A Review on Human-Computer Interaction (HCI)

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Abstract— Human-Computer Interaction (HCI), has risen to prominence as a cutting–edge research area in recent years. Human-computer interaction has made significant contributions to the development of hazard recognition over the last 20 years, as well as spawned a slew of new research topics, including multimodal data analysis in hazard recognition experiments, the development of efficient devices and sensors, and the human-computer interaction safety management platform based on big data. The basic concepts and terminology, existing technologies, and recent breakthroughs in the field of HCI are all included in this research paper's overview. The ability to respond and sense efficiently and appropriately in response to user affective feedback, as well as to detect and comprehend the affective states displayed by the user, is the first step toward developing an intelligent HCI. This paper also looks at several methods for HCI design. In addition, this paper includes a thorough list of references for each HCI idea, method, and application. In addition to being user centric, we design with both usability and business goals in mind. Rather than focusing solely on the application's functional objectives, our design will need to address the entire customer experience. The customer experience will determine how users/customers see the organization as a viable and trustworthy brand both online and offline. To attain these objectives, we must address several fundamental difficulties with the ART (Access, Relationship, and Trust) of interface design.

Keywords—Human-Computer Interaction (HCI), Architecture and design, Emotional intelligence, E-commerce, Applications.

I. INTRODUCTION

Human-Computer Interaction (HCI), as the name implies it's comprised of three parts namely the user, the computer, and their interaction. It refers to the concept or principle of high and low fidelity, which is basically called exactness with which anything is replicated. The capacity to respond to the sense properly based on the user's affective feedback and identify and then analyzing user's affective states is the first step towards an intelligent HCI [1].

It is based on the idea of the science concerned with the designing of an effective web user interface between the users and the computers, which means that the process of exchanging information that is happening between a human and computer using leave kind of conversational language to achieve our goal on the task. Some of the applications of HCI are found in electronic commerce, team collaboration, culture and globalization, and information technology in health care.

For specifying a picture sequence to be generated by a computer, special animation languages have been developed. Despite the fact that this method of computer animation has provided some organization and control over the specification of image sequences, most animators are unable to use the computer due to communication difficulties [2].

The conundrum of whether computers will make it simple or complicated for humans to know who they are, identify their genuine problems, respond more fully to beauty, place sufficient value on life and make their society safer than it now [3].

Despite what some call the "internet crash," web use for e-commerce continues to increase as more established brick-and-mortar businesses add online components into their marketing efforts. Companies cannot simply trust that if they establish web sites, customers will come as competition for online client rises. The truth is that the internet is largely about "immediate gratification". Users expect to be able to find the information they need quickly and with the minimal effort. The buyer seller relationship is subjected to unique sets of constraints in the web-based environment that do not exist in traditional transactions.

II. LITERATURE REVIEW

Following a survey of related literature, this paper initially introduces the Multimodal Interaction System, including its design and operating mechanism, as well as practical applications. Apart from standard technology devices such as keyboard, mouse, and screen touching, the latest voice and face expression recognition technology can be employed for
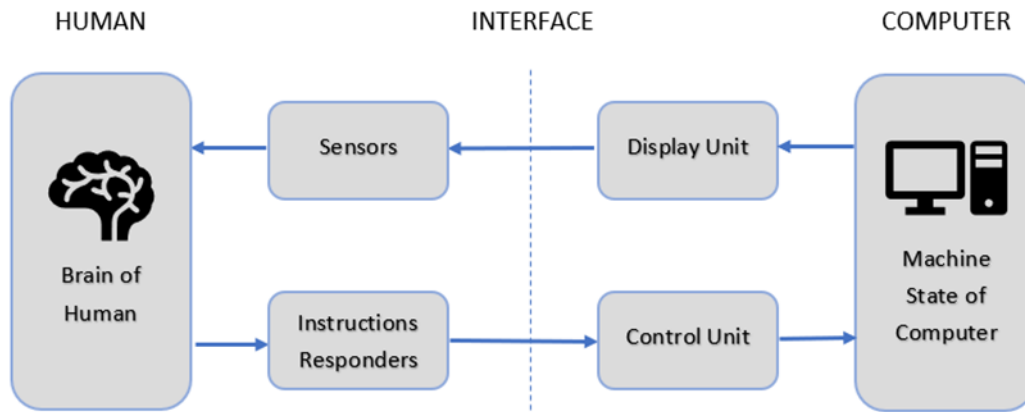
Fig. 1. Human Factors view of the human operator in a work environment

