ISSN No:-2456-2165

The Impacts of Artificial Intelligence and Nanotechnology on Human Computer Interaction

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Abstract:- The relevance of any computer depends on its functionality and how easy it is for users to interact with. The impact of artificial intelligence and nanotechnology on Human Computer Interaction explores the extent with which artificial intelligence and nanotechnology improves the interaction interfaces between humans and computers. In particular, this work examines the architecture of Human Computer Interaction on the bases of number of inputs acceptable by the interacting interface, possible ways by which artificial intelligent technology and nanotechnology fits into Human Computer Interaction interfaces as well as benefits that are associated with proper harmonization of these fields.

Keywords-*: Artificial-Intelligence, Nanotechnology, Human-Computer-Interaction, Unimodal-Interaction, Multimodal-Interaction.*

I. INTRODUCTION

Right from the time of punch cards till now, the human-computer interaction (HCI) background has gone through a lot of advancements. Researchers in this field continue to demand for new ways of bridging the gap that exists between man and computers [1]. This determination motivates the researchers to develop keyboards, mouse and touch screens, which made computational power more accessible. There is now practically a computer in everything, from coffee makers to vehicles, airplane engines and the human body. One of the major aims of HCI both scientific and practical section is to improve the quality of user interfaces, which is important part of quality software product [2].

For every effective result oriented academic discipline there exist a meaningful relationship among the fields that constituted that discipline. This research provides a detailed knowledge of human computer interaction architecture and the various application areas that artificial intelligence and nanotechnology has improved the efficiency of human computer interaction interfaces as the effectiveness of the field of Human Computer Interaction is highly associated with nanotechnology, artificial intelligence and beyond which shows that Human Computer Interaction is a multidisciplinary arena that draws from the fields of computer science [3] and other related areas such as psychology, cognitive sciences among other. It is a field that emphasis on innovating, evaluating and abstracting principles for the design of human usable interfaces. It equally explores the construction of novel interactive systems (i.e. hardware and software system), the evaluation and study of interactive systems in use, and the construction of theoretical understandings of those evaluations.

Human Computer Interaction is defined as a discipline that deals with the design, evaluation, and implementation of interactive computing systems for human use (Hewett, T.T. etal (1996) in [4]). Every machine (computer system) is worthless if human beings can't interact with it efficiently. The value of any computer system is centered on two essential features: functionality and usability which determines the amount of services that the computer system provides to its operators and how much useful the system is to the users respectively. The main and abiding technical focus on HCI was and still remains the concept of usability. This concept was initially articulated somewhat naively in the slogan "easy to learn, easy to use" [5] usability is a developing quality which shows the grasp as well as the scope of human computer interaction. In modern epochs, most users require additional functionality from a computer order than the "ease of use" which leads to a Spectacular growth in HCI [6] as interfaces that are highly intelligent and easily adaptive are now available. The perfect example of this can be seen in the extra-sensory perception game (ESP Game) in which paired players attempt to match descriptive tags for images, resulting in the rapid collection of human-constructed annotations for large numbers of images [7] and other modern technologies like desktop game, mobile applications among others. It extended from the popular graphical user interfaces (GUI) to include other numerous interaction techniques and devices, multi-modal interactions, tool support for model-based user interface specification, and a lot of emerging ubiquitous, handheld and context-aware interactions. Human computer interaction goes beyond its earlier focus on individual and generic user behavior to include social and organizational computing, provide easy means of access for elderly people, easy usability for cognitively and physically impaired people, and easy general computer application in the widest possible areas of human endeavors hence it is referred to as a community of communities.

ISSN No:-2456-2165

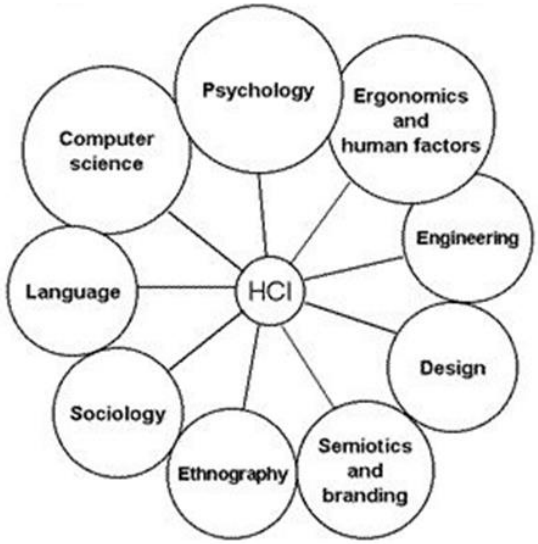

Fig.1:- HCI as Community of Communities

Nowadays, Human Computer Interaction is a wide spread and diverse community, linked by the growing theory of usability, and the immense determination to value human activities and experiences as the basic goal for technological changes.

