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Human Computer Interfacing Using Eye Gazing and Movements

V. Geetha[1*] , R. Akshaya[2]

[1]Department of computer science, STET Women's College, Mannargudi, India
[2]M.Sc., Computer science, STET Women's College, Mannargudi, India

Corresponding Author: kkmannaig@gmail.com

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***Abstract*—**Eye gaze is staring at the face of others to examine and see what they\'re staring at and to signal interest in interacting. it\'s a nonverbal behaviour wont to convey or exchange info or specific emotions while not the utilization of words. The important aspect of this paper is to give the basic idea of Human Computer Interaction (HCI). The outline of this paper includes the introduction of what exactly are these HCI Systems, current existing systems and recent developments in the field, most common frameworks or architectures used in the design of HCI systems that may include unimodal and multimodal modes, and the applications of HCI.

***Keywords*—**Human, Computer, Interaction, eye, gaze.

I. INTRODUCTION

Eye gaze is staring at the face of others to examine and see what they\'re staring at and to signal interest in interacting. it\'s a nonverbal behaviour wont to convey or exchange info or specific emotions while not the utilization of words.

Mistreatment computers often have sealed the approach for interfacing that had lead in human strategies for interacting to a good extent. Furthermore vital factor is that new styles of systems seem a lot of and more each day and therefore the analysis during this space augmented speedily within the previous couple of decades.

The growth in Human-Computer Interaction (HCI) field has not solely been in quality of interaction, it\'s conjointly fully fledged completely different branching in its history.

Rather than planning regular interfaces, varied analysis branches had completely different specialise in the ideas of multimodality instead of uni-modality, intelligent adaptation interfaces instead of command/action primarily based ones, and ultimately active instead of passive interfaces.

II. HUMAN COMPUTER INTERFACING

A Sometimes called as Man-Machine Interaction, concept of Human-Computer Interaction/Interfacing (HCI) was automatically represented with the emerging of computer. Basic reason behind it is almost clear because sophisticated machines are worthless unless until they are used properly by men. This simple argument presents the important aspects that should be considered in the design of HCI i.e., functionality and usability [1].

Ultimate purpose of why a system is intended are outlined by what the system will do i.e., however the functions of a system will facilitate towards the action of the aim of the system.
Functionality of a system is outlined by the set of actions or services that it provides to its users. However, the worth ofpracticality is visible only if it becomes attainable to be expeditiously utilized by the user [2].

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Usability of a system with a definite functionality is the scope and extent by which the system is able to be used resourcefully and sufficiently to achieve assured goals for certain users. The real effectiveness of a system is achieved when there is an appropriate balance between the functionality and usability of a system [3].

Having these ideas in mind and considering that the terms laptop, machine and system square measure usually used interchangeably during this context, HCI may be a style that

ought to manufacture a match between the user, the machine and therefore the needed services so as to attain a precise performance each in quality and optimality of the services [4]. Determinant what makes a precise HCI style smart is usually subjective and context dependant. The out there technology may conjointly have an effect on however differing kinds of HCI square measure designed for identical purpose. One example is mistreatment commands, menus, graphical user interfaces (GUI), or computer game to access functionalities of any given laptop.

Motivation behind HCI Systems: Interaction between humans and computers is often restricted to writing on a keyboard or inform and clicking the push button. This kind of interaction is extremely unnatural for humans since human-human interaction is often supported multi-modal interaction. People with physical disabilities will do several things with their eyes that they might otherwise do with their hands. Simply by staring at management keys displayed on a pc monitor screen, the user will perform a broad kind of functions together with speech synthesis, environmental management, causing emails, browsing the net, enjoying games, typing, and dominant most laptop and mack computers. This paper discuss the appliance of eye movements to user interfaces each for analyzing interfaces, measure usability, Associate in Nursing gaining insight into human performance and as an actual management medium among a human-computer dialogue, the attention movements don't have an effect on the interface inreal time. As an on the spotmanagement medium, the attention movements are obtained Associate in Nursing employed in real time as an input to the user-computer dialogue.