data input. The standard screen display, as well as the most up-to-date voice, face expression synthesis and gesture generating, can be employed for output. This review paper discusses a number of various major research topics in the field of human-computer interaction in the context of e-commerce. It identifies some of the difficulty users have when exploring Web sites and doing information searches, as well as various study areas for improving navigation and search. It also examines the importance of emotional intelligence in the realm of human-computer interaction, where the initial answer is to recognize the Basic Emotions utilizing cultural commonalities for easy differentiation. Once you've gotten over the basic emotional, cultural, and individual differences, you'll run into design challenges and opportunities.

III. HUMAN-COMPUTER INTERACTION: BASIC DEFINITION, TERMINOLOGY

HCI in other words known as man-machine Interaction, which is the interaction between the man and machine, or we can call it interfacing [4]. HCI is built on the idea that even the most advanced machines are worthless until and unless they can use by the public, and to avoid this, the basic HCI design is based on functionality and usability.

The Functionality of the effective HCI is defined by how the actions are being responded to the users, and how the functions of a system can provide help towards the main goal of the user. The values of the functionality can be identified truly when it is efficiently used by the user [4]. Communication and information technology are becoming increasingly important in our lives as the development and the of implementation information systems accelerates. As it becomes persuasive and fundamental [5].

The breadth and degree to which a system can be used to fulfil the task given efficiently and appropriately are referred to as the usability of a system with a specific capability. The proper balance between functionality and usability defines the actual effectiveness of an HCI system [4].

Having all these references and ideas in mind, HCI should be designed in such a way that it balances the interface between the user and the computer, to enhance the performance both in service quality and effectiveness of a service.

IV. HCI OVERVIEW

The advancements in human-computer interaction (HCI) over the last decade have made it practically impossible to tell what is fiction and what is and can be real. Many aspects of human-computer interaction (HCI) technology are centered on more in-depth interpretations of human behaviour. The constant twists in marketing and the thrust of research enable new technologies to become widely available in a short period of time. HCI is most likely to become the only truly global study topic in the Artificial Intelligence (AI) community. If a breakthrough in HCI design is made, the world could be forever changed.

A. Existing Technologies

In order to create an effective HCI design, several factors of human behaviour are considered. When compared to the simplicity of the connection, a human's engagement with a man-machine is sometimes imperceptible. The present interface on the market differs in terms of both functionality and usability, as well as the machine's financial and economic aspects [4]. To offer you some improvements in the physical side of the interaction, as well as several methods of interaction that may be combined, and to demonstrate how each approach can be enhanced for even greater performance resulting in a better and faster user interface. Existing HCI physical technologies are built on human behaviour and are meant to support it, and these devices can rely on human senses: the senses of sight, hearing and touch and feel.

Human vision-based input devices, including switches and pointing devices, are the most often utilized. Buttons and switches are one of the examples, whereas graphic tablets, touch-based panels, trackball mouse, and stylus inputs are an example of the latter. One example that fits into both

categories is the joystick. Pointing devices or visual displays can also be used as output devices.

Auditory-based devices are often more advanced than those that need voice recognition and aim to make interaction as simple as feasible. Non-speech and speech signals, as well as messages created by output signals, are all examples of output auditory services. Beeps, alarms, GPS, and other similar devices are an example of this.

Another sort of device is a haptic device, which uses weight, touch, and relative harness to induce sensations in the skin and muscle. These gadgets are typically used for virtual reality or assistive technology.

Existing approaches and technologies are now attempting to integrate with newer technology like networking and animation.

Wearable gadgets, wireless devices, and virtual devices are among the recent innovations. All of this is occurring so quickly that we can't tell where the lines between these new technologies are. GPS navigation systems, military super-soldier augmenting gadgets, radio frequency identification (RFEID) goods, virtual tours for real estate businesses, personal digital assistance (PDA), and many others are just new examples [4].

