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A Methodological Study of Human-Computer Interaction: A Review

Hiren Dhakecha
JN Softech, Surat-385006, India

Abstract: The concept of human-computer interaction has emerged as a result of advancements in computer technology. As emerging technologies in the fields of mobile and cloud computing, as well as the internet of things (IoT), become more and more ingrained in our daily lives, they have started to pose a serious challenge for professionals in human-computer interaction (HCI). These technologies call for greater dedication from HCI experts in terms of systems interface design. A comprehensive study of human-computer interaction (HCI) has been presented in the current study. The design process of human-computer interaction and the current state-of-art of the same is explained in brief along with the applications of HCI. Based on the results of the review, the study recommended combining human-centred design with agile interface design methodologies. It also encouraged future research using a qualitative or quantitative approach to further explore HCI interface design methodologies, with a focus on cloud-based, AR, VR technologies and other organizational information systems.

I. INTRODUCTION

Digital technologies are now used for interaction in the contemporary environment. One of the most fundamental components of all fields and industries nowadays is computing. Mobile computing has emerged as one of the key trends in our period among all the modern technologies [1]. In several cutting-edge fields, technological interaction has been given prominence. From the technological standpoint, interaction elements are equally crucial since they make a product simple to use and maintain for the user [2]. By integrating itself within the systems with the aid of various technological acceptance theories, artificial intelligence (AI) is playing a crucial role in increasing the flexibility and intelligence of interaction [3]. The field of human-computer interaction (HCI) is mostly utilized to facilitate user engagement with technology [4].

Usability is something that is practised and studied in human-computer interaction. It is about the interaction between a person and a machine, their shared understandings, and the development of software that would make life easier for people and that they would like to use. It is also possible to describe it as a study of how people interact with computers to accomplish things in a pleasant and efficient way [5, 6]. It consists of three components, the user, the computer, and how they interact, as the name would imply. It entails sketching low and high fidelity or the level of accuracy with which an item is replicated. The first stage in developing an intelligent HCI is to equip it with the skills necessary to detect, understand, and react correctly to the affective input provided by the user. Figure 1 depicts the development of the HCI [7].

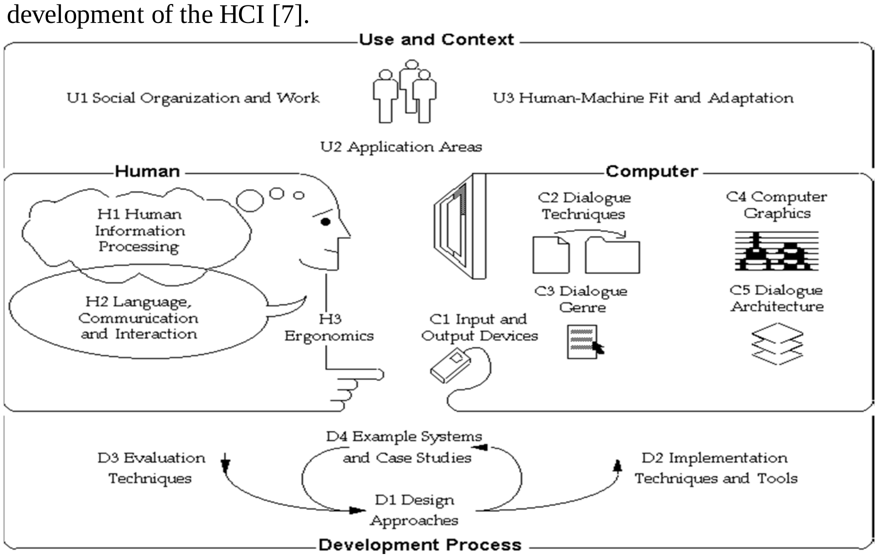

Figure 1: Development of HCI [8]

Humans, who are the product's users, generate and consume the HCI product. Memory, attention, problem-solving, learning, motivation, motor skills, conceptual models, and diversity are characteristics of the human/user as a processor of information that must be understood to comprehend humans as an information-processing system, how they interact, and these characteristics. Humans excel at doing complex, imprecise calculations [9]. Because they have unique components that can communicate with users, computers are utilized for user interaction. The computers also give users a platform to think through and engage with the elements, facilitating efficient learning. Computers are good in counting and measuring, precise storage and recall, quick and reliable answers, data processing or calculation, formulas, repetitive activities, and performance over time. The skill set is kind of complement. To produce an effective product, a computer and a human must interact. The interaction between a user and a computer is two-way [10, 11].

