



MULTI MODEL INTERACTION TECHNIQUES FOR UNIVERSAL DESIGN AND ITS APPLICATIONS

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Abstract—A person's interaction with the outside world occurs through information being received and sent: input and output. In an interaction with a computer, the user receives information that is output by the computer, and responds by providing input to the computer – the user's output becomes the computer's input and vice versa. Universal design is a designing system for Human computer Interaction, which can be used by anyone in any circumstance. In the late 1990s, a group at North Carolina State University in the USA proposed seven general principles of universal design. These were intended to cover all areas of design and are equally applicable to the design of interactive systems. This paper gives the basic principles to develop Universal Design, discusses about the Multi Model Interaction used for Universal Design and also the real world applications of Universal Design.

Keywords— Human Computer Interaction, Multi model Interaction, Sensory channels, Universal Design, User disabilities.

I. INTRODUCTION

Universal design is the process of designing products so that they can be used by as many people as possible in as many situations as possible. In our case, this means particularly designing interactive systems that are usable by anyone, with any range of abilities, using any technology platform. This can be achieved by designing systems either to have built in redundancy or to be compatible with assistive technologies. Universal Design means designing a new system for diversity including people with different ages, people with sensory, physical or cognitive impairment and people with different background and cultures.

II. PRINCIPLES OF UNIVERSAL DESIGN

There are seven principles to be followed to develop universal designs.

Principle - I is “*equitable use*”. This principle states that the design is useful to people with a range of abilities and is attractive to all users. All types of users should be included and the same access should be given to all. If required, privacy, safety and security should be available to all users.

Principle - II is “*flexibility in use*”. This principle states that the design should allow for a range of preference and ability by providing a choice of methods of use and also adapt to the user's custom, pace and precision.

Principle – III is the system be “*simple and intuitive to use*”, regardless of the knowledge, experience, language or level of concentration of the user. The design needs to support the user's expectations and accommodate different language and literacy skills. It should be very simple and it should be organized to facilitate access to the most important areas. It should provide prompting and feedback as far as possible.

Principle – IV is “*perceptible information*”. This principle states that the design should provide effective communication of information regardless of the environmental conditions or the user's abilities. Information can be redundant and can be represented in different forms or modes like verbal, graphic, touch, text. Essential information should be emphasized and differentiated clearly from the peripheral content. Presentation should support the range of devices and techniques used to access information by people with different sensory abilities.

Principle – V is “*Error tolerance*”. This principle states that this is used to minimize the impact and damage caused by mistakes or unintended behavior. Potentially dangerous situations should be removed or made hard to reach. Potential

hazards should be shielded by warnings. Systems should fail safe from the user's perspective and users should be supported in tasks that require concentration.

Principle – VI is “*low physical effort*”. This principle states that the systems should be designed to be comfortable to use, minimizing physical effort and fatigue. The physical design of the system should allow the user to maintain a natural posture with reasonable operating effort. Repetitive or sustained actions should be avoided.

Principle – VII is the “*size and space for approach and use*”. This states that the placement of the system should be such that it can be reached and used by any user regardless of body size, posture or mobility. Important elements should be on the line of sight for both seated and standing users. All physical components should be comfortably reachable by seated or standing users. Systems should allow for variation in hand size and provide enough room for assistive devices to be used.

III. MULTI MODAL INTERACTION FOR UNIVERSAL DESIGN

The Multi model Interaction is providing access to information through more than one mode of interaction, which is an important principle of universal design.

There are five senses used for Human interaction namely sight, sound, touch, taste and smell. Sight is the predominant sense for the majority of people, and most interactive systems consequently use the visual channel as their primary means of presentation, through graphics, text, video and animation. Sound is also an important channel, keeping us aware of our surroundings, monitoring people and events around us, reacting to sudden noises, providing clues and cues that switch our attention from one thing to another. Touch, too, provides us with an important information: tactile feedback forms an intrinsic part of the operation of many common tools – cars, musical instruments, pens, anything that requires holding or moving. It can form a sensuous bond between individuals, communicating a wealth of non-verbal information. Taste and smell are often less appreciated when compared with the above three senses but they also provide useful information in daily life like checking if food is bad, detecting early signs of fire, noticing that manure has been spread in a field, pleasure.