B. Recent Technologies in HCI

The recent directions and advances of research in HCI are mainly adaptive interfaces and ubiquitous computing which includes the different levels of user activity and is physical, cognitive, and affection.

- *Intelligent and adaptive HCI*

  The majority of devices used by the public are kind of plain command action setups using no such simple physical apparatus, and thus it is directed the research of intelligent and adaptive interface. In order to build HCI design for a satisfying experience. To incorporate this the Interfaces are getting more natural to use every single day. From typewriter to where we are right now and that is using PCs to write with your handwriting or even you can say and it will convert it to the text.

  To build a new generation interface its important to distinguish between applying intelligence in the creation of interface (intelligent interface) and how the interface interact with people (adaptive HCI). This includes at least some sort of intelligence in perception from and/or response to users. An Example of the same is the speech-enabled interface that uses a natural language to interact with the user.

  Adaptive HCI designs may not include intelligence in interface building but they do use intelligence in some way to communicate with users. A website that uses a

graphical user interface to offer things is one example. This site would be helpful and adaptive if it will be able to recognizes the user and stores information about his searches and transactions or automatically recommend products that are on sale or which he might need. The majority of these adaptations cope with user's cognitive and emotional level of activity.

Another example that combines the two is a PDA or a tablet PC with handwriting recognition capabilities.

The absolute difference between the two that is intelligent interfaces are passive in nature whereas the intelligent and adaptive interfaces are active in nature. Examples are smart billboards or advertisements.

- *Ubiquitous Computing*

  Mark Weiser, then the chief technologist of Xerox PARC's Computer science Lab, was the first to describe the concept of ubiquitous computing in 1998 [2].

  The concept was to allow people to connect with several computers at once while remaining unseen to them and wirelessly taking with one another by placing them around our surroundings.

  The third way of computing has been dubbed UBI comp computing. The first wave was the core period when many individuals shared a single computer, and the second wave was when one person shared a single computer [4].

V. HCI SYSTEM ARCHITECTURE AND DESIGN

To have multiple task performance which is suited for human multi- modelling Executive process interaction control EPIC is a cognitive architecture [6].

Ebert offered four HCI design approaches that may be applied to the user interface design in order to generate an efficient user interaction experience. One or more techniques can be employed in the single user interface design.

The 4 approaches are below [1]:

- Anthropomorphic Approach:

  This method builds in creating a human interface that has human-like features or characteristics.

- Cognitive Approach:

  This method was used to build and use a user interface that supports the end-user and takes the account of the human brain and sensory recognition abilities.

- Empirical Approach:

This method is used to analyse and compare the utility of multi-conceptual architectures.

- Predictive Modelling Approach:

The GOMS approach is used to examine and assess a user's experience in terms of the time, to fulfil a goal efficiently and effectively.

In GOMS, g stands for goals, o for operators, m for methods and s for section rules.

prototyping techniques that enable them to focus on high-level interaction design instead of details or visual style [7].

Low Fidelity Prototyping:

This method of product and design translation is basic and straightforward and also known as low tech prototyping.

It's utilized to convert design concepts into concrete, tested artefacts by gathering and assessing user demand early on.

Low-Fidelity

Paper-based sketches

Paper-based storyboard / PICTIVE

Computer aided sketches / storyboard

Wizard of Oz / Slide shows / Video prototyping

Computer-based scenario simulation

Computer-based Horizontal simulation

Computer-based Vertical simulation

Computer-based full functionality simulation
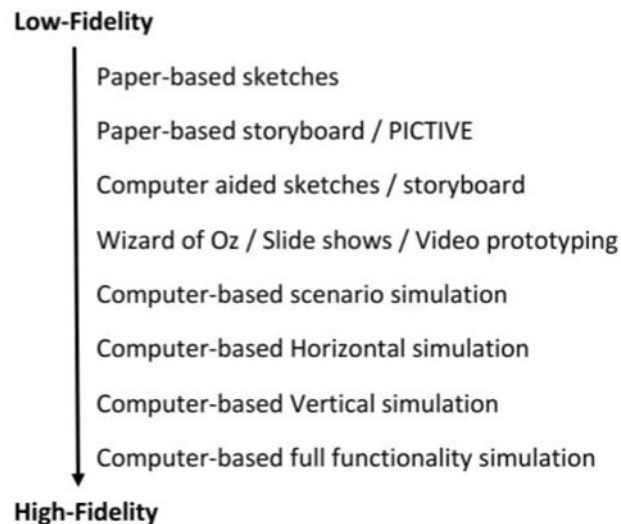
High-Fidelity

Fig. 2. Precedence diagram of HCI.