II. LITERATURE REVIEW

The study will provide a detailed analysis of the evaluated works that pertain to human-computer interaction design techniques in the sections that follow by synthesizing the prior works.

According to its definition, human-computer interaction is a field concerned with the "evaluation, design, and implementation" of efficient computing systems [12, 13]. HCI is the most crucial step in the design of any type of computer system since it is a crucial component of "man-machine systems" [14]. whose presence is intended to achieve a shared communication as well as the task itself to develop a shared platform between "people and machines" in order to comprehend the actions carried out by the machines, such as "creating input and output ways of information" [15, 16]. The success of any interface design depends on how well it enables "communication between human and computer systems" in its entirety [17].

In a similar vein, [18] emphasized that a good user interface achieves faultless and harmonic interactions between human and computer systems, as this is the only way people's mental loads can be essentially compressed and their "operational capacities" improved [19]. Because of the interface's "composition of regulator board consisting of display and organiser, touch screen integrated by regulatory and showing, and another software interface," users today regard it as the system [20]. It can be utilized in intricate products or systems.

The process of "input & extraction" of data and information occurs during "human and computer" interaction through an interface created for that purpose, users enter their commands to the system, which looks at the commands, computes and processes them, and then delivers back the results to users through the same interface [21, 22]. Today, individuals and systems entered and exited each other in a variety of ways, including "data communications, numerical and symbolic engagement, speech interaction, and intelligent interactions," etc. [23].

Additionally, [24, 25] claimed that the interface design process for human and computer interactions can be broadly separated into three portions: "the interactive design, structure design, and visual design," and that these three were further classified into subclasses [26]. For instance, "the kinds of interactions" and "how the interaction takes place" can be further separated in interactive design, which focuses on how people engage with systems [27]. Similar to this, [28] emphasized that when designing an interactive interface, "interactive design" must take into account the following: people's orientation, consistency, users' operation ability, shortcuts, help & feedback. This is the only way that an interface can be effective for users [29]. Gain, structure design may be further broken down into three categories: "user needs analysis, task design, and task purpose" [30]. which analyzes the demands of the individual, the purpose of the work, and the task's design [31].

Finally, "visual design," which has do with including "complexion & graphics," aims to make users satisfied with the interface [32]. However, research has indicated [33], Over the past ten years, the "HCIdiscourse," which focuses on new approaches for designing contemporary information systems (emerging technologies), has consistently urged a reconsideration of current approaches to interface design [34]. With a growing focus on understanding HCI methods for information systems development, the standard of HCI interface approaches to developing technologies has recently become a discussion point among information systems experts' study of information systems [35-37]. The bulk of design techniques now utilized by "Human-Computer Interaction" professionals, according to [38, 39], are not useful since they don't fit or take into account how design is used in the "real world" [40]. In a similar vein, [41] emphasized that "digital technologies" in the field of health care are creating a greater challenge for HCI specialists as "we now live in the time of change" from an era where individuals are likely to be involved in decision-making regarding their health [42]. using cutting-edge techniques that supported information resources. Consequently, new approaches to the construction of information systems are required.

