Human-Computer Interaction: A Review

Sunita Dixit[1], Dr. MD Yusuf Mulge[2]
[1]Research scholar, Pacific University, Udaipur
[2]Principal, PDM College of Engineering for Women, Bahadurgarh

Abstract: **HCI (Human Computer Interaction) aims to improve the interactions between users and computers by making computers more usable and receptive to users' needs. It involves the study, planning, design and uses of the interaction between people (users) and computers. This paper intends to provide an overview of HCI systems and existing technologies. Broadly, HCI systems can be classified into two main categories: unimodal HCI systems and multimodal HCI systems.**
Keywords: **Human computer interaction, unimodal, multimodal.**

I. INTRODUCTION

The growth in Human-Computer Interaction (HCI) field has not only been 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, and finally active rather than passive interfaces. Humans interact with computers in many ways, and the interface between humans and the computers they use is crucial to facilitating this interaction. Desktop applications, internet browsers, handheld computers, and computer kiosks make use of the prevalent Graphical User Interfaces (GUI) of today. Voice User Interfaces (VUI) are used for speech recognition and synthesizing systems, and the emerging multi-modal and gestalt User Interfaces (gUI) allow humans to engage with embodied character agents in a way that cannot be achieved with other interface paradigms. Why a system is actually designed can ultimately be defined by what the system can do i.e. how the functions of a system can help towards the achievement of the purpose of the system. 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 [1]. Usability of a system with a certain functionality is the range and degree by which the system can be used efficiently and adequately to accomplish certain goals for certain users. The actual effectiveness of a system is achieved when there is a proper balance between the functionality and usability of a system.

II. EXISTING TECHNOLOGIES

In the 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, cognitive, and affective. 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 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. These new advances can be categorized in three sections: wearable devices [2], wireless devices [3], and virtual devices [4]. The technology is improving so fast that even the borders between these new technologies are fading away and they are getting mixed together. Few examples of these devices are: GPS navigation systems [5], military super-soldier enhancing devices (e.g. thermal vision [6], tracking other soldier movements using GPS, and environmental scanning), radio frequency identification (RFID) products, personal digital assistants (PDA), and virtual tour for real estate business [7]. Some of these new devices upgraded and integrated previous methods of interaction. Recent directions and advances of research in HCI are intelligent and adaptive interfaces and ubiquitous computing. 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 [8] that use natural language to interact with user and devices that visually track user's movements or gaze [9] and respond accordingly. Adaptive HCI designs, on the other hand, may not use intelligence in the creation of interface but use it in the way they continue to interact with users [10]. An adaptive HCI might be a website using regular GUI for selling various products. This website would be adaptive -to some extent- if it has the ability to recognize the user and keeps a memory of his searches and purchases and intelligently search, find, and suggest products on sale that it thinks user might need. The term ubiquitous

ISSN: 2278 – 7798

computing is 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 while surrounding them everywhere hence the term ambient.

III. GOALS OF HCI

The user interacts directly with hardware for the human *input* and *output* such as displays, e.g. through a graphical user interface. The user interacts with the computer over this software interface using the given input and output (*I/O*) hardware. Software and hardware must be matched, so that the processing of the user input is fast enough, the latency of the computer output is not disruptive to the workflow. HCI (Human Computer Interaction) aims to improve the interactions between users and computers by making computers more usable and receptive to users' needs. Specifically, HCI has interests in:

- methodologies and processes for designing interfaces (i.e., given a task and a class of users, design the best possible interface within given constraints, optimizing for a desired property such as learnability or efficiency of use)
- methods for implementing interfaces (e.g. software toolkits and libraries)
- techniques for evaluating and comparing interfaces
- developing new interfaces and interaction techniques
- developing descriptive and predictive models and theories of interaction

A long term goal of HCI is to design systems that minimize the barrier between the human's mental model of what they want to accomplish and the computer's support of the user's task.

IV. Unimodal HCI Systems

An interface mainly relies on number and diversity of its inputs and outputs which are communication channels that enable users to interact with computer via this interface. Each of the different independent single channels is called a 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:

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

Visual-Based HCI

The visual based human computer interaction is probably the most widespread area in HCI. Considering the extent of applications and variety of open problems and approaches, different aspects of human responses which can be recognized as a visual signal are:

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

Facial expression analysis generally deals with recognition of emotions visually. Body movement tracking and gesture recognition are usually the main focus of this area and can have different purposes but they are mostly used for direct interaction of human and computer in a command and action scenario. Gaze detection is mostly an indirect form of interaction between user and machine which is mostly used for better understanding of user's attention, intent or focus in context-sensitive situations. The exception is eye tracking systems for helping disabilities in which eye tracking plays a main role in command and action scenario, e.g. pointer movement, blinking for clicking. It is notable that some researchers tried to assist or even replace other types of interactions (audio-, sensor-based) with visual approaches. For example, lip reading or lip movement tracking is known to be used as an influential aid for speech recognition error correction.