The time it takes a human to complete a specific goal is calculated using an accurate measure of that human's performance.

Fidelity is a method of creating simple prototypes for a well-known product that can be adjusted to modify or focus on the design. Designers and consumers can benefit from quick, low-

High Fidelity Prototyping:

This type of prototyping is extremely interactive, and is close to the final product in terms of features. It's utilized in usability testing to find out whether there are any concerns that might arise later in the workflow, such as interaction.

- Sensor-based – For instance, stylus interaction, gamepad sensor, input devices sensor, taste/smell sensor, and so on.

A. Unimodal Hci System

In HCI, an interface's inputs and outputs, which are essentially transmit channels that allow humans to engage with the computer via this interface, are primarily determined by the amount and variety of its inputs and outputs.

Each single channel is referred to as a modality. A unimodal system is one that only uses one modality. They may be split into three groups based on the number of various modalities:

- Vision-based – For example, identification of facial movements, body movements, and gestures.

- Audio-based – For instance, voice recognition, speaker identification, audio recognition, etc.

B. Multimodal

The Multimodal concept refers to the combination of multiple modalities. Research disciplines such as computer vision, intelligence, group vision, psychology, and many more are all part of multimodal human interaction [8]. These modalities correspond to the manner in which the system responds to input, i.e. communication channels, which are inherited from human modes of communication, which are essentially its sense: hearing, touch, smell, and uses taste, but not restricted to these. Therefore, a multimodal interface facilitates HCL by providing two or more types of input in addition to the keyboard to the keyboard and mouse. There can be differences between multimodal systems. Different mixes of speech, gaze, and other non-conventional of input are

used in these systems. Collaboration of several modalities to aid the recognitions example is an intriguing idea. Lip movement monitoring (virtual) can aid with speech recognition (audio-based).

Multimodal systems benefit from modelling at many levels of abstraction, as platforms imply implementation using primitives that are far distant from ideas like modality or multimodal integration. As a result, rather than identifying an interaction like voice or gestures, the model focuses on the general properties of HCI modalities regardless of their precise manifestations [9]
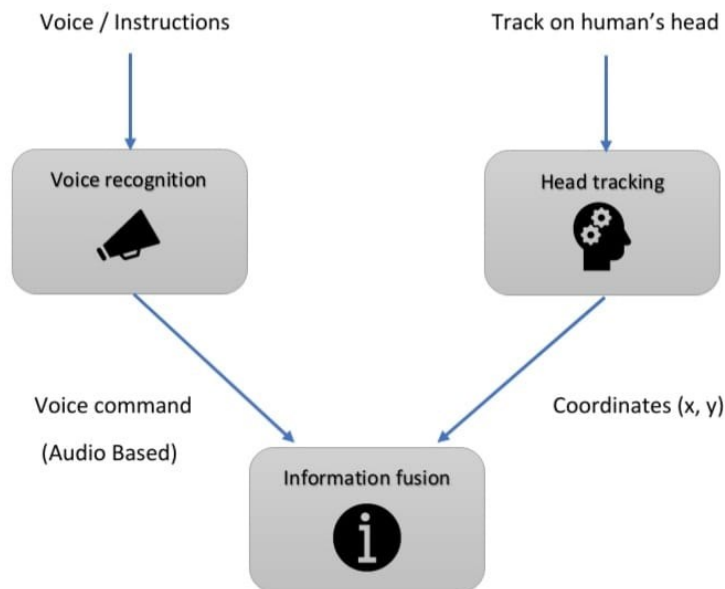

Fig. 3. Diagram of a bimodal system

VI. EMOTIONAL INTELLIGENCE IN HCI

The question of which interface should an HCI designer focus on [4]. The first solution is simply the Basic Emotions that may be recognized using the benefit of cultural similarities for easy discrimination. Once you get over the basic emotional, cultural, and individual variance, you'll run into difficulties and potential for designers.

