Human Computer Interaction – A Review

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ABSTRACT : *A widely accepted prediction is that human user will be in the foreground and computing will move to the background, getting included in our everyday living spaces. If so, then human computing, that is next generation computing will focus on anticipatory user interfaces that should be built for humans based on human models. They should include natural, human-like interactive functions including understanding and emulating certain human behaviors such as affective and social signaling and transcend the traditional keyboard and mouse to. This article discusses human computer interaction, recent advances in the field, systems architecture applications and challenges involved.*

Keywords - *human-computer interaction, ubiquitous computing*

I. INTRODUCTION

The interaction methods by which humans have been interacting with computers have come a long way. The research in this area has been growing very fast in the last few decades and new designs of technologies and systems appear every day [2]. The growth in Human-Computer Interaction (HCI) field has experienced different branching in its history along with quality of interaction. Different research branches have had different focus on the concepts of multimodality rather than unimodality. Also focus on the intelligent adaptive interfaces rather than command/action based ones, and active rather than passive interfaces has surfaced instead of designing regular interfaces.

This paper provides an overview on HCI systems. Basic definitions and terminology of HCI are given. An overview of existing technologies and also recent advances in the field is provided, followed up by a description of the different architectures. The final section pertains to some of the applications of HCI.

II. HUMAN - COMPUTER INTERACTION: DEFINITION

If most sophisticated machines cannot be used properly by men then they are as good useless [5]. Basic argument that should be considered in the design of HCI includes functionality and usability.

What the system can do defines why a system is actually designed i.e. how the functions of a system can help towards the achievement of the purpose of the system.

- Functionality [7]: The set of actions or services that is provided to its users define functionality.
- Usability [7]: The range and degree by which the system can be used efficiently to accomplish certain goals with certain functionality define usability.

Many aspects of human behaviors should be considered in HCI design. The existing interfaces differ in the degree of complexity both because of degree of functionality/usability and the financial and economical aspect of the machine in market. For instance, an electrical kettle need not to be sophisticated in interface since its only functionality is to heat the water and it would not be cost-effective to have an interface more than a thermostatic on and off switch [10].

Therefore, the degree of activity that involves a user with a machine should be thoroughly thought in design of HCI. The user activity has three different levels: affective, cognitive and physical. 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 [6].

III. EXISTING TECHNOLOGY

The relative human sense that the device is designed for categorize the existing physical technologies for HCI. These devices basically rely

on three human senses: vision, audition, and touch [7].

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

Devices that usually need some kind of speech recognition rely on audition and are more advanced. These devices are much more difficult to build since they aim to facilitate the interaction as much as possible. Output auditory devices are however easier to create [10].

Haptic devices are the most difficult and costly devices to build. Through touch, weight and relative rigidity, these kinds of interfaces generate sensations to the skin and muscles. Haptic devices are generally made for virtual reality or disability assistive applications [10].

IV. RECENT ADVANCES IN HCI

- *Intelligent HCI [7]*

HCI designs should provide the users with a satisfying experience, should be easier to implement, and more pleasurable to work with. The interfaces are getting more natural to use every day to realize this goal. A differentiation between using intelligence to make the interface (Intelligent HCI) or in the way the interaction with users takes place (Adaptive HCI) is important.

Interfaces that incorporate at least some kind of intelligence in perception from and/or response to users are called Intelligent HCI designs [12]. On the other hand, interface that do not use intelligence in the creation of interface but use it in the way they continue to interact with users are called Adaptive HCI designs [4]. Finally, another factor to be considered about intelligent interfaces is that ultimate intelligent and adaptive interfaces must be active interfaces while most non-intelligent HCI design only respond whenever invoked by user i.e. they are passive in nature.

- *Ubiquitous Computing [7]*

Ubiquitous computing is unmistakably the latest research in HCI field. Often used interchangeably by pervasive computing and ambient intelligence refers to the methods of human-computer interaction with the deletion of a desktop and embedding of the computer in the environment. This makes them invisible to humans while surrounding them everywhere.

Mainframe era, wherein many people one computer model was used, was the First Wave of computing. The Second Wave was called PC era where one person one computer model was used. Ubiquitous Computing is named the Third Wave of computing where many computers one person model is incorporated [6].

