

Human Computer Interaction – A Modern Overview

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Abstract

Human Computer Interaction (HCI) is a discipline which aims at an established understanding and designing of different interfaces between humans and computers in a way that it defines systems that are enjoyable to use, are engaging and are accessible. In 1970's, the development in HCI was majorly inclined towards "usability" of the interaction systems. Since then, HCI has set a positive growth in developing designs as well as evaluation methods to ensure that technologies are easy to learn and use. While, HCI leads to efficient user handling, the questions about increasing human dependency on computers and how it leads to a change such as: not being able to respond fully to beauty, are ignored with development. Hence, with novel touch to our future, the HCI practitioners in the coming years should strive for a confliction free world where technology and quotidian life exists in harmony.

I. INTRODUCTION

Ever since the advent of personalized computing in the market, there has been constant efforts in a direction which leads to an efficient, user centered design which can easily be understood and used by the user. Personal computers, which included both, productivity applications and personal computer platforms made everyone in the developing world a computer user. Need for efficient designs and usability testing automatically manifested itself with the proliferation of such users and corresponding applications. Other fortuitous developments also contributed to the establishment of HCI as a separate field. Software Engineering, started to focus on non-functional requirements, ranging from usability to maintainability. Computer graphics and data mining were some other opportune advancements which gained popularity and led to awareness that

interactive systems were the key to further innovation. Thus, these all these threads in the development of computer science highlighted the most important part of the machine interaction process, that is, its user.

The advancements made in the interaction systems field made it necessary to realize a separately coexisting branch, that is, HCI. The main terms which are now defined under this branch are: functionality and usability.

Functionality of the system is defined as the complete set of actions or services proved to the user. Complementing the functionality factor of the system is its *Usability*, which is defined as the range and degree to which the system can be efficaciously utilized by the user to perform the tasks covered in the functionality of the system. The actual balance is achieved when there is a balance between these two factors of the system.

Functionality and usability of the system is basically tested on HCI design, which involves user activity and hence should be clearly thought and tested. The involvement of user is classified under three categories: physical, cognitive and affective. Physical aspect is about the interaction of users with the machines mechanically, while the cognitive aspect is about the ways in which users understand and interpret the system, expect from the system and finally interact with it. The affective aspect is relatively recent which aims at creating an everlasting impact on users mind by making his interaction with the system an overall pleasurable experience. This paper will further explain the recent advancements and its influences in the physical aspect of HCI and then recapitulate some implications of growing technological trend which need to be looked upon.

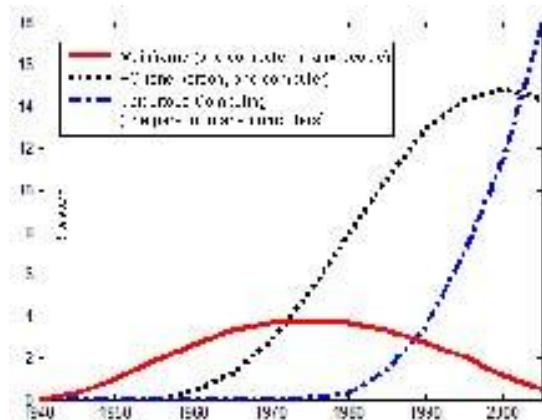
II. RECENT ADVANCEMENTS

Following sections now discuss the twentieth century advancements and innovative prospects in the research of HCI.

II.1 Ubiquitous Computing:

The latest research field and the widest growing work is Ubiquitous Computing (UbiComp). Also widely known as *Ambient Intelligence* or *Pervasive Computing*, it refers to methods of integrating technology with environment and everyday objects. In other words, it deals with deletion of desktop as a separate device and aims to embed it in everyday objects which users are habitually equipped with.

Mark Weiser, a chief technologist at Computer Science Lab in Xerox PARC in 1998, introduced the idea of embedding the computers everywhere in everyday objects so that people can interact with many computers at same time.



UbiComp has theoretically been named as the Third wave of computing. The First Wave was the mainframe era, that is, many people one computer. Then it was the Second Wave, which implies one person one computer, that is called PC era and now UbiComp introduces many computers one person era. Below Figure 1 shows the major trends in computing.

Fig 1: Major Trends in Computing

The concept of UbiComp promises the user that in future that he will not have to beforehand learn the working of computer in order to operate it, rather, the computers will be embedded in his daily activities giving him a liberal sense of comfort. Although, we are still a long way from seeing a perfectly embedded environment as promised by UbiComp, the barriers in

the road are falling as the technologies such as Nanotechnology and Wireless Computing are augmenting the ease of software usage.