When an interface is viewed as a tool, criteria like learnability, efficiency, and accuracy are prioritized, resulting in application-specific goals [11].

If we consider the interface to be a medium, then uses and gratifications come into play. The terms "infotainment" and "edutainment" refer to attempts to balance the job and impact.

In order to accurately portray the emotion, a minimum level of exactness is essential [12].

A user's level of confidence is also required for the interface to properly act on their emotional state. Any interaction between two individuals is reacted to by one person assessing the other's emotional state and responding accordingly. How do interfaces keep track of our mood? There is frequently a sense of "surreptitiousness" or "exploitation" when robots gather and act on information about users without making the acquisition and adoption obvious. If customers want software that monitors and adapts to their emotions, there are sufficient benefits to publicizing and promoting these capabilities. Computers, on the other hand, maybe highly useful when it comes to human engagement, resulting in deeper relationships.[12].

VII. APPLICATIONS

An Interactive system is a key to successful human-computer interaction. It involves the bringing together of understandings of human abilities, and a basic understanding of hardware and software technologies [10].

Applications of HCI in our day to day life:

In global development:

A. Industry:

The mobile phone, mobile phone is a wireless hand-held communication tool that enables call making and receiving. Modern mobile phones are far more versatile than their predecessors, which could simply make and receive calls. They can now support web browsers, games, cameras, video players, and navigational systems.

B. Methodological Innovations

Based on utility, reproducibility, validity, and reliability methodological contributions are formed [13].

- Method application. Consolvo, S., and Walker M. Using the experience Sampling method to evaluate ubicomp applications.

- Method innovation. Druin, A. Cooperative inquiry: Developing new Technologies for children with children.

- Method adaptation. Millen, D.R. rapid ethnography: Time deepening strategies for HCI field research.

Few other purposes of a multimodal system are:

- Intelligent homes and offices

- E-commerce

- Smart video conferencing

- Driver monitoring

- Intelligent games

Research contribution types in human-computer interaction are both technological and related to human behaviour [14].

C. E-commerce

The growing emphasis on e-commerce will alter our perceptions of human-computer interface design. We'll need to be more customer-centric, as well as user-centric, and include both usability and business objectives into our designs. Rather than focusing solely on the application's functional aims, the designs will need to address the entire customer experience. The customer experience will determine how users/customers see the organization as a viable and trustworthy brand both online and offline. To attain these objectives, we must address several fundamental difficulties with the ART (Access, Relationship, and Trust) of interface design [15].

VIII. CONCLUSION

HCI is the critical component of system design, and as we all know, the quality of a system is determined by how it is represented and utilized by users. HCI is built on people interacting with computers in a way that makes it simple to use and is completely reliant on humans / utilizes and follows the user's commands. In intelligent, multimodal adaptive, natural ways of interaction, research in new disciplines of HCI is being done to replace typical regular means of interaction with multimodal adaptable, intelligent, natural methods. As a result, you'll have a useful direction for navigation in the field of HCI, and you'll be able to take your initial steps. Emotional intelligence is an emerging field of HCI that will help the great potential to become the widely used protocol of upcoming time period. E-commerce human-computer interaction is an important study field. Designing useable and productive Web sites, especially in the e-commerce scenario, necessitates a thorough understanding of Web-based interaction. The amount of research that demands attention is remarkable, given the popularity of the WWW and the ongoing introduction of new technologies developed for the Web E-commerce has become a reality because to advances in Web-based technology; unfortunately, a lack of trust, or the difficulty of establishing trust in an online context, is a fundamental barrier to the future of e-commerce. Ambient intelligence or Ubiquitous computing tries to incorporate technology into the environment. By combining multimodal approaches with HCI technology, several implementations of multimodal methods have energized hazard recognition research, surmounted the limitations imposed by unimodal, and generated dozens of new study subjects. This paper gives an overview of these subjects as well as an assessment of previous research via a thorough reference list.

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