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RESEARCH ARTICLE

Human Computer Interaction: Analysis and Journey through Eras

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Abstract:

This paper provides an overview of Human Computer Interaction (HCI). It includes the explanation regarding how, when did the HCI emerge and how it evolved during years till date and what could be the future inventions in the field of HCI. This excerpt also gives an overview of HCI related terminologies and its design principles. The design models of HCI include unimodal and multimodal architectures. Various tools used for building interfaces have also been discussed in this paper. The interface building tools design theories and principles of HCI systems have been discussed in the medieval sections. Finally the future and various applications of the HCI are discussed.

Keywords: UIMS, Ubicomp, MMHCI, PENCIL

1. Introduction:

Computers have been an important and unavoidable part of our lives. This attachment and reliability on computers have made good as well as bad effects on human's life. Originally computers were used merely as calculators. Now we can accomplish great range of tasks using computers which includes airline booking, playing video games and sending and receiving of emails, video conferencing etc and the list is endless. The growth in human computer interaction has been spectacular. It has not focused on improving the quality of existing interfaces rather it is looking forward to create intelligent and adaptive interfaces. The architecture of HCI has evolved replacing regular interfaces with unimodal and

multimodal interfaces. The excerpt would explain the concept of unimodal and multi modal architecture of HCI later in the text. The latest fields of human Computer interaction are 3D animation, virtual reality, speech and gesture recognition. Later in this text we will also include the tools that are used for interface building. The initial sections will give a description about the definition of HCI and related terminologies, the fundamental interaction styles and design principles of the HCI systems. The last sections of the paper would describe about the future of HCI, its applications and conclusion.

1.1. Definition of HCI:

The concept of Human Computer Interaction came into existence when computers or machines that serve human requirements came into existence. Any machine or system is worthless if it cannot be properly handled by human beings. For accomplishing our tasks through computers we need to be able to interact with the system and here comes the importance of human Computer interaction. The worth of a machine for a user depends on two major factors i.e. functionality and usability. The term Functionality means the range of services that a system can provide to its users. The term usability means for a particular user how much useful can be a particular system be. HCI system should be designed in such a way so that it provides quality and optimization in the services it provides. For example an electric water heating kettle does not need to have a proper and versatile interface because it needs just an ON/OFF switch to heat the water. Whereas if we are building a regular web page should build an interface that is enough complicated to provide good usability to its customers though the page may be limited in functionality. We can also build interfaces that can be used for meeting the requirements of more than one systems, for example pc's and laptops use windows as the interface. Now a days even mobiles, tablets, palm tops use windows as there interface. In the next section we will study about the fundamental interaction styles and interface builders.

2. Fundamental Interactive Styles :

Direct manipulation interfaces: In this the objects that are visible on the screen can be directly manipulated using some pointing device. Ivan Sutherland was the first one to show this on sketchpad. He manipulated the objects on the screen using a light pen which could grab objects and place them on different locations on the screen. Also we can change the size of the objects on the screen. Air force and NSF supported the creation of this system in Lincoln labs. Yet another system that called AMBIT/G developed in Lincoln Labs in 1968 implemented iconic representations, dynamic menus with their options which could be selected using a pointing device. Macintosh that developed in 1984, Xerox Star developed in 1981 and the Apple Lisa developed in 1982 were the first commercial systems which made use of Direct Manipulation.

Windows: The idea of overlapping windows was first introduced by Alan Kay in 1969 at University of Utah. Lisp machines and symbolic Lisp machines were the first ones to use the windows commercially. The first major tiled window manager was created by Xerox PARC named Cedar Window Manager in 1981. Apple Macintosh, Xerox Star and the Apple Lisa majorly popularized the windows.

Mouse: the mouse is a pointing device established for cheap replacement of light pens and was developed at Stanford Research Laboratory in 1965. In 1970's the Xerox PARC made mouse a popular practical input device.

3. Tools for Building Interfaces:

The software tools for creating interfaces are in great trends now. Such tools are sold by many companies. Today various interfaces are built using these software tools.

Interface builders: through these tools we can create interfaces which are composed of widgets like menus, buttons and scrollbars that can be placed on the screen using mouse. Xerox PARC developed TRILLIUM in 1981. Resource Editor was an interface builder that allowed placing and editing of the widgets. The first modern interface builder was the "SOS Interface" created by Jean-Marie Hullot. It was built in lisp for the Macintosh system and was known as the first "modern interface builder". This was commercialized in 1986. This was the starting of the production of Interface Builders. Now there are a huge number of interface builders in the market. A very common example of interface builder for android system is PENCIL.