V. HCI SYSTEMS ARCHITECTURE

- Unimodal HCI Systems [7]

An interface relies on an input from the user. This input needs to come via some channels. Modality is defined as each of the different independent channels. A unimodal system is based on only one modality. They can be divided into three categories based on the nature of different modalities:

1. Visual

The visual channel is the most widely used in HCI. Based on different types of applications of a system, researchers have tried to incorporate the visual channel in various areas. Some of the applications include [3]:

- ➢ Detection of Gaze
- ➢ Tracking of Body Movements
- ➢ Analysis of Facial Expression
- ➢ Gesture Recognition

2. Audio

Another important modality in HCI systems is the audio channel. It deals with signals acquired by the

audio channels of a system. The audio channel is more reliable than the visual channels, even though visual channels provide a larger variety of information. Research areas in this section are divided as [3]:

- ➢ Recognition of Speech
- ➢ Analysis of Auditory Emotion
- ➢ Detection of Signs and Human-Made Noise (Laugh, Cry, Gasp, Sigh, etc.)
- ➢ Interaction via Music

3. Sensor

This section has a variety of wide range of applications. The only point of similarity is that at least one of the sensors is used between the user and the machine for interaction. The following types of sensors are usually employed [8].

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

• Multimodal HCI Systems [7]

Multimodal HCI systems refer to a combination a two or more of the modalities being combined for interaction. The channels generally used for the task are derived from human users such as his senses like hearing, sight, touch, taste, etc. However, the systems may use these along with other channels and so the use of these modalities is not mandatory. Therefore, a multimodal interface goes beyond the traditional keyboard and mouse and acts as a facilitator of human-computer interaction via two or more modes of input [9]. The use of different types of modalities may vary widely from one multimodal system to another.

VI. APPLICATIONS

1. Interactive Control of Music[1]

We discover an interface to mix pieces of music by moving their body in different emotional styles. In this application, the user's body is a part of the interface. The system analyzes the body motions and produces a mix of music to represent expressed emotions in real time. To classify body motions into emotions, the machine learning is used. To begin, training phase is needed. After the training part, the system is able to recognize user's natural movements associated with each emotion.

2. Tele-home health care[1]

The goal of this system is to provide communication between patient and medical professional via multimedia and empathetic avatars when hands on care are not required. The Tele-HHC can be used to collect different vital sign data remotely.

3. Arthur and D.W Aardvarks[1]

Positive emotions play an important role in learning and mental growth of children. Two animated, interactive plush dolls ActiMates Arthur and D.W. were developed. Seven sensors located in their body allow children to interact with them. When the dolls speak three emotional interactions are used: humor, praise and affection. Children interact with these dolls to play games or to listen to joke. The goal of these dolls is to promote the mental growth of children through the systematic use of social responses to positive affect during their playful learning efforts.

4. Multimodal Systems for Disabled people [7]

One good application of multimodal systems is to address and assist disabled people (as persons with hands disabilities). In such systems, disabled users can perform work on the PC by interacting with the machine using voice and head movements. Two modalities are then used: speech and head movements. Both modalities are active continuously.

5. Emotion Recognition Multimodal Systems [7]

A natural human-computer interaction cannot be based solely on explicitly stated commands. Computers will have to detect the various behavioral signals based on which to infer one's emotional state. People are able to make prediction about one's emotional state based on their observations about one's face, body, and voice. Facial features and body posture features are combined to produce an indicator of one's

frustration. Machine classification of emotion is better when based upon face and body data, rather than either modality alone. Machine classification of emotion as neutral, sad, angry, or happy was most accurate when the facial and vocal data is combined.

6. Multimodal Human-Robot Interface [7]

Human-robot interfaces usually have to provide mechanisms for pointing to particular locations and for expressing operation-initiating requests. The human-robot interface built by the Naval Research Laboratory (NRL) allows users to point to a location while saying "Go over there". Additionally, it allows users to use a PDA screen as a third possible avenue of interaction. Another multimodal human-robot interface is the one built by Interactive System Laboratories (ISL), which allows use of speech to request the robot to do something while gestures could be used to point to objects that are referred to by the speech.

VII. CONCLUSION

Human behavior understanding is a complex and very difficult problem, which is still far from being solved in a way suitable for anticipatory interfaces and human computing application domain. In the past two decades, there has been significant progress in some parts of the field like face recognition and video surveillance [11]. Although the research in different parts of the field is still detached, and although there remain significant scientific and technical issues to be addressed, we are optimistic about the future progress in the field. The main reason is that anticipatory interfaces and their applications are likely to become the single most widespread research topic of AI and HCI research communities. Even nowadays, there are a large and steadily growing number of research projects concerned with the interpretation of human behavior at a deeper level.

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