthetics and usability of H products H may be improved. Aspects include overall shape of the object, colors, textures, sounds & product ergonomics.

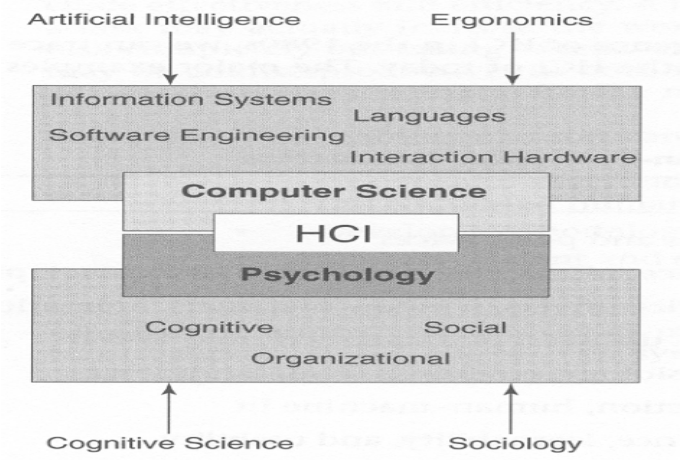

Fig-1 Various disciplines involved in HCI

III. People in HCI Business

Famous companies which provide HCI consultancies: Nielsen Norman Group: "help companies enter the age of the consumer, designing human-centered products and services" (www.nngroup.com)

Swim: "provide a wide range of design services, in each case targeted to address the product development needs at hand" (www.swimstudio.com)

IDEO: "create products, services and environments for companies pioneering new ways to provide value to their customers" (www.ideo.com)

IV. Existing HCI Technologies

In design of HCI, the degree of activity that involves a user with a machine should be thoroughly thought. The user activity has three different levels: physical [5], cognitive [6], and affective [7]. The physical aspect determines the mechanics of interaction between human and computer while the cognitive aspect deals with ways that users can understand the system and interact with it. The affective aspect is a more recent issue and it tries not only to make the interaction a pleasurable experience for the user but also to affect the user in a way that make user continue to use the machine by changing attitudes and emotions toward the user.

The existing physical technologies for HCI basically can be categorized by the relative human sense that the device is designed for. These devices are basically relying on three human senses: vision, audition, and touch [1].

Input devices that rely on vision are the most used kind and are commonly either switch-based or pointing devices [8] [9]. The switch-based devices are any kind of interface that uses buttons and switches like a keyboard [10]. The pointing devices examples are mice, joysticks, touch screen panels, graphic tablets, trackballs, and pen-based input [11]. Joysticks are the ones that have both switches and pointing abilities. The output devices can be any kind of visual display or printing device [3].

The devices that rely on audition are more advance devices that usually need some kind of speech recognition [12]. These devices aim to facilitate the interaction as much as possible and therefore, are much more difficult to build [13]. Output auditory devices are however easier to create. Nowadays, all kind of non-speech [14] and speech signals and messages are produced by machines as output signals. Beeps, alarms, and turn-by-turn navigation commands of a GPS device are simple examples.

The most difficult and costly devices to build are hap tic devices [15]. "These kinds of interfaces generate sensations to the skin and muscles through touch, weight and relative rigidity [1]." Haptic devices [16] are generally made for virtual reality [17] or disability assistive applications [18].

Fig-II Virtual Keyboard

The recent methods and technologies in HCI are now trying to combine former methods of interaction together and with other advancing technologies such as networking and animation.

One important factor in new generation of interfaces is to differentiate between using intelligence in the making of the interface (Intelligent HCI) [28] or in the way that the interface interacts with users (Adaptive HCI) [29]. Intelligent HCI designs are interfaces that incorporate at least some kind of intelligence in perception from and/or response to users. A few examples are speech enabled interfaces [30] that use natural language to interact with user and devices that visually track user's movements [31] or gaze [32] and respond accordingly.

V. Ubiquitous Computing and Ambient Intelligence

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

The idea of ubiquitous computing was first introduced by Mark Weiser during his tenure as chief technologist at Computer Science Lab in Xerox PARC in 1998. His idea was to embed computers everywhere in the environment and everyday objects so that people could interact with many computers at the same time while they are invisible to them and wirelessly communicating with each other [27].

Ubicomp has also been named the Third Wave of computing. The First Wave was the mainframe era, many people one computer. Then it was the Second Wave, one person one computer which was called PC era and now Ubicomp introduces many computers one person era [27].

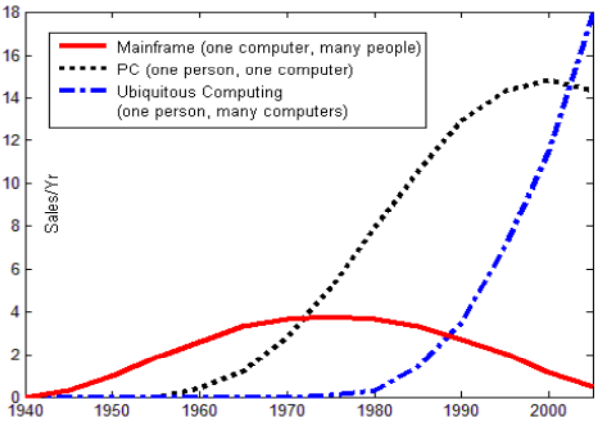

Fig III shows the major trends in computing.

VI. UNIMODAL HCI SYSTEMS

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:

1. Visual-Based
2. Audio-Based
3. Sensor-Based

Visual-Based HCI

Some of the main research areas in this section are as follow:

» Facial Expression Analysis
» Body Movement Tracking (Large-scale)
» Gesture Recognition
» Gaze Detection (Eyes Movement Tracking)

Audio-Based HCI

Research areas in this section can be divided to the following parts:

» Speech Recognition
» Speaker Recognition
» Auditory Emotion Analysis
» Human-Made Noise/Sign Detections (Gasp, Sigh, Laugh, Cry, etc.)
» Musical Interaction

Sensor-Based HCI

These sensors as shown below can be very primitive or very sophisticated.

1. Pen-Based Interaction
2. Mouse & Keyboard
3. Joysticks
4. Motion Tracking Sensors and Digitizers
5. Haptic Sensors
6. Pressure Sensors
7. Taste/Smell Sensors

Multimodal HCI Systems

The term multimodal refers to combination of multiple modalities. In MMHCI systems, these modalities mostly refer to the ways that the system responds to the inputs, i.e. communication channels. The definition of these channels is inherited from human types of communication which are basically his senses: Sight, Hearing, Touch, Smell, and Taste. The possibilities for interaction with a machine include but are not limited to these types.

Applications of multimodal systems are listed below:

» Smart Video Conferencing [59]

» Intelligent Homes/Offices [60]

» Driver Monitoring [61]

» Intelligent Games [62]

» E-Commerce [63]

» Helping People with Disabilities

Gaze detection pointing system for people with disabilities (taken from www.adamfulton.co.uk)

VII. CONCLUSION

Human-Computer Interaction is an important part of systems design. Quality of system depends on how it is represented and used by users. Therefore, enormous amount of attention has been paid to better designs of HCI. The new direction of research is to replace common regular methods of interaction with intelligent, adaptive, multimodal, natural methods. Virtual reality is also an advancing field of HCI which can be the common interface of the future.

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