UIMS: These are the software tools that create user interfaces by writing program codes. Reaction Handler created by William Newman at Imperial College, London was the first User Interface Management System (UIMs). NASA, NSF, DOE, NBS and SRC funded for its development. The first commercial system to have a large collection of widgets was Xerox PARC. These widgets included popup menus and scrollbars etc. The first commercial system to actively promote the use of its toolkit for the development of interfaces to other commercial systems was The Apple Macintosh. Stanford Research Laboratory developed a c++ toolkit called Inter Views in 1988.

4. Design Principles for HCI:

Typically there are many rules for the development of an interface system in order to as much as high usability as possible. Some rules were produced or formulated by Jacob Nielsen that explain a large amount of problems that are faced in designing the interface. These rules should be followed by all user interface designers:

1. One should avoid adding irrelevant information on the interface because every unit of irrelevant information destroys the importance and weightage of relevant information. Irrelevant information diminishes the relevance of correct information.

2. Actions, widgets, icons, situations should have same meaning and should trigger same action wherever they are used in system irrespective of the applications or programs under which they are used.

3. The interface should be developed in concepts and languages that are understood by the users rather than being familiar to systems.

4. A message should timely popup giving the information regarding what is going on in the System.

5. Error messages written in human readable languages should be shown in response to solution of any problem that has occurred in the system.

6. We sometimes do functions that we did not actually intend to do. In this the interface should provide clearly marked exits in order to undo the previous action without extending the dialog.

7. Shortcuts for different functions should be provided in order to speed up the human computer interaction.

5. Architecture of HCI systems:

The number of inputs and outputs in an interface defines its architecture. HCI system architecture shows how these input and output work together. Following is the categorization of the interfaces in the basis of the no of modes input/output in the system:

5.1 Unimodal: In unimodal systems only one communication channel is used to communicate with the machine. There can be different communication channels like speech, face gesture, body movements etc. all these are called communication channels. If only one of these media of communication is used in the system then the system is called Unimodal HCI System. These unimodal systems can be categorized into 3 categories as follows:

5.1.1. Visual Based HCI System: the most widespread area in HCI is the visual based computers interaction. In this the user communicates with the machine using visual movements that may be minor but still visible to the computer. There are different types of visual movements that can be detected by a system. These are listed as follows:
- Analyzing facial expressions
- Recognizing Gestures
- Tracking body movements
- Tracking eyeball movements

The facial expression analysis and the body movements tracking is normally used in creating animation movies where the facial expressions in different emotions and the corresponding body movements are tracked for creating the same body movements in the cartoon characters of the animation movie. Gesture recognition

techniques are generally used for manipulating the objects on the screen. For example we can manipulate an image on the screen using motions of our hands. We can select the image, zoom its size, scroll through parts of screen etc. These all areas of visual HCI systems have something in common but the fourth one i.e. the tracking of eyeball movements is used for disabled people who can move only their eyes. The movements of the eyes manipulate the coordinate positions on the screen. And the blinking of eyes may act as clicking of the mouse button.

(Image shows tracking of body movements for animation)

5.1.2. Audio-Based HCI System

In these systems the user interacts with the system using audio or speech as input. The nature of audio signals is not as variable as the visual signals but the audio signals prove to be more reliable source of correct information. There are following categories or research fields under this HCI system:

- Distinguish the users on the bases of their speech
- Recognizing the actions to be performed on different speech
- Synchronizing speech with lip movements to produce more accurate operations
- Analyzing emotions in the audio e.g. Anger, sadness, neutral, happy, etc.
- Recognizing musical interactions

The speech recognition and the speaker recognition have been used for very long. A recent appearance in this field is the analysis of emotions in the audio signals. Typical audio sounds produced by humans in different emotions, along with pitch and tone of the data was manipulated to design more intelligent HCI systems. Art industries use the latest area of audio-based HCI i.e. recognition of musical interactions. This is used in both audio based and video based systems.

5.2. Multimodal HCI systems:

As the name suggests multimodal means many modes. In these systems multiple channels of communication are used for interacting with computers. These systems are able to take five senses of human beings as input which includes sight, smell, hearing, touch and taste. When two or more such modes are used as inputs then the interface is called a multi modal interface. The number and diversity of the modes and their combinations used can vary from one MMHCI System to another. The most commonly used combination of inputs used is gestures and speech. No doubt the multimodal systems are giving us more accuracy as compared to single modal systems because the combination of these modalities produces more reliable operations. Another aspect worth noticing are those different modalities can collaborate together to assist each other. For example, lip movement tracking that is visual based is used for helping speech recognition which is audio-based. And further the speech recognition can help gesture recognition. In next section we will discuss about the Existing HCI technologies.