They might be the only real input, usually for disabled users or hands-busy applications, or they may be used joined of many inputs, combining with mouse, keyboard, sensors, or alternative devices.

The advances created in last decade in HCI have nearly created it not possible to appreciate that thought is fiction and that is and might be real. The thrust in analysis and also the constant twists in selling cause the new technology to become accessible to everybody in no time. However, not all existing technologies are accessible neither reasonable by public. during this paper an outline of the technology that additional or less is accessible to Associate in Nursingd utilized by public that beside an outlook of the direction to that HCI analysis is heading has been drawn.

III. EXISTING HCI TECHNOLOGIES

A HCI style ought to take into account several aspects of human behaviours and wishes to be helpful. the present interfaces take issue within the degree of quality each as a result of degree of functionality/usability and therefore the money and economical facet of the machine in market.

In style of HCI, the degree of activity that involves a user with a machine ought to be completely thought. The user activity has 3 completely different levels:

- Physical facet determines the mechanics of interaction between human and pc.

- Cognitive facet deals with ways in which users will perceive the system and move with it.

- Affective facet may be a more modern issue and it tries not solely create to form the interaction an agreeable expertise for the user however additionally to have an effect on the user in a very means that make user still use the machine by dynamic attitudes and emotions toward the user [1].

The focus of this paper is mostly on the advances in physical aspect of interaction and to show how different methods of interaction can be combined (Multi-Modal Interaction) and how each method can be improved in performance (Intelligent Interaction) to provide a better and easier interface for the user. The existing physical technologies for HCI basically can be categorized by the relative human sense that the device is designed for. These devices are basically relying on three human senses: vision, audition, and touch [1]. Input devices that rely on vision are the most used kind and are commonly either switch-based or pointing devices. The switch-based devices are any kind of interface that uses buttons and switches like a keyboard.

The pointing devices examples are mice, joysticks, touch screen panels, graphic tablets, trackballs, and pen-based input. Joysticks are the ones that have both switches and pointing abilities. The output devices can be any kind of visual display or printing device. The devices that rely on audition are moreadvance devices that usually need some kind of speech recognition [5]. These devices aim to facilitate the interaction as much as possible and therefore, are much more difficult to build. Output auditory devices are however easier to create. Nowadays, all kind of non-speech [6] and speech signals and messages are produced by machines as output signals. Beeps, alarms, and turn-by-turn navigation commands of a GPS device are simple examples.

The most difficult and costly devices to build are haptic devices [7]. “These kinds of interfaces generate sensations to the skin and muscles through touch, weight and relative rigidity [1].” Haptic devices are generally made for virtual reality or disability assistive applications. The recent methods and technologies in HCI are now trying to combine former methods of interaction together and with other

advancing technologies such as networking and animation. These new advances can be categorized in three sections: wearable devices [8], wireless devices [9], and virtual devices [10].

The technology is improving so fast that even the borders between these new technologies are fading away and they are getting mixed together. Few examples of these devices are: GPS navigation systems, military super-soldier enhancing devices (e.g. thermal vision, tracking other soldier movements using GPS, and environmental scanning), radio frequency identification (RFID) products, personal digital assistants (PDA), and virtual tour for real estate business. Some of these new devices upgraded and integrated previous methods of interaction. As an illustration in case, there is the solution to keyboarding like *Canasta keyboard* as shown in figure 1. This is a virtual keyboard that is made by projecting a QWERTY like pattern on a solid surface using a red light. Then device tries to track user's finger movement while typing on the surface with a motion sensor and send the keystrokes back to the device.