a. Sound

Sound is an important multi model interaction to usability. The experimental evidence suggests that the audio confirmation of modes, when added in the form of changes in key clicks, reduces many errors. Another important evidence is Video games, since the experts have a possibility to score less well when the sound is turned off than when it is on. The users the Video game picks up vital clues and information from the sound while concentrating their visual attention on different things. The dual presentation of information, which has sound and vision supports universal design, by enabling access for users with visual and hearing impairments respectively. More widespread effective use of sound in the interface would alleviate the problems faced by visually impaired people. There are two types of sound namely speech and non-speech.

Speech

Human beings have a great and natural mastery of speech and makes it difficult to appreciate the complexities. But it's an easy medium for communication. The structure of the Speech consists of mainly three parts namely Phonemes, Allophones and Morphemes.

The Phonemes of the speech are basic atomic units and they sound slightly different depending on the context they are in. These are larger units and there are 40 types of phonemes. The Allophones represent all the sounds in the language and depending on the analysis of language used, and the regional accent, there are between 120 and 130 allophones. These allophones can in turn be formed into *morphemes*. The Morphemes are the smallest unit of language that has meaning. Morphemes can be either parts of words or whole words, and they are built into sentences using the rules of grammar of the language.

The other terminologies used for Speech are Prosody, Co-Articulation, syntax and semantics. The Prosody represents an alteration in tone and quality. These show variation in emphasis, stress, pauses and pitch. These provide more meaning to the sentence. The Co-Articulation gives the effect of context on the sound. It Transforms the phonemes into allophones. The Syntax represent the structure of a sentence and the Semantics describes the meaning of the sentence.

Non-Speech

Non-Speech sound are used to provide transitory information, such as indications of network or changes in system or indication of errors. It can also be used to provide status information on back-ground processes, since the users are able to ignore continuous sounds but still respond to changes in those sounds. The two alternatives of Non-speech sounds are the Auditory Icons, which occur naturally in the world and Earcon, which uses more abstract generated sounds.

- i. **AuditoryIcon** : This uses natural sounds to represent different types of objects and actions in the interface. For example, a glass breaking noise is different from a hollow pipe being tapped. In the SonicFinder, auditory icons are used to represent desktop objects and actions. In SonicFinder, a folder is represented by a papery noise, and throwing something in the wastebasket is identified by the sound of smashing.
- ii. **Earcons** : This is an alternative to using natural sounds and it devises synthetic sounds. This Earcon use structured combinations of notes, called motives, to represent actions and objects. These motives varies according to different rhythm, volume, pitch, scale and timbre. The two types of earcon are Compound and Family Earcon. The Compound earcons combine different motives to build up a specific action. Family earcons represent compound earcons of similar types. Examples of compound Earcon are combining the two motives file and create. Examples of Family Earcon is the combination of different errors are put in a single error family.

b. Touch

Touch is the only sense that can be used to both send and receive information for Multi model Interaction. Haptic interaction is referred as the use of touch in the interface. Haptics is a generic term relating to touch. Haptics can be roughly divided into two areas namely cutaneous perception, which is concerned with tactile sensations through the skin and kinesthetics, which is the perception of movement and position. An example of the cutaneous perception is the vibration on the skin and for kinesthetics is force feedback.

c. Handwriting Recognition

Handwriting is another communication mechanism which we are used to in day-to-day life. There are various technologies used for recognition of Handwriting. Digitizing Tablet is the major technology which is used to capture handwriting. The Handwriting consists of complex strokes and spaces. The strokes are transformed into a sequence of dots or coordinates. The Rapid movements produce widely spaced dots, in comparison with slow movements. The Larger Tablets can be used, which are more suitable for digitising maps and technical drawings. Tables are also available as smaller devices, some incorporating thin screens to display the information. Example is PDAs such as Palm Pilot, tablet PCs. The problems in using these devices are personal differences in letter formation, co-articulation effects, etc.

d. Gesture Recognition

Gesture Recognition can be used to control the computer with certain movements of the hand. It would be advantageous in many situations where there is no possibility of typing, or when other senses are fully occupied. This could also support communication for people who have hearing loss, if signing could be translated into speech or vice versa. Gesture is user dependent and it is subject to variation and co-articulation. The technology for capturing gestures is very expensive, which uses either computer vision or a special data glove. The benefits of Gesture recognition are natural form of interaction and it uses pointing device, it enhances communication between signing and non-signing users. The disadvantage of Gesture recognition are user dependent, variable and issues of coarticulation.