6. Existing HCI technologies:

The existing HCI technologies differ in the combination of degree of functionality and usability they show to the users. Before designing an HCI we should thoroughly think about the usability or the functionality it can provide to the users and according to that we should consider the number of modalities in a system. The existing technologies can take the following categories of signals as input: namely- audition, touch and vision. The devices that use vision as their input are generally switch based or pointing devices. The switch based devices contain buttons and switches and the examples of pointing devices is mouse, light pen, joysticks etc. the devices that use audio as their input normally deal with speech recognition. It is difficult to create input auditory devices as compared to output auditory devices where the output signals are in the form of audio. For example, All the electronic devices like telephones, mobiles, beeps and

alarms give audio output. A recent advancement in the HCI systems is the haptic devices which produce sensations to skin and muscles through touch or weight. They are generally used in virtual reality. Now a days the conventional systems have been replaced by wearable, virtual and wireless devices. These new technologies rather being used in separate systems, they are clubbed together to create a system that uses a combination of these technologies. For example, military super-soldier enhancing devices, GPS navigation systems, personal digital assistance, RFID products etc. A solution to conventional keyboarding, Compaq's iPAQ created a virtual keyboard which is made by projecting a keyboard like pattern using a red light on a solid surface. The device tracks the motion of the fingers and captures the keystrokes using motion sensors and sends it back to the device.

7. Advancements in HCI technologies:

7.1. Intelligent and Adaptive Systems:

Majority of the public in today's life uses command or action based interfaces that are not very sophisticated. But researchers are heading towards the design of intelligent systems. Intelligent systems are created by a large scale growth and development in usability and functionality in upcoming devices. Intelligent systems provide a more natural interface to the users and provide them with more pleasurable and satisfying experience. Earlier for writing text, typewriters were used, and then keyboards came into scenario. And now we use touch phones and tablets to write text messages and send to many users. These are also used for writing text in our own handwriting and the system would interpret the text and display it on the screen. New systems have been introduced smart phones in the market which can capture the speech of the users and convert it into text without the need of writing anything at all on the device with our hands. New advances have come in speech recognition interfaces. They can take speech input in a particular language and can convert or translate it into a different language to be produced as output. An adaptive HCI on the other hand does not use intelligence. It simply keeps the tracks of actions performed by the user and remembers the action and use these actions to be performed as suggestions when the user is likely to perform such an action in future. For example, a regular website having graphical user interface selling various products in the market can be called adaptive if it is able to keep a record of his purchases on the site, and keeps a record of the types of searches the user makes so that whenever in future the person visits the same website, he is able to see advertisements and products on the site which relate to his interest.

7.2.   Ubiquitous computing (Ubicomp)

Ubiquitous computing refers to the embedding of virtual computers in the environment which can't be seen or felt by the humans but they are always present around them. The idea is to embed computers everywhere in the objects surrounding human beings and the people are able to interact with more than one system at the same time.

8. Applications of Various HCI systems:

Multi-modal systems offer a wide range of applications over single modal interfaces because they can offer a more user friendly and pleasurable interaction with the system. Few examples of applications of multimodal systems are as follows:

- Helping disabled people
- Intelligent gaming
- E-commerce
- Emotion Recognition
- Medicine

8.1.   Multimodal Systems for Disabled People

These are used by people who are physically handicapped who need different interfaces than normal people. Since these people can't use their hands or body parts for giving input instructions to the systems, they should be provide with system with which they can interact using eye, head movements and speech signals. In such systems both the movement

input and voice inputs are sensed simultaneously in the computer. Head position indicates the coordinate position on the screen whereas the voice signals are used to perform meaningful action on an object selected by the cursor.

A Mobile, Multi-Modal Human Interface Device for People with Disabilities

8.2. Emotion Recognition Multimodal System

Emotion recognition systems detect various behavioral signals produced by humans in order to make out one's emotional state. Generally whether a person is happy or neutral or angry or sad, it may be seen by the effects these emotions cause on their face, body and voice. If we consider making a single mode interface the best option out of these modes of input signal is the face modality as it would produce the best predictions. An increase in 35% of accuracy would be made if we combine the face and body modalities which prove that single modality systems produce lesser accuracy than multimodal systems. Machines classify the emotions as sadness, anger, neutral and happy most accurately when facial and voice data are fused. It has been observed that audio based emotion recognition system provide 70% of accuracy in predicting the mood of a person whereas 89% accuracy is provided by facial expression (visual based) systems. There fusion i.e. bimodal systems which are a combination of both vocal and facial data as input produce an accuracy of 90%.

9. Conclusion:

Human Computer Interaction is a very important part to be considered while building up a new system which has some usability and functionality for the users. A system can be highly sophisticated which can serve wide range of applications but they become worthless if the services provided by the system are not presented properly to the user which finally leads to less understanding between system and users. Because of this the user may not be able to make full use of a system. The upcoming technologies in the field of HCI are ubiquitous computing which is trying to embed computers in environment to make its use more natural. Virtual reality is also a new advancement in the field of HCI. This paper used following references for its creation.

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