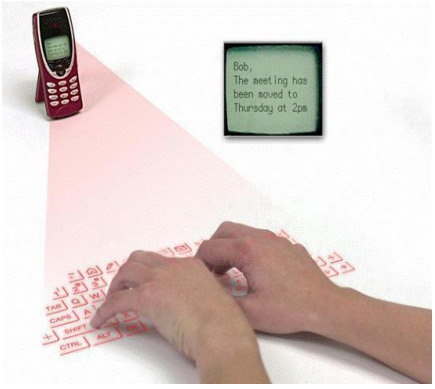

Fig 1: Canesta Virtual Keyboard

IV. RECENT ADVANCES

Below are a unit the recent directions and advances of analysis in HCI, specifically intelligent and adaptive interfaces and present computing, area unit given. These interfaces involve totally different levels of user activity: physical, cognitive, and heart.

A. Intelligent and adaptive HCI

Although the devices employed by majority of public area unit still some reasonably plain command/action setups victimisation not terribly refined physical equipment, the flow of analysis is directed to style of intelligent and adaptive interfaces. the precise theoretical definition of the idea of intelligence or being sensible isn't far-famed or a minimum of not publically agreeable. However, one will outline these ideas by the apparent growth and improvement in practicality and value of recent devices in market.

As mentioned before, it's economically and technologically crucial to form HCI styles that offer easier, a lot of pleasant and satisfying expertise for the users. to appreciate this goal, the interfaces have gotten a lot of natural to use daily. Evolution of interfaces in note-taking tools could be a example. 1st there have been typewriters, then keyboards and currently bit screen pill PCs that you simply will write victimisation your own handwriting and that they acknowledge it modification it to text and if not already created, tools that transcript no matter you say mechanically thus you are doing not have to be compelled to write in the slightest degree.

One necessary consider new generation of interfaces is to differentiate between victimisation intelligence within the creating of the interface (Intelligent HCI) or within the manner that the interface interacts with users (Adaptive HCI).

Intelligent HCI styles area unit interfaces that incorporate a minimum of some reasonably intelligence in perception from and/or response to users. Adaptive HCI styles, on the opposite hand, might not use intelligence within the creation of interface however use it within the manner they still act with users. Let us see associate degree example that uses each intelligent and adaptive interface could be a PDA or a pill computer that has the handwriting recognition ability and it will adapt to the handwriting of the logged in user thus to boost its performance by memory the corrections that the user created to the recognised text.

Finally, another issue to be thought-about regarding intelligent interfaces is that the majority non-intelligent HCI style area unit passive in nature i.e. they solely respond whenever invoked by user whereas final intelligent and adaptive interfaces tend to move interfaces. the instance is wise billboards or advertisements that gift themselves consistent with users' style.

B. Ubiquitous computing and ambient intelligence

The latest analysis in HCI field is remarkably omnipresent computing (Ubicomp). The term which frequently used interchangeably by close intelligence and pervasivecomputing, refers to the last word strategies of human-computer interaction that's the deletion of a desktop and embedding of the pc within the surroundings so it becomes invisible to humans whereas encompassing them all over thence the term close.

The idea of omnipresent computing was initial introduced by Mark Weiser throughout his tenure as chief individual at engineering science workplace in Xerox PARC in 1998. His plan was to imbed computers all over within the surroundings and everyday objects so folks may act with

several computers at constant time whereas they're invisible to them and wirelessly human activity with one another.

Omnipresent computing has additionally been named the Third Wave of computing. the primary Wave was the mainframe era, many of us one pc. Then it absolutely was the Second Wave, one person one pc that was referred to as laptop era and currently omnipresent computing introduces several computers one person era. Figure a pair of shows the foremost trends in computing.

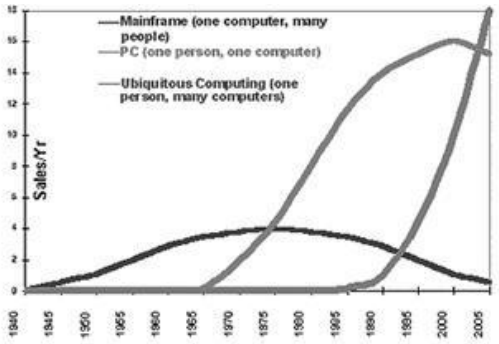

Figure 2: Major trends in computing [11]

V. FRAMEWORK OF BASIC HCI SYSTEM

A Most important issue of a HCI style is its configuration. In fact, any given interface is usually outlined by the amount and variety of inputs and outputs it provides. Design of a HCI system shows what these inputs and outputs area unit and the way they work along. Following sections make a case for completely different configurations and styles upon that associate degree interface is predicated.