❖ *Human Computer Interaction Architecture*

The human computer interaction can be categorized based on the number of inputs and outputs acceptable by the available interface into two categories which includes Unimodal and Multimodal interaction system respectively**.** Human computer Interaction interfaces such as Text based User Interface, Graphical User Interface, Pointer based Interface, Touch based Interface [8] uses different communication channels such as text, face gesture, body movements among others.

➢ *Unimodal Human Computer Interaction Architecture*

In a unimodal system, the interface accept only one channel of communication and strictly uses that mode in its interactions i.e. when only one means of communication is used for interacting with the computer then such computer system is said to support a unimodal Human Computer Interaction architecture. The unimodal architecture exists in three different categories which includes **Visual-Based,**

- ***Audio-Based and Sensor-Based*** *respectively.*

The visual-based unimodal architecture **is** the most widespread unimodal system that enables the user to communicate with the machine using visual movements that are visible to the system. A computer system can detect different types of visual movements such as: analysis of facial expressions, gesture recognition, tracking of body movements, tracking of eyeball movements [5] among others.

- **Visual-based unimodal** architectural designs are mainly used for manipulation of objects on the visual display unit as seen in the manipulation of an image on the screen using hand motions to select the image, scroll through parts of screen, zoom its size among others. In particular, the facial expression analysis (emotion recognition) are the facial changes in response to a person‘s internal emotional states, intentions, or social communications as can be seen in the structure of facial expression analysis architecture

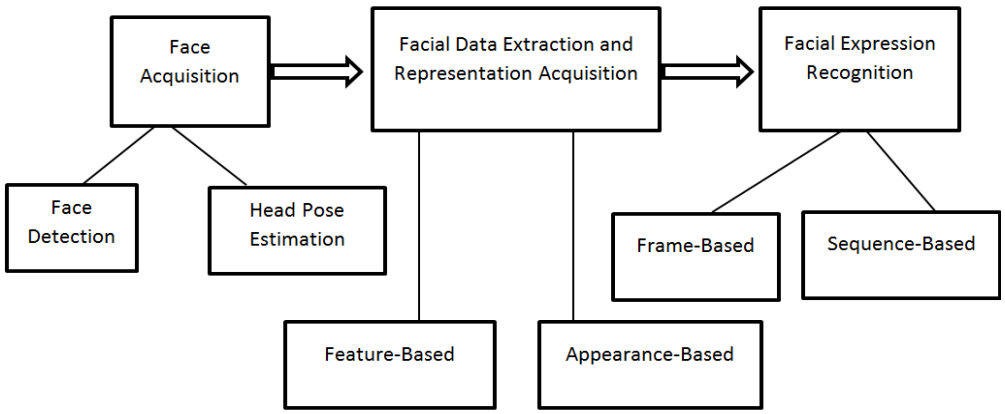

Figure 2: Automatic Facial Expression Analysis Architecture

Face acquisition is a processing phase that automatically finds the face section of the inputted image or sequences. It could be a finder to find the face for every frame or to find face in the initial frame and later trails the face throughout the video series. In order to capture a great head motion, the head finder, head tracking, and pose estimation may be used in the facial expression analysis system. When the searched face is located, the succeeding stage is to obtain and show the facial changes caused by the facial expressions analysis. There are two major approaches used in facial feature extraction for expression analysis and they include: geometric-based approach and appearance-based approach. In the geometric-based approach, the facial features show the shape and locations of facial structures such as mouth, eyes, brows, and

ISSN No:-2456-2165

nose. The facial structural points are pulled out to produce the feature vector which denotes the face geometry while in the appearance-based approach, image filters, such as Gabor wavelets, are used on either the whole-face or specific regions in a face image to generate the feature vector. In line with the type of facial feature extraction methods used, the effects of the in-plane head rotation and diverse scales of the faces can be detached by face normalization which took place earlier than the feature extraction or at feature representation earlier than the step of expression recognition. Facial expression recognition is the final phase of automatic facial expression analysis (**AFEA**) schemes.

- **Audio-Based** unimodal Human Computer Interaction architecture enables the user to communicate with the computer system through speech as input. This communication medium offers greater dependable source of correct information than the visual-based architecture. This architecture differentiates the system users based on their speech where it recognizes the action to be executed on different speech by matching speech with lip motions to yield a greater precise operation used to analyze emotions such as the state of anger, sadness, neutral, happiness among others for the purpose of developing intelligent human computer interaction system. For instance a speech recognizer implements two significant operations which include signal modeling and pattern matching. Signal modeling is the translation of speech signal into a set of parameters. It contains four principle activities which include spectral shaping, feature extraction, parametric transformation, and statistical modeling. Spectral shaping refers to the technique of translating speech signal from sound pressure wave to a digital signal; and highlighting significant frequency modules of the given signal. Spectral shaping comprises of two fundamental processes which include digitization i.e. the process by which analog speech signal changes from sound pressure wave to digital signal; and digital filtering i.e. highlighting vital frequency parts of the given signal.