III. DESIGN PROCESS OF HUMAN-COMPUTER INTERACTION

In order to provide an intuitive, methodical, and user-friendly user experience for the users, Ebert identified four human-computer interaction design techniques that may be applied to user interface designs. One user interface design may incorporate one or more strategies. The four methods for creating a user interface are as follows [43-45]:

1) *Anthropomorphic Approach:* This methodology entails creating a human interface with human-like traits.
2) *Cognitive Approach:* This methodology is used to create an interface that helps the user and takes into account the capabilities of the brain and sensory perception.
3) *Empirical Approach:* Utilizing this method, multi-conceptual designs' usefulness is examined and contrasted.
4) *GOMS Method:* The acronym GOMS is made up of the letters G for goals, O for operators, M for methods, and S for section rules. The GOMS approach is used to look at and assess a user's experience in terms of how long it takes them to efficiently and effectively fulfil a goal.

IV. CURRENT STATE-OF-ART

The device's relative human sense classification of the physical technologies is now in use for HCI. These gadgets primarily rely on the three senses of vision, audio, and touch [46]. The most popular pointing or switch-based input devices depend on visual perception. Switch-based devices are any types of user interface that employ buttons and switches, such as a keyboard. The pointing devices include things like mice, joysticks, touch screen panels, graphic tablets, trackballs, and pen-based input. The only devices with switches and pointing capabilities are joysticks. Any type of visual display or printing equipment can be used as an output device [47].

Advanced devices that often require some form of speech recognition rely on audition. Since these devices want to make interaction as easy as possible, they are far more challenging to construct. However, it is simpler to make output auditory devices [48]. The most expensive and challenging to construct are haptic gadgets. These interfaces produce sensations in the skin and muscles through touch, weight, and relative rigidity. Haptic devices are typically created for virtual reality or applications that aid people with disabilities [49].

HCI designs ought to be more enjoyable to use, easier to deploy and give users a gratifying experience. Every day, the interfaces used to achieve this purpose become easier to use. It's critical to distinguish between intelligent user interface design (Intelligent HCI) and adaptive user interface design (HCI), which changes how humans interact with technology. Intelligent HCI designs are interfaces that incorporate at least a minimal level of intelligence in user response and/or perception [50]. Conversely, adaptive HCI designs refer to interfaces that do not use intelligence in their initial development but do so in subsequent interactions with users [51]. Last but not least, another aspect of intelligent interfaces to take into account is that, in the end, intelligent and adaptive interfaces must be active interfaces, whereas the majority of non-intelligent HCI designs only react when the user invokes them, or are passive in nature.

Undoubtedly, the most recent HCI research is in the area of ubiquitous computing. Pervasive computing and ambient intelligence are terms that are frequently used interchangeably to describe ways of interacting with people and computers that do away with desktops and integrate computers into their surroundings. They surround humans everywhere, making them invisible to us. The First Wave of computing occurred during the mainframe era when numerous users shared a single computer model. The one-person, one-computer model was employed during the Second Wave, also known as the PC era. The Third Wave of computing, known as ubiquitous computing, incorporates the "many computers, one person" paradigm.

V. APPLICATION

A. *Augmented and Virtual Reality (AR and VR)*

The objective of the field of human-computer interaction (HCI) is to develop new software and hardware that can identify and understand human traits and behavior in order to increase the efficacy and efficiency of human-computer interactions. By offering more organic and effective ways for a user to engage with a real or virtual environment, advancements in HCI technology can result in improved virtual reality (VR) and augmented reality (AR) experiences. Providing a person sensory input that simulates being present in a real or imagined setting is known as virtual reality. The sensory input is typically only confined to sight and hearing, though it can also include other senses including touch. A live direct or indirect experience of an environment is combined with computer-generated sensory input, typically in the form of images, video, and/or sound, to create augmented reality.

Applications of virtual reality and augmented reality (VR and AR) include, but are not limited to: education - enhanced learning experiences; medical and healthcare - treatments for PTSD, phantom pain, anxieties and phobias, and autism in children; support for difficult tasks like surgery, equipment assembly, or maintenance and repair by adding relevant information to the user's field of view; training for medical professionals, law enforcement, the military, and emergency responders; engineering and design; telepresence - for meetings and remote workers; market research - experiencing a virtual product that doesn't yet exist; architectural design - experiencing a virtual building before it is built; Tourism, product advertising and promotion, computer games, and entertainment including movies, music, and sports.