A. Unimodal HCI systems

As mentioned earlier, associate degree interface primarily depends on variety and variety of its inputs and outputs that square measure communication channels that modify users to move with laptop via this interface. Every of the various freelance single channels is termed a modality. A system that's supported only 1 modality is termed unimodal. Supported the character of various modalities, they'll be divided into 3 classes:

1. Visual-Based
2. Audio-Based
3. Sensor-Based

The next sub-sections describe each category and provide examples and references to each modality.

1) *Visual based HCI:*The visual based mostlyhuman pc interaction is perhaps the foremost widespread space in HCI analysis. Considering the extent of applications and form of open issues and approaches, researchers tried to tackle completely different aspects of human responses which might be recognized as a visible signal. A number of the most analysis areas during this section are as follow:

- Facial Expression Analysis
- Body Movement Tracking (Large-scale)
- Gesture Recognition
- Gaze Detection (Eyes Movement Tracking)

While the goal of every space differs as a result of applications, a general conception of every space is often ended. Face expression analysis typically deals with recognition of emotions visually. Body movement pursuit and gesture recognition square measure typically the most focus of this space and may have totally different functions however they're principally used for direct interaction of human and pc in a very command and action state of affairs. Gaze detection is generally associate degree indirect kind of interaction between user and machine that is generally used for higher understanding of user's attention, intent or focuses in context-sensitive things. The exception is eye pursuit systems for serving to disabilities during which eye pursuit plays a main role in command and action state of affairs, e.g. pointer movement, blinking for clicking. It's notable that some researchers tried to help or perhaps replace alternative sorts of interactions (audio-, sensor-based) with visual approaches. As an example, lip reading or lip movement pursuit is thought to be used as associate degree potent aid for speech recognition error correction.

2) *Audio based HCI:* The audio primarily basedinteraction between a laptop and a personality's is another vital space of HCI systems. This space deals with info no inheritable by totally different audio signals. whereas the character of audio signals might not be as variable as visual signals however the knowledge gathered from audio signals will be additional trustable, helpful, and is a few cases distinctive suppliers of data. Analysis areas during this section will be divided to the subsequent parts:

- Speech Recognition
- Speaker Recognition
- Auditory Emotion Analysis
- Human-Made Noise/Sign Detections (Gasp, Cry, etc.)
- Musical Interaction

Historically, speech recognition and speaker recognition are the most focus of researchers. Recent endeavours to integrate human emotions in intelligent human pc interaction initiated the efforts in analysis of emotions in audio signals. Aside from the tone and pitch of speech information, typical human audible signs like sigh, gasp, and etc helped feeling analysisfor planning a lot of intelligent HCI system. Music generation and interaction may be a terribly new space in

HCI with applications in art business that is studied in each audio- and visual-based HCI systems.

3) *Sensor based HCI:* This section may be acombination of form of areas with a good vary of applications. The commonality of those completely different areas is that a minimum of one physical device is employed between user and machine to supply the interaction. These sensors as shown below are terribly primitive or terribly refined.

- •Pen-Based Interaction
- • Mouse & Keyboard
- • Joysticks
- • Motion Tracking Sensors and Digitizers
- • Haptic Sensors
- • Pressure Sensors
- • Taste/Smell Sensors

Some of these sensors are around for a short while and a few of them are terribly new technologies. Pen-Based sensors are specifically of interest in mobile devices and are associated with pen gesture and handwriting recognition areas. Motion following sensors/digitizers is progressive technology that revolutionized flick, animation, art, and video-game trade. They are available within the kind of wearable textile or joint sensors and created computers way more able to move with reality and human able to produce their world just about. Figure three depicts such a tool. Perception and pressure sensors are of interest for applications in artificial intelligence and computer game. New automaton robots embrace many perception sensors that build the robots sensitive and aware to the touch. These kinds of sensors are employed in medical surgery application. A couple of analysis works are done on space of style and smell sensors; but they're not as fashionable as different areas.