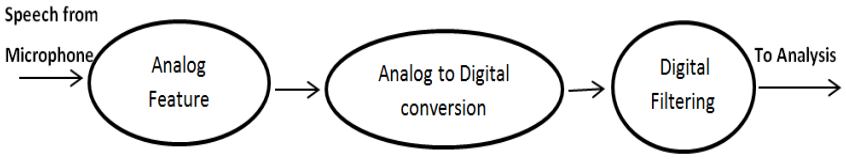

Figure 3: spectral shaping

- **Sensor-based** human computer interaction architectures are progressively becoming an important component in the design of user interfaces. This architecture has a minimum of one physical sensor that interfaces the operator with the computer to offer an improved communication interface. It might be a pen-based, joysticks, keyboard and mouse, motion tracking sensors and digitizers, haptic sensors, pressure sensors among others.

➢ *Multimodal Human Computer Interaction Architecture*

The Multimodal interaction offers the user with more than one channel of communicating with the computer order than the normal keyboard and mouse used for inputting data into the system. The commonest among those interfaces uses several channels such as visual, audio and sensor based channels.

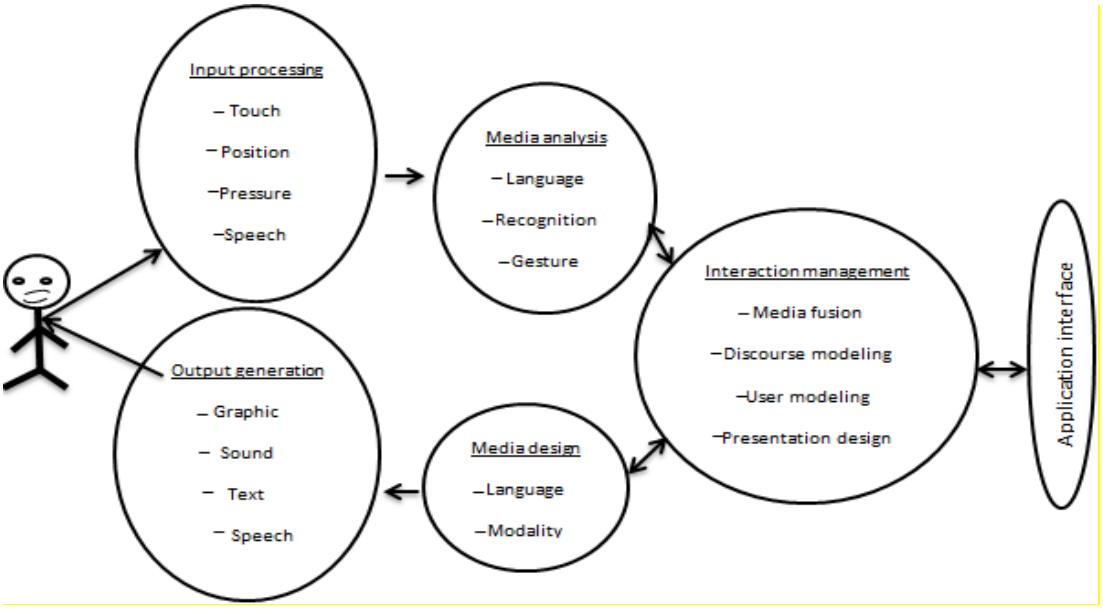

Fig 4:- Architecture of Multimodal Human Computer Interaction

The multimodal architecture in figure 4 shows a situation where users interfaces with the system through diverse communication channel which was processed in media analysis and interaction management phases to produce the expected outputs.

II. THE IMPACT OF ARTIFICIAL INTELLIGENCE ON HUMAN COMPUTER INTERACTION

The current wide spread usage of Interactive Systems (Dialog Systems) has attracted a lot of attention because of its ultimate goal of transforming the current systems into real intelligent systems that can communicate with users effectively and naturally. To design and implement an intelligent and user friendly human machine interface for any kind of software or hardware oriented application requires the in-depth knowledge of artificial intelligence. Artificial Intelligence (AI) is the emulation of human intellectual abilities by computers. These abilities include learning (to acquire knowledge with the rules of applying the knowledge), reasoning (applying the rules to attain appropriate decisions) and self-correction [9]. All multimodal Human Computer Interaction interfaces requires the capacity to learn and reason in order to obtain a valid inference from its set of inputs. In fact with time, the computer's role in our lives would be a lot more rather our life would be of the artificial intelligence [10]. This is due to the fact that there are many notable instances of successful intelligent interactive systems that make user interfaces more effective and easier for people to use. The impact of AI in HCI will make user interfaces smarter and less frustrating to use by different users [11]. Artificially intelligent user interface (UI) design have a minimum of five important characteristics of design principles which includes problem-solving, agency, speculation, sense-making and reflection.