B. HCI in UX

Through study on HCI design methods, contemporary user experience design has developed. Research has assisted fields like interface design, user-centered design, and micro-interactions by identifying the best engagement strategies to enhance product usability, functionality, and the user's enjoyable experience. Techniques for UX design have been influenced by HCI design.

C. Multimodal Human-Robot Interface

Human-robot interfaces typically need to have ways of pointing to specific places and making requests that start operations. The Naval Research Laboratory (NRL) developed a human-robot interface that enables people to direct a robot to go somewhere by pointing at it and saying, "Go over there." Additionally, it enables PDA screens to be used by users as a third mode of communication. The interface created by Interactive System Laboratories (ISL) is another multimodal human-robot interface that enables the use of speech to request the robot to perform something while gestures could be used to point to items that are referenced by the speech [52].

D. Emotion Recognition Multimodal Systems

The only basis for a meaningful human-computer connection cannot be explicitly given orders. Computers will need to be able to recognize the numerous behavioural cues from which to infer an individual's emotional state. Based on their observations of someone's face, body, and voice, people are able to forecast someone's emotional condition. An indicator of one's displeasure is created by combining facial traits and body posture characteristics. Instead of using either modality alone, machine categorization of emotion performs better when based on facial and body data. When facial and verbal data are combined, machine classification of emotion as neutral, sad, angry, or pleased is most accurate [53].

E. Multimodal Systems for Disabled people

One effective use of multimodal systems is to support and cater to people with impairments (such as persons with hand disabilities). In such systems, people with disabilities can work on the PC by speaking to it and moving their heads. Speech and head movements are thus employed as two modalities. Both modes are constantly in use [54].

F. Interactive Control of Music

By moving the person’s body in various emotional styles, a way is created to combine musical components. The user's body functions as the user interface in this program. In order to portray expressed emotions in real-time, the system detects body movements and creates a musical mix. The machine learning method is employed to categorize body motions into emotions. A training phase is required to get started. Following the training phase, the system can identify the user's natural movements that correspond to each emotion [55, 56].

G. Arthur and D.W Aardvarks

Children's learning and mental development are significantly influenced by their positive emotions. ActiMates Arthur and D.W are two animated, interactive plush dolls that were created. Children can communicate with them because of seven sensors on their bodies. Three emotional reactions are used by the dolls when they speak: comedy, adulation, and praise. These dolls are used by kids to play games or laugh at jokes. These dolls are designed to encourage children's mental development by methodically using social reactions to positive affect during their enjoyable learning activities [57].

H. Tele-home health care

When hands-on care is not necessary, this technology aims to give patient and medical professional connections via multimedia and sympathetic avatars. Remote vital sign data collection is possible with the Tele- HHC [58].

VI. CONCLUSION

The Artificial Intelligent research community's single most popular area of study is most likely to be human-computer interaction (HCI). The unexpected finding in HCI design may cause a profound impact on the world. There are many facets of HCI technology that deal with deeper interpretations of human behaviour. HCI will significantly alter the world. Since human-computer interaction is based on how people interact with computers, it would be more desirable because it is simple to use, completely dependent on people/users, and operates in accordance with user instructions. People's work in the future will be made easier by a small effort in this area. Understanding human behaviour is a complex and challenging subject that is still far from being resolved in a way that is appropriate for anticipatory interfaces and the application domain of human computing. Some areas of the industry, such as facial recognition and video surveillance, have made tremendous development over the last 20 years. Researcher's are enthusiastic about the field's future development even though research in several areas is still fragmented and despite the fact that there are still important scientific and technical problems to be solved. The primary reason is that anticipatory interfaces and applications are probably going to overtake other topics as the most popular ones among AI and HCI researchers. Even now, a sizable and continuously expanding number of research initiatives are focused on the deeper interpretation of human behaviour.