II.2 Intelligent and Adaptive HCI

Intelligent and Adaptive HCI refer to the interaction which supports user tasks such as navigation or manipulation. With the discernable growth in the market, the interactive devices have transformed their own way of interfacing with the user. Intelligent systems are one such consequence. Intelligent HCI designs are interfaces which use some kind of intelligence in perception assisting the user in an innovative and different way. Some examples such as visually tracking the movements of the user, using speech recognition technology to interact dynamically with the user, and pattern recognition, depict the modern day deployment of intelligent designs.

Adaptive HCI is different from intelligent HCI in the sense that it may or may not use intelligence in assisting users. A simple example of adaptive interaction is a Graphic user interaction (GUI) based website which saves the searches and results of the queries user entered in history and uses them in future to search, navigate and suggest results to user.

Today, designs implement both intelligence and adaptive nature of HCI into designs which results in an active design, rather than a passive one. As an example that uses both intelligent and adaptive interface is a PDA or a tablet PC that has the handwriting recognition ability and can adapt to the handwriting of the logged in user and improves its performance by remembering the corrections that the user made to the recognized text. The main focus of HCI practitioners is to create an adaptive and intelligent system designs which efficiently get embedded with user's natural environment.

III. CONFIGURATION OF HCI

Architecture of configuration of a HCI system constitutes one of the most important factors in its modern day design. Any interface is generally defined by the number and variety of inputs and outputs it generates. Architecture of HCI showcases these inputs and outputs in a system and how they integrate to work together. We now discuss some developing configurations and designs on which interfaces today are based.

III.1 Unimodal Interaction Systems

Modality of a system is defined by each of its different independent single channels that ensure user to interact with computer. A HCI system having a single such channel, that is, is based on a single modality is termed as *unimodal*. These systems can be broadly classified into three sub categories:

- Visual-Based
- Audio-Based
- Sensor-Based

We now briefly describe each category stating their sub divisions and examples.

III.1.1 Visual-Based HCI

In Visual-based interaction systems, human responses are recognized as a visual signal. Some of the below research areas have made this as one of the most widespread and popular research concentrations.


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

Facial expression analysis deals with the recognition and noting down of the expressions and emotions of the user visually. Body movement tracking and gesture recognition are main concentrations in this area covering most of the newly developed applications and relative designs. Gaze Detection is not a direct form of human computer interaction in the sense that it is primarily used for a better understanding of user's attention, intent and focus in sensitive situations. Recently launched, Samsung SIII has a gaze detection technology which senses users focus and turns off the user's attention is not directed. Similar researches are being carried and researchers are trying to integrate other types of HCI (such as audio, sensor-based) with the visual-based interactive systems. *OmniTouch*, *Skinput* and *Sixth Sense* are some of the ongoing prototypes being

worked upon and they implement visual-based HCI along with the sensor-based HCI systems.

III.1.2 Audio-Based HCI

The audio-based HCI systems deal with the processing of information acquired by the audio signals incoming from the user side. Comparing these systems with Visual-based systems, the information gathered by these systems is more reliable and helpful due to the fact that the nature of sound signals not as variable as visual signals. Research areas in this branch are divided into following categories:

- Speech Recognition
- Speaker Recognition
- Auditory Emotion Analysis
-  Human made noise/Signal Detections (Gasp, Laugh, Sigh, Cry and so on)
- Musical Interaction

While historically, the main focus has been speech and speaker recognition, modern day endeavors also focus upon integrating human emotions within the intelligent interactive systems. Human factors such as tone, gasp, sigh and so on are being used as a part of emotion analysis and is being developed as an integral part of any interactive modern day design. Music generation category is relatively novel and has been worked under audio and visual-based systems.

III.1.3 Sensor-Based HCI

This area of HCI consists of most number of applications and is a combination of wide range of areas. The common feature in every application under this field is that at least one physical sensor is used between machine and human to provide interaction. While this remains the most utilized field of HCI, integrated applications such as *OmniTouch*, are finding their own scope and innovation in the market. Some of the sensors as listed below, range from very sophisticated to being primitive.

- Pen-Based Interaction
- Mouse & Keyboard
- Joysticks
- Motion Tracking Sensors and Digitizers
- Haptic Sensors

- Pressure Sensors
- Taste/Smell Sensors

Some of the sensors such as Mouse, Keyboard and joysticks have been around for a while, however technologies such as Pen-Based Interaction have found a place in the market recently. Pen-Based interaction is particularly deployed in the mobile devices and is used for handwriting recognition. Motion tracking sensors and Digitizers are technologies that revolutionized and brought a vast amount of change in art, movie and video-game industry. Users interact with the motion tracking sensors by wearing a cloth, special glasses or joint sensors. Haptic Sensors are usually used by the practitioners in robotics, virtual reality and in medical surgery applications. Few research works have also been performed in the area of Taste/Smell sensors, however, this area is relatively new and developing as compared to others.