- As stated earlier gesture is a well-known mode of interaction on mobile devices such as smart phones or tablets leading to the integration of its usability into the interface between humans and machines in modern time. The impact of AI in HCI brought about the realization of a dynamic hand gesture recognition interface that is proficient in detecting gestures in real-time through Machine Learning models [12].
- Another link between these two disciplines: AI and HCI is the development of brain-computer interface. A brain-computer interface (BCI) is a way of linking the brain to an external device to facilitate their direct exchange of information. It is a direct link between human brain and a computer system [13]. In this mode of communication, regulation of neuroelectrical activity or brain activity as a response to sensory stimulation is used to substitute or enhance lost or impaired function i.e. BCIs capture neural activities from external stimuli or mental tasks, without any connection with nerves and muscles and then offers another non-muscular communication Wolpaw, J.R. etal (2002) in [14]. The interpreted brain activities are directly transformed into sequence of commands to perform a specific task such as controlling wheel chairs, home appliances, robotic arms, speech synthesizer, computers and gaming applications. The brain-computer interface is one of the highly significant technologies as it enable users to capture their ideas into words, images or even video in real time, without the need to reconstruct them with software, access information and data from the Internet on the fly, upload their memories, have a cognitive AI assistant to aid in decision making and task management [15]. This technology helps the disabled people to easily interact with the computer system with negligible level of complications.

Figure 5: Quadriplegic woman controlling robot arm with her mind [15]

- Another area where AI has impacted positively on human computer interaction was the design of situated intelligent agents that can interact with users effectively and naturally across diverse tasks by merging speech, natural language processing and human-computer interaction together [16].

III. THE IMPACTS OF NANOTECHNOLOGY ON HUMAN COMPUTER INTERACTION

Nanotechnology deals with materials and systems whose structures and components shows a novel and meaningfully improved physical, chemical, and biological properties, phenomena, and processes due to their nanoscale size [17]. These are the technologies that deal with the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale.

- The influence of nanotechnology in human computer interaction was noted in the development of systems that allows medical practitioners to use tiny, painless needles for monitoring patient's medical condition or receiving health information from patients without necessarily looking at the screen as seen in the work that explores the convergence of micro- and nanotechnology, wearable sensors and actuators for human computer interactions [18]. This research "Wearable Human Interface Devices Using Micro-Needles," lead to the development of current

methods of medical self-monitoring and interesting means to receive information without looking at the screen which serve as impending boon for distraction-free driving, immersive gaming among others. This technology leads to the creation of flexible and wearable needle-type electro-tactile displays that could be embedded in human body for efficient information transmission to users through tactile sensation. This device is normally wear around wrist region for sending tactile information and feedback to a user which provide the patients with new means of capturing critical medical information in the comfort of their home. One of such critical information is the timely measurement of medications effectiveness by patients.

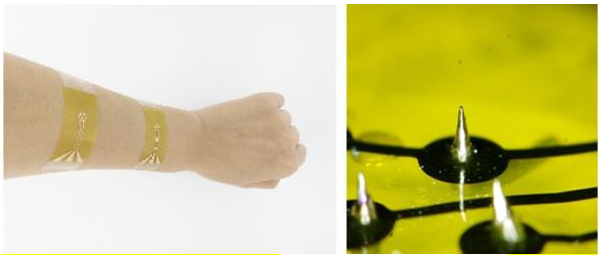

Fig 6:- Wearable micro-needle devices

- Another impact of nanotechnology was felt in the construction of a device that creates an intuitive experience where users are able to interact with invisible self-organizing atoms through a magnetic force feedback interface. This intuitive installation raises public awareness of nanotechnologies by showing how complex and intricate interactions of atoms are on a nano-scale level. This design was facilitated using Nanotechnology, Self-organization in Complex system, and Human Computer Interaction Systems [16] particularly the haptic user interfaces that often rely on force-feedback systems to create a strong sense of reality and immersion when users interact with virtual objects.

IV. CONCLUSION

The impacts of artificial intelligence and nanotechnology in Human Computer Interaction reviews some massive improvements in the way people interacts with their computers ranging from making the interfaces smarts to direct connection from brain to the computers. Proper harmonization of these fields will eliminate the difficulties of using computer by most people as interaction will be based purely on multimodal architecture and people will communicate with the computer without any form of restriction and difficulties most especially the physically challenged persons.

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