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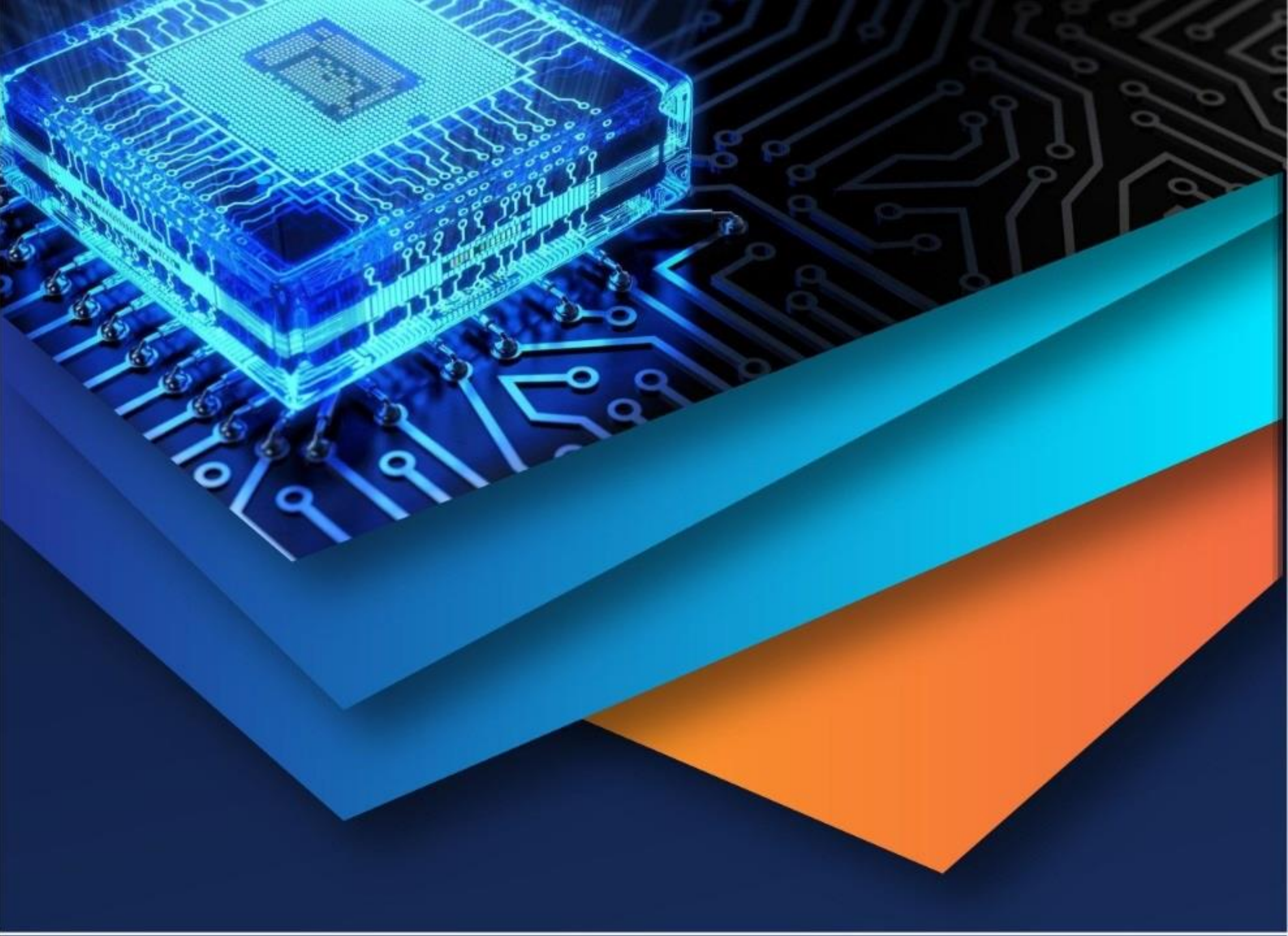

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