III.2 Multimodal Interaction Systems

Combination of multiple modalities, or usage of more than one independent channel signals for the interaction between a user and a machine is termed as multimodal human computer interaction system (MMHCI). The need for multimodal system arises with the need to increase the rate of error avoidance and error resolution. Apart from assisting in error solving, multimodal systems also accommodate wider range of users and environmental situations, making it more suitable to use over unimodal systems. Although, a practically ideal multimodal system must contain a combination of different single multimodal systems that work collectively, there are certain issues and challenges which enforce the developers to treat each modality separately and towards the end, splice the results of the different modalities. In the figure below, the architecture of basic multimodal user interface has been depicted and shows how the different unimodals are analyzed by the system and towards the end are spliced together.

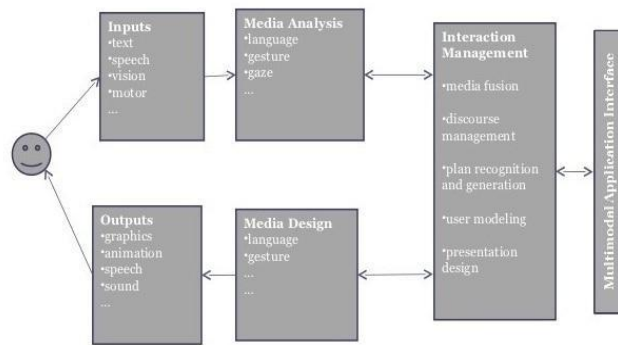


Fig 2: Architecture of Multimodal User Interface

Several issues and challenges are faced while developing and working with multimodal systems such as lack of universal interface design, unambiguous interpretation, realizing a natural user interface and increase in the cost of hardware.

Despite these hurdles in the development of multimodal systems, there are many applications which make use of recognitions and are coming up in the market and are a consequence of combination of several modalities. Mostly, these applications range in the field of art and science. As an example, in [8], MIDI sounds are generated when a wearable camera worn by the user interprets mouth gestures and movements. Similarly, in [9], there is a description of a technique which uses multiple modalities (video, audio, pressure sensors) to generate different “emotional states” in an intelligent environment which responds to such multimodal input from visitors. Robotics is yet another thriving application of MMHCI, authors of [10], typically explain and review robots socially and realize the role of speech, gesture and gaze as modalities. Other important application areas of MMHCI include: benefit for people with disability, as reviewed by [11], [5] explicates the technique of presenting digital pictures non-visually but using multimodal output and finally, gaming, as described in [6] and critical safety interface applications as comprehensively described in [12].

IV. HCI: Looking Forward Into Future

Considering the diverse number of researches and technological breakthroughs, it is not hard to discern the moment in future where the term natural will get transparently embedded into the world of science and technology. Looking at the goals HCI has to offer with a slightly different perspective, there is a conclusion which states that the developments in HCI can intervene in the rapidly changing world. Designs in HCI will need to be more sensitive and aware towards the human society and values. Various encumbrances in such a pathway like changing human values, techno-dependency and stress, technophobia, disregard for the natural beauty and finally, no single interface stability, will have to be dealt in a much more different way and must be included in the goals of HCI practitioners. For accomplishing this seamless transition into innovation, HCI will have to integrate itself with several adjoining disciplines.

In the near future, as the HCI 2020 [6] states, the relationship of the society with the technology will not just be a user based experience. Unlike today, computers will be flowing everywhere and most of our lives will be directed by computers. Meanwhile, the darker side of this proliferation can be explained by examples such as violation of privacy due to the presence of ubiquitous machines, wrong use of HCI computer applications, and respective cultural trends and values even in a digitized modern world. Hence, the main agenda of HCI practitioners gets defined as visualizing a human in a completely digitized future, where in technology understands human desires, expectations and aspirations and at the same time is human-centric and includes ethics and values from user's society.

V. Conclusion

In this paper, we give an overview of a sophisticated discipline called Human Computer Interaction (HCI) from a modernistic perspective which is in accordance with the increasing dependence of humans on technology, as well as taking a positive action against the nefarious nature of humans which

can result in harmful use of such high level technologies. This new direction aims to replace the common interaction techniques with the intelligent, innovative and adaptive design methods.

VI. References

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