IV. APPLICATIONS OF UNIVERSAL DESIGN

The Universal Design can be designed for diversity including for the people with physical, sensory, cognitive impairment, people of different ages and also for people of different cultures and backgrounds.

TABLE 1 : APPLICATIONS OF UNIVERSAL DESIGN BASED ON TYPES OF USERS

S.NO	TYPE OF UNIVERSAL DESIGN	USER/FACTOR	APPLICATIONS
1.	Design for people with disabilities	Visual impairment	<ul style="list-style-type: none"> ❖ Image Enhancement application - Brighter, Bigger and Super Vision Tablet/Smart Phone perform different types of image enhancements, image magnification and image stabilization ❖ Global applications - overTHERE is a free iPhone application which guides blind pedestrians for quick and easy access to accurate location information about businesses and other points of interest in the world.
		Hearing impairment	<ul style="list-style-type: none"> ❖ Gesture recognition – This is used to enable translation of signing to speech or text, again to improve communication particularly with non-signers

			❖ Captioning audio content is used to make audio files easier and more efficient to index and search
		Physical impairment	❖ Eyegaze system is used to track eye movements to control the cursor
			❖ Keyboard driver that can be attached to the user's head to control the cursor
		Speech impairment	❖ Reactive keyboard is used to anticipate the commands that are being typed and offering them for execution.
			❖ Speech synthesis are used to reflect natural conversation and responses can be pre-programmed and selected using a single switch.
Dyslexia	❖ Predictive algorithms can be used to anticipate the words used and fill them in, to reduce the amount of typing required.		
		Dyslexia	❖ Color coding information can be used to support textual that can make the meaning of text much easier.
		Autism	❖ Consistent navigation structure and clear signposting cues can be used for people with dyslexia.
2.	Design for different age groups	Older people	❖ Computers plays a major role to play in education of children with autism, particularly by enabling them to experience the various social situations and learn the appropriate responses from them.
		Children	❖ Email and instant messaging provides social interaction in the case of the absence of mobility or any speech difficulties, which reduce face-to-face possibilities
3.	Design for people with cultural differences	Older people	❖ Mobile technologies can be used to provide memory aids where the older age people have a problem of memory loss
		Children	❖ Interfaces that provides multiple modes of input, including touch or handwriting, may be easier for children than standard devices like keyboard and mouse.
		Language	❖ Redundant displays, can be used so that the information is presented through text, graphics and sound will also enhance their experience
		Symbol	❖ Layouts and designs can be used as one of the Universal design that reflect a language read from left to right and top to bottom, but this is not suitable for the languages that do not follow this pattern.
		Symbol	❖ Symbols have different meanings in different cultures.
		Gesture	❖ For example in some culture, ticks and crosses represent positive and negative respectively and are interchangeable in others.
		Color	❖ Gestures do not specify the same meaning.
		Color	❖ For example, an Indian student shakes his head if he understands the lecture but other country student does not give the same gesture.
			❖ Colors represent different meaning in different countries.
			❖ For example red represents life (India), happiness (China) and royalty (France) and Green is a symbol of fertility (Egypt) and youth (China) as well as safety (Anglo-American).

V. CONCLUSION

The Universal Design is used to design a product which can be used by anyone in any circumstance. In this paper, the principles of Universal Design has been discussed. The Multi model Interaction plays an major role in Universal design and different types of Multi model Interaction is also described in this paper. We had also listed out the different types of Universal design based on the types of Users and their applications in the real world.

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