Audio-Based HCI

The audio based interaction between a computer and a human is another important area of HCI systems. This area deals with information acquired by different audio signals. While the nature of audio signals may not be as variable as visual signals but the information gathered from audio signals can be more trustable, helpful, and is some cases unique providers of information. Techniques related to audio-based HCI are:

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

Sensor-Based HCI

This section is a combination of variety of areas with a wide range of applications. The commonality of these different areas is that at least one physical sensor is used between user and machine to provide the interaction. These sensors as shown below can be very primitive or very sophisticated:

- Pen-Based Interaction
- Mouse & Keyboard

ISSN: 2278 – 7798

- Joysticks
- Motion Tracking Sensors and Digitizers
- Haptic Sensors
- Pressure Sensors
- Taste/Smell Sensors

V. 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. Therefore, a multimodal interface acts as a facilitator of human-computer interaction via two or more modes of input that go beyond the traditional keyboard and mouse. The exact number of supported input modes, their types and the way in which they work together may vary widely from one multimodal system to another. Multimodal interfaces incorporate different combinations of speech, gesture, gaze, facial expressions and other non-conventional modes of input. One of the most commonly supported combinations of input methods is that of gesture and speech. Although an ideal multimodal HCI system should contain a combination of single modalities that interact correlatively, the practical boundaries and open problems in each modality oppose limitations on the fusion of different modalities. In spite of all progress made in MMHCI, in most of existing multimodal systems, the modalities are still treated separately and only at the end, results of different modalities are combined together.

VI. FUTURE FOR HCI

The future for HCI, based on current promising research, is expected to include the following characteristics:

- *Ubiquitous communication*. Computers are expected to communicate through high speed local networks, nationally over wide-area networks, and portably via infrared, ultrasonic, cellular, and other technologies. Data and computational services will be portably accessible from many if not most locations to which a user travels.
- *High-functionality systems*. Systems can have large numbers of functions associated with them. There are so many systems that most users, technical or non-technical, do not have time to learn them in the traditional way (e.g., through thick manuals).
- *Mass availability of computer graphics*. Computer graphics capabilities such as image processing, graphics transformations, rendering, and interactive animation are becoming widespread as inexpensive chips become available for inclusion in general workstations and mobile devices.
- *Mixed media*. Commercial systems can handle images, voice, sounds, video, text, and formatted data. These are exchangeable over communication links among users. The separate worlds of consumer electronics (e.g., stereo sets, VCRs, televisions) and computers are partially merging. Computer and print worlds are expected to cross-assimilate each other.
- *High-bandwidth interaction*. The rate at which humans and machines interact is expected to increase substantially due to the changes in speed, computer graphics, new media, and new input/output devices. This can lead to some qualitatively different interfaces, such as virtual reality or computational video.
- *Large and thin displays*. New display technologies are finally maturing, enabling very large displays and displays that are thin, lightweight, and low in power consumption. This is having large effects on portability and will likely enable the development of paper-like, pen-based computer interaction systems very different in feel from desktop workstations of the present.
- *Information utilities*. Public information utilities (such as home banking and shopping) and specialized industry services (e.g., weather for pilots) are expected to proliferate. The rate of proliferation can accelerate with the introduction of high-bandwidth interaction and the improvement in quality of interfaces.

VII. CONCLUSION

People have interacted with computers from the start, but it took time for human–computer interaction (HCI) to become a recognized field of research. Human–computer interaction in the personal computing era has been marked by the spread of Internet and intranet use, graphical user interfaces, and the World Wide Web. This paper attempted to give an overview on HCI systems and provide a survey of existing research in this field.

VIII. REFERENCES

[1] B. Shneiderman and C. Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction(4th edition), Pearson/Addison-Wesley, Boston (2004).

[2] W. Barfield and T. Caudell, Fundamentals of Wearable Computers and Augmented Reality, Lawrence Erlbaum Associates, Mahwah (2001).

[3] M.D. Yacoub, Wireless Technology: Protocols, Standards, and Techniques, CRC Press, London (2002).

ISSN: 2278 – 7798

[4] K. McMenemy and S. Ferguson, A Hitchhiker's Guide to Virtual Reality, A K Peters, Wellesley (2007).

[5] S.G. Burnay, T.L. Williams and C.H. Jones, Applications of Thermal Imaging, A. Hilger, Bristol (1988).

[6] J. Y. Chai, P. Hong and M. X. Zhou, "A probabilistic approach to reference resolution in multimodal user interfaces", Proceedings of the 9th International Conference on Intelligent User Interfaces,Funchal, Madeira, Portugal, pp 70-77 (2004).

[7] S.L. Oviatt, P. Cohen, L. Wu, J. Vergo, L. Duncan, B. Suhm, J. Bers, T. Holzman, T. Winograd, J. Landay, J. Larson and D. Ferro, "Designing the user interface for multimodal speech and pen-based gesture applications: state-of-the-art systems and future research directions", Human-Computer Interaction, 15, pp 263-322 (2000).

[8] D.M. Gavrila, "The visual analysis of human movement: a survey", Computer Vision and Image Understanding, 73(1), pp 82-98 (1999).

[9] L.E. Sibert and R.J.K. Jacob, "Evaluation of eye gaze interaction", Conference of Human-Factors in Computing Systems, pp 281-288 (2000).

[10] Various Authors, "Adaptive, intelligent and emotional user interfaces", Part II of HCI Intelligent Multimodal Interaction Environments, 12th International Conference, HCI International 2007 (Proceedings Part III), Springer Berlin, Heidelberg (2007).

[11] B. Fasel and J. Luettin, "Automatic facial expression analysis: a survey", Pattern Recognition, 36, pp 259-275 (2003).

[12] M. Pantic and L.J.M. Rothkrantz, "Automatic analysis of facial expressions: the state of the art", IEEE Transactions on PAMI, 22(12), pp 1424-1445 (2000).

[13] O. Khatib, O. Brock, K.S. Chang, D. Ruspini, L. Sentis and S. Viji, "Human-centered robotics and interactive haptic simulation", International Journal of Robotics Research, 23(2), pp 167-178 (2004).

ISSN: 2278 – 7798