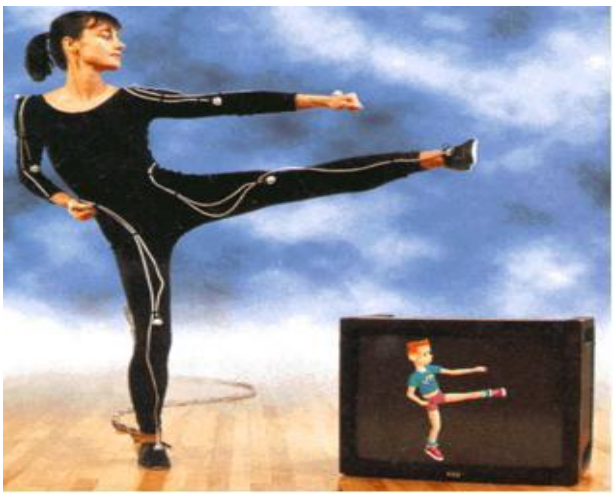

Figure 3: Wearable motion for Capturing Live Motion in Real Time

B. Multimodal systems

The term multimodal refers to combination of multiple modalities. In MMHCI systems, these modalities principally ask the ways in which the system responds to the inputs, i.e. communication channels. The definition of those channels is familial from human forms of communication that square measure essentially his senses: Sight, Hearing, Touch, Smell, and Taste. the chances for interaction with a machine embody however aren't restricted to those sorts.

Therefore, a multimodal interface acts as a supporter of human-computer interaction via 2 or a lot of modes of input that transcend the standard keyboard and mouse. the precise range of supported input modes, their sorts and therefore the approach during which they work along could vary wide from one multimodal system to a different. Multimodal interfaces incorporate completely different combos of speech, gesture, gaze, facial expressions and different non-conventional modes of input. one amongst the foremost unremarkably supported combos of input ways is that of gesture and speech.

Although a perfect multimodal HCI system ought to contain a mixture of single modalities that move correlatively, the sensible boundaries and open issues in every modality oppose limitations on the fusion of various modalities. In spite of all progress created in MMHCI, in most of existing multimodal systems, the modalities square measure still treated on an individual basis and solely at the top, results of various modalities square measure combined along. the rationale is that the open issues in every space square measure however to be formed that means that there's still work to be done to accumulate a reliable tool for every sub-area. Moreover, roles of various modalities and their share in interaction aren't scientifically celebrated. "Yet, folks convey multimodal communicative signals in an exceedingly complementary and redundant manner. Therefore, so as to accomplish a human-like multimodal analysis of multiple input signals no heritable by completely different sensors, the signals cannot be thought-about reciprocally severally and can't be combined in an exceedingly context-free manner at the top of the supposed analysis however, on the contrary, the computer file ought to be processed in an exceedingly joint feature area and consistent with a context-dependent model. In apply, however, besides the issues of context sensing and developing context-dependent models for combining multi sensory info, one ought to address the dimensions of the desired joint feature area. Issues embody giant spatial property, differing feature formats, and time-alignment."

An interesting side of multimodality is that the collaboration of various modalities to help the recognitions. as an example, lip movement chase (visual-based) will facilitate speech recognition ways (audio-based) and speech

recognition ways (audio-based) will assist command acquisition in gesture recognition (visual-based). Future section shows a number of applications of intelligent multimodal systems.

VI. APPLICATIONS

Multimodal interfaces can offer a number of advantages over traditional interfaces. For one thing, they can offer a more natural and user-friendly experience. Some of applications of multimodal systems are listed below:

- Smart Video Conferencing
- Intelligent Homes/Offices
- Driver Monitoring
- Intelligent Games
- E-Commerce
- Helping People with Disabilities

In the following sections, some of important applications of multimodal systems have been presented with additional details.

A. Multimodal systems for disabled people

One sensible application of multimodal systems is to deal with and assist disabled individuals (as persons with hands disabilities), which require other forms of interfaces than standard individuals. In such systems, disabled users will perform work on the laptop by interacting with the machine exploitation voice and head movements. Figure four is AN actual example of such a system.

Figure 4: Gaze detection pointing system for people with disabilities

Two modalities square measure then used: speech and head movements. Each modalities square measure active unendingly. the top position indicates the coordinates of the pointer in current time moment on the screen. Speech, on the opposite hand, provides the required data regarding the that means of the action that has to be performed with associate object hand-picked by the pointer.

Synchronization between the 2 modalities is performed by scheming the pointer position at the start of speech detection. this can be chiefly because of the very fact that in the method of saying the whole sentence, the pointer location may be rapt by moving the top, and so the pointer may be inform toalternative graphical object; furthermore the command that should be consummated is appeared within the brain of a personality's in a very short time before starting of phrase input. In spite of some decreasing of operation speed, the multimodal assertive system permits operating with pc while not exploitation normal mouse and keyboard. Hence, such system may be with success used for hands-free laptop management for users with disabilities of their hands.

B. Multimodal human robot interface applications

Similar to some map-based interfaces, human-robot interfaces typically need to offer mechanisms for inform to specific locations and for expressing operation-initiating requests. As mentioned earlier, the previous sort of interaction is well accommodated by gestures, whereas the latter is best accommodate by speech. Thus, the human-robot interface designed by the military service science lab (NRL) ought to return as no surprise. NRL's interface permits users to purpose to a location whereas speech "Go over there". in addition, it permits users to use a personal organiser screen as a 3rd attainable avenue of interaction, that might be resorted to once speech or hand gesture recognition is failing. Another multimodal human-robot interface is that the one designed by Interactive System Laboratories (ISL), that permits use of speech to request the golem to try and do one thing whereas gestures might be accustomed purpose to things that square measure stated by the speech. One such example is to raise the golem, "switch on lightweight the sunshine" whereas inform to the light. in addition, in ISL's interface, the system might elicit clarification from the user once unsure regarding the input.

C. Multimodal HCI in medicine

By the first Nineteen Eighties, surgeons were getting down to reach their limits supported ancient strategies alone. Human hand was impossible for several tasks and bigger magnification and smaller tools were required. Higher preciseness was needed to localize and manipulate among little and sensitive elements of the organic structure. Digital robotic neuro-surgery has come back as a number one answer to those limitations and emerged quick because of the large enhancements in engineering, engineering and neuro-imaging techniques. Artificial intelligence surgery was introduced into the surgical space. State University of part Instrumentation, University of ruhe (Germany) and Harvard

school of medicine (USA) has been functioning on developing man-machine interfaces, adaptive robots and multi-agent technologies meant for neuro-surgery. The neuro-surgical automaton consists of the subsequent main components: associate degree arm, feedback vision sensors, controllers, a localization system and an information process centre. Sensors give the operatingsurgeon with feedbacks from the surgical website with period imaging, wherever the latter one updates the controller with new directions for the automaton by victimization the pc interface and a few joysticks. Neuro-surgical artificial intelligence give the flexibility to perform surgeries on abundant smaller scale with much higher accuracy and preciseness, giving access to little corridors that is totally necessary once a surgical process is concerned.

VII. CONCLUSIONS

Human-Computer Interfacing is major side in systems style. Quality of system depends on however it's delineate and employed by users. Therefore, tremendous quantity of attention is paid to higher styles of HCI. The new direction of analysis is to interchange common regular ways of interaction with intelligent and